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## Editorial

### Dear authors, reviewers, and readers

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to **THE VOL-7, ISSUE-11 of IJIER** which is scheduled to be published on **30<sup>th</sup> November 2019**.

International Journal for Innovation Education and Research (IJIER) is an open access, peer-reviewed and refereed multidisciplinary journal which is published by the International Educative Research Foundation and Publisher (IERFP). IJIER aims to promote academic interchange and attempts to sustain a closer cooperation among academics, researchers, policy makers and practitioners from a wide range of disciplines, which contribute to state of the art in science, education, and humanities. It provides a forum for the exchange of information in the fields mentioned above by welcoming original research papers, survey papers, and work-in-progress reports on promising developments, case studies, and best practice papers. The journal will continue to publish high-quality papers and will also ensure that the published papers achieve broad international credibility.

The Chief Editor, appointed by the Associate Editors and the Editorial Board, is in charge for every task for publication and other editorial issues related to the Journal. All submitted manuscripts are first screened by the editorial board. Those papers judged by the editors to be of insufficient general interest or otherwise inappropriate are rejected promptly without external review. Those papers that seem most likely to meet our editorial criteria are sent to experts for formal review, typically to one reviewer, but sometimes more if special advice is needed. The chief editor and the editors then make a decision based on the reviewers' advice.

We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

**Thanks,**

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# **Proposals for Reducing Damage Caused by Dams Collapse in Pitinga - Amazonas**

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## **Abstract**

*Mining is an extractive activity that interferes with the economic, environmental and social environment. Thus, its intrinsic characteristic is locational rigidity, environmental transformation and the generation of social and environmental risks. Thus, this study aimed to present in the literature what is the best mitigating measure to be adopted in order to try to reduce the impacts on possible collapses in the Pitinga tailings dams in the Amazon. From this study it can be stated that among the 29 dams located in the State of Amazonas, 8 are from ore tailings and are located in the municipality of Presidente Figueiredo, in the Pitinga region, as regards supposed risks of a disaster, the perceived scenario in Minas Gerais can hardly occur, since the tailings dams have a natural containment because they are built in valleys. However, in order to reduce damage and prevent possible collapse in ore enterprises, it is essential that mitigation measures are used to compensate for environmental damage caused by the practice of ore extraction.*

**Keywords:** Mining; Extractive activity; Collapse; Compensation;

## 1. Introduction

Dams are high geotechnical structures created by individuals, and for millennia have been built by mankind for various purposes and purposes, according to the need of each location where it is located, such as power generation, water storage and control. ore tailings, among others [1].

The tailings dam is a structure produced for the mining tailings stock and is identified as a residue from the separation of ore from the rock deposited in the dam. With the development of the need for social and environmental preservation and mineral exploration, the theme of mining tailings dams has been reaching prominence, due to its damaging capacity in case of failures [2].

In the state of Amazonas there are 38 registered dams, of these 8 dams are intended for the mining sector. Only at the Pitinga mine in Presidente Figueiredo does a dam present a high risk, according to the National Mining Agency [3]. Thus, the issue of safety of Pitinga tailings dams has been presented as a public concern.

It has been observed in recent years, a huge amount of accident episodes that have occurred in the ore tailings dams, can be cited the rupture of large dams such as Mariana and Brumadinho, both in the state of Minas Gerais, which resulted in ore tailings dam disasters with fatalities, unprecedented in the history of Brazil.

Thus, this study aims to show what would be the possible environmental damage, caused by a disaster in an ore tailings dam in, and what would be the mitigating measures for likely collapses in the tailings dams in Pitinga in the Amazon.

## 2. Theoretical Foundation

### 2.1 Definition and Characteristics of Ore Dams

It is an extractive activity that produces many interferences in the social, economic and environmental environments. If, on the one hand, the characteristics of mining mark the economic evolution, on the other hand the negative impacts and consequent damages of the mineral exploration cannot be forgotten. Mining contributes to the creation of numerous direct and indirect jobs, precisely by offering raw material for various types of industry. After all, what would be the vehicle assembly industries without steel, glass and petroleum derivatives, materials that come directly from mining. It is precisely this indirect relationship with other industries that makes mineral extraction one of the main sources of job creation [4].

By observing the characteristics of mining it is possible to identify its peculiarities about the activities developed. However, the mineral enterprise enables the operation of capitals, lighting, automobiles, household appliances, food already prepared for consumption, health institutions, schools, among others. An important point is that the Amazon mining that increases the demand for mineral goods and, consequently, their prices, encouraging the search for new deposits [5].

To follow a dam analysis pattern, it is necessary to determine some important points regarding the source of the tailings. Mining represents a set of steps aimed at obtaining essential substances, found in their natural state, to be verified and appropriate to their final destination. With these characteristics, the



transformation of resources into economic goods will only occur when technology is part of the mining of discovered ores [6].

## 2.2 Brief History of Pitinga Ore District

Vila de Pitinga is a village located in the municipality of Presidente Figueiredo, 320 kilometers from Manaus, in the direction of Boa Vista (RR, BR174), in the state of Amazonas. It has approximately 2,500 inhabitants, being founded from the beginning of the Pitinga, a mineral exploration sector in which minerals are extracted, the main products are: niobium, iron, alloy, tantalum and tin and belongs to the mining company Taboca [7]. In Figure-1, the location map of the Pitinga mining district is presented.

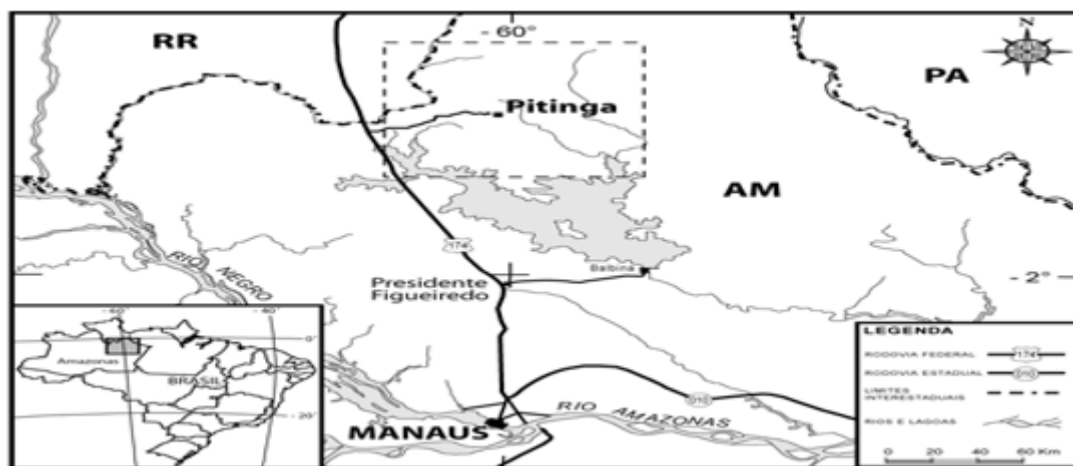


Figure 1 - Location map of the Pitinga mining district.

Source: Prado et al. (2007).

The existing ores in the mining district of Pitinga were unveiled in 1979 by the Mineral Resources Research Company (CPRM). Subsequently, exploration began through the Taboca S.A. Mining and in the late 1980s, the primary ore related to good water and Madeira granites was discovered [8].

Mining Taboca S / A was founded in 1969, characterized as the pioneer in metallurgy and tin mining in Brazil, also identified as the third largest tin manufacturer in the world. It has joined Minsur since 2008, has its own mine, its own Mining works are carried out at the Pitinga mine (Presidente Figueiredo-AM), working at the site, currently 2,000 employees [7].

In the Amazon Region itself, the company created an urban-industrial complex for education, health, housing, telecommunications and energy, making the Pitinga mine one of the most prominent industrial projects in the country. In Pitinga, the columbite and cassiterite ores are processed and mined.



In Figure-2, the Taboca Mining Crushing and Concentration site is highlighted.

Source: Google Earth (2019).

### 2.3 Types and Locations of Pitinga Ore Dams

According to information from the Amazonas Environmental Protection Institute (IPAAM) (2019), the state of Amazonas currently has 38 dams under the Dam Safety Law, including those for aquaculture, electricity, and mining. Among these dams, 8 are mining and are located in the Pitinga region and belong to the company Mineração Taboca SA, which operates in the exploration of Primary Tin Ore and set up in the group introduced in the National Dam Safety Policy (PNSB) [9] .

In Table-1, some information about the Pitinga Mining Dams is presented.

Table 1: Main Pitinga Dams

Dam Name	Name of the entrepreneur:	Locality	Main Ore
0-1	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
103 (Cross)	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
111 (Indian)	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
158 (A-1)	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
161 (A-2)	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
444 (A-3)	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
81-1	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore
Pau D'Arco	Taboca S.A Mining	Presidente Figueiredo	Primary Tin Ore

Source: National Mining Agency (2019).

### 2.4 Imminent Risks in Tailings Dams

The disaster that occurred at the Brumadinho ore tailings dam in the state of Minas Gerais on January 25, 2019, by Companhia Vale SA, has raised concerns about the risks of rupture of other dams throughout Brazil, in the mining areas. ores, including those located in the village of Pitinga.

According to information provided by [9], if ore dams disruption occurs in Pitinga, the environmental impacts may be greater than in Brumadinho (MG), due to its factory, geographical layout and containment methodology. , be different. Since the Amazonian plain is totally at sea level, while the Minas Gerais plain was a totally mountainous place.

The constructive form used in the ruptured dams is upstream, the method where the tailings grow by steps made with the tailings itself over the initial dike, while the method used at the Pitinga mine is downstream, where the tailings only grow over it. same, towards the waste stream, which improves the stability of the structure, considered safer [9].

According to [3], among the eight tailings dams in Pitinga, seven are classified as type C, have low risk category and medium potential damage, only Dam 158-A1 has presented high associated potential, presenting risks of disruption.

According to [3] Dam 158-1 A1 is currently 30 meters high, a volume of 53,380,000.00 m<sup>3</sup> and is classified as Type B, which are dams that present a high risk or potential damage category and whose anomalies if present, they must be controlled, monitored and interventions may be implemented over time to maintain safe conditions.

Dam construction techniques are at the center of technical-scientific discussions, however, based on the new disruptions related to these containment works, they must respond to the requirements of environmental protection and safety, in addition to being part of the production process.

In Figure-3, the methods of construction of tailings dams are presented.

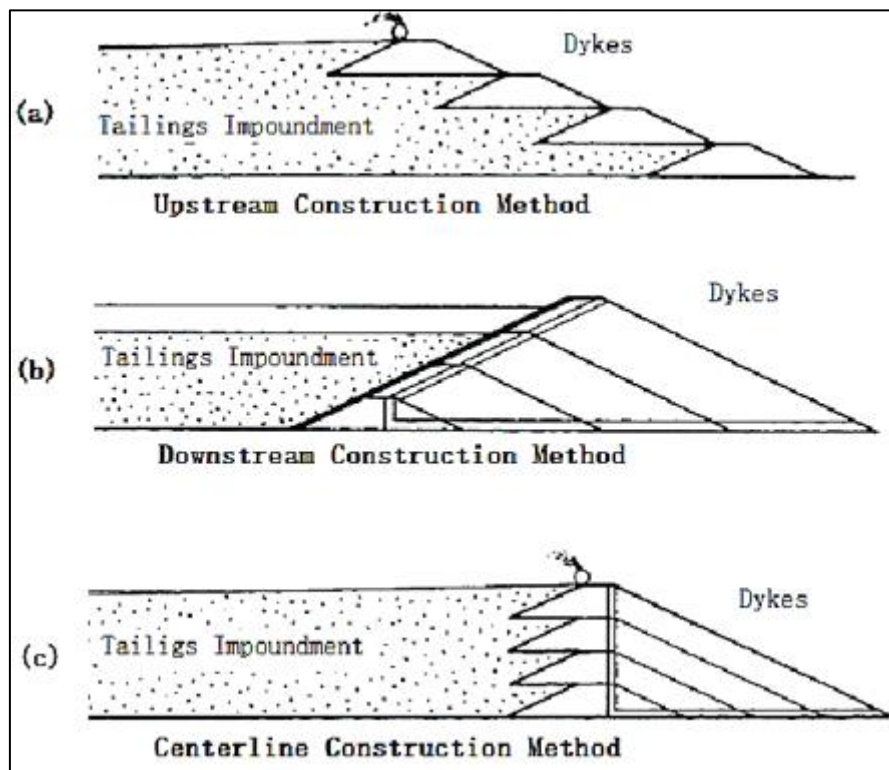


Figure 3- Methods of construction of tailings dams

Source: [21]

## ***2.5 Dam Safety Legislation***

The Law no. 12,334 of September 20, 2010, which established the National Dam Safety Policy (PNSB) aims to ensure compliance with safety standards, regulate, promote monitoring and monitor the safety actions employed by those responsible for dams, in order to reduce the possibility of accidents and their consequences, especially for the potentially affected population [10]. In compliance with this law, resolutions and ordinances were established, such as:

CNRH Resolution No. 143, of July 10, 2012, establishes general criteria for classifying dams by risk category, associated damage and reservoir volume.

Resolution No. 144, of July 10, 2012, establishes guidelines for the implementation of the National Dam Safety Policy, the application of its instruments and the performance of the National Dam Safety Information System.

Resolution No. 13, of August 8, 2019, establishes regulatory measures aimed at ensuring the stability of mining dams, notably those built or raised by the method known as "upstream" or by method declared as unknown and other measures.

Resolution No. 4 of February 15, 2019, which establishes precautionary regulatory measures to ensure the stability of mining dams, the standard prohibits the use of the method of construction or elevation of mining dams called "upstream" throughout the national territory. .

Ordinance No. 14, of January 15, 2016, establishes deadline for presentation of proof of delivery of physical copies of the Mining Dam Emergency Action Plan (PAEBM) to municipal and state governments and civil defenses.

Ordinance No. 70,389, of May 17, 2017, creates the National Register of Mining Dams, the Integrated Management System for Mining Dams Safety and establishes the periodicity of execution or updating, the qualification of the responsible technicians, the minimum content level of detail of the Dam Safety Plan, Regular and Special Safety Inspections, the Periodic Dam Safety Review and the Mining Dams Emergency Action Plan.

## ***2.6 Mitigating Measures for Environmental Impacts***

### ***2.6.1 Preventive Mitigation Measure***

It is based on a measure that aims to reduce or eliminate adverse events that are capable of causing damage to environmental components evidenced in the physical, anthropic and biotic environments. It is widely used to precede episodes of negative impact [11].

According to Law no. 12.334, which established the National Dam Safety Policy (PNSB) the preventive measures are:

- Keep Dam Safety Plan up to date
- Conduct Periodic Dam Safety Reviews
- Perform Regular and Special Dam Safety Inspections
- Preventive Emergency Action Plan in the event of a claim.

### ***2.6.2 High Precision Laser (Trueline)***

According to [12], TrueLine is a device that is positioned in front of the structure to be monitored, would

be on inert ground, outside the busbar area, and would read multiple points in the structure of a dam. This gives you accurate information about the dam's stability and safety in real time 24 hours a day.

TrueLine generates a database of positions different from the monitored points. The analysis of the data collected by the artificial intelligence of the software goes through the behavior processing of the structures, indicating irregularities that may be occurring in the dams. These are sent to the cloud through reports, data, graphs and instantaneous values about the current behavior of structures, and can be accessed from anywhere, facilitating the user's access through computers or smartphones.

In addition, TrueLine combines weather data, date and time, and position readings of targets installed on the dam, providing true interpretations of structural safety status [12].

In Figure-4, the TrueLine equipment is presented.



Figure 4- TrueLine Equipment Illustration

Source: EPTV Reproduction, 2019.

### 2.6.3 Brazil Ozon

Brazil Ozone is a company that has developed a 100% clean technology that treats water contaminated by heavy metals, such as iron and manganese, the same residues found in the tailings dam of the Córrego do Bean Mine, through the transformation of oxygen from air in ozone. The idea is to treat contaminated water so that it can be returned to the rivers without harming the environment, as well as reducing the pressure on the dam so that it is not overloaded, minimizing the risk of rupture.

Ozone is a corrective treatment in these tailings, oxidizing the heavy metals that are diluted in water, allowing the filtration of these materials. This makes it possible to treat water by removing the waste and returning it to nature without risk to the ecosystem. All dams should have a water treatment system so as not to overload the structure [13].

In Figure-5, the illustrative method of ozone treatment is presented.

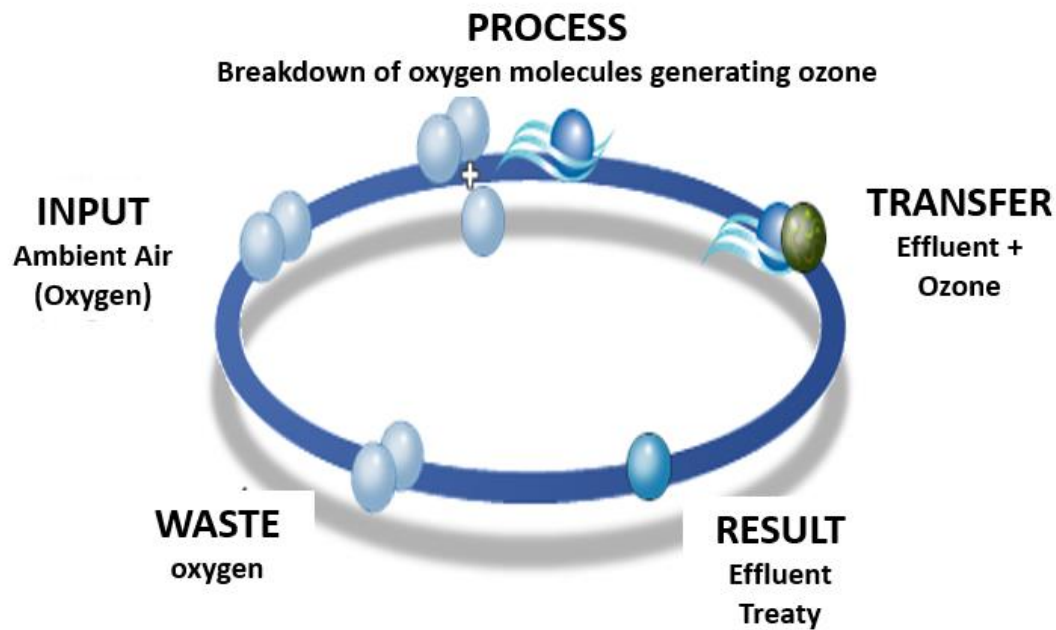


Figure 5- Ozone treatment process.

Source: Brasil Ozone Company, 2019.

A survey by the World Commission on Dams determines that for good mitigation, it is important to have a good phase of information, cooperation, from the beginning of environmental analysis, between dam designers, ecological and affected population, monitoring systematic, and analysis suffers from the effectiveness of mitigation measures [14].

### 3 Methodology

The development of this qualitative bibliographic research was divided into 3 phases, which were: general qualitative research, where articles were explored with the descriptors: Definition and Characteristics of Mineral Dams and data were collected from the National Dam Information System [15]. Restrictive selection occurred through the analysis of reports in the responsible bodies such as: National Confederation of Municipalities (CNM) [16], Brazilian Institute of Mining (IBRAM) [17], and in the body responsible for the supervision of Pitinga the Institute of Environmental Protection of Amazonas (IPAAM) [18].



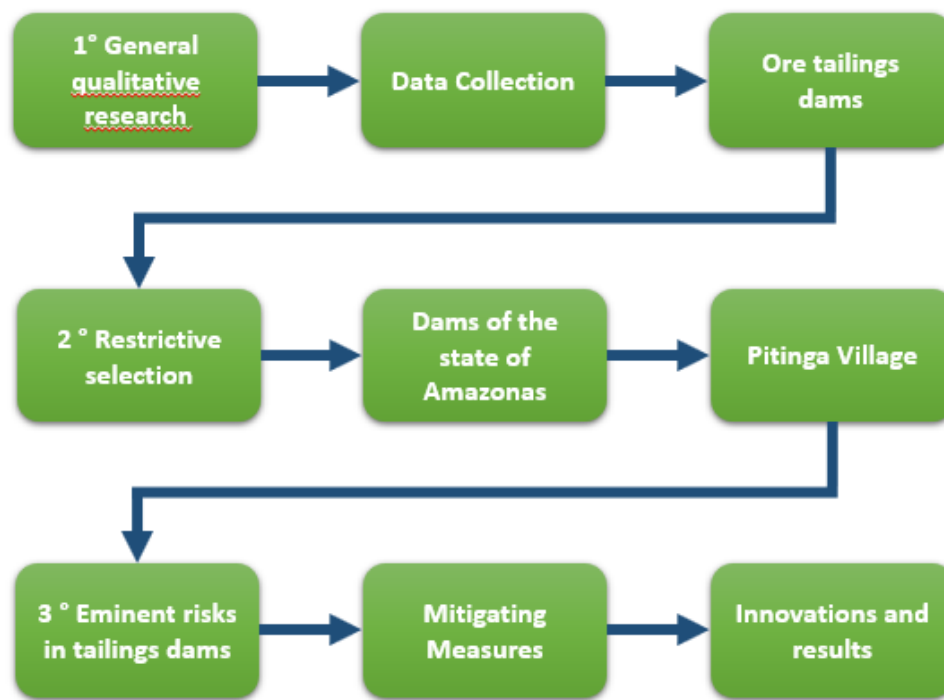


Figure 6- The flowchart of the methodology of this study is presented.

Source: Own Authorship (2019).

Observing the imminent risks on the website of the National Mining Agency (ANM) [19], mitigating measures proposed by (ANM) were presented, and the new technologies found to prevent collapse of ore tailings dams. Thus showing the best mitigation measure to be adopted to try to reduce the impacts on possible collapses in the Pitinga tailings dams in the Amazon.

## 4 Results and Discussion

From the development of this study, it can be seen that there are some factors that contribute to the collapse of tailings dams. Rico (2008) [20], states that dams become more vulnerable to rupture due to a number of particular characteristics, among the factors that can be cited are: the landfills formed by area-origin fillings (coarse waste, soil); overload of tailings operations; phases of dam elevation to withstand the growth of tributary and stored solid material and stability of dams that require successive control and monitoring during the implementation, construction and development of activities.

In the event of a possible breach of the 158-A1 dam, all existing material would reach the environment like a gigantic wave of mud, with magnesium iron, copper and other substances that will be agglomerated with the clay, creating a virtually non-existent oxygen mud.

Figure 7- The possible affected areas are shown if the 158-A1 dam rupture occurs.





Figure 7- Areas of influence of Mineiro tailings dams in Pitinga.

Source: Adapted from Google Maps (2019).

In the event of the dam's disruption, as the project is a potential hazard, environmental impacts may occur throughout the region. Thus, there is a need for an analysis that configures and evaluates the impacts caused by the rupture of the Pitinga dams, which may affect downstream communities, water bodies, the Uatumã Sustainable Development Reserve Units and the Uatumã Biological Reserve. Vila Waimiri, both in the area of influence of the Balbina Hydroelectric Power Plant.

The preventive mitigating actions follow the procedures of execution of each stage of the dam, accompanying any and all signs that the dam may present, especially in its technical aspects. Investments in new technologies covered in 2.6.2 and 2.6.3 provide reports on the dam's stability and real-time safety, as well as the analysis of disease control or progression. Therefore, it is recommended to perform integrated mitigation measures, which will provide preventive solutions in the Pitinga Ore Tailings Dams.

## 5. Final Considerations

It is understood that the failed methods in the inspection of the Ore Tail Dam in Mariana and Brumadinho result not only from the constructive method being the most risky, but also from the neglect of the responsible company, with poor safety and health management, and the inefficient system of the bodies that regulate and supervise the dams in the state of Minas Gerais.

Due to these disasters, the Government of the state of Amazonas convened a delegation with the presence of the Amazon Environmental Protection Institute (IPAAM) and the National Mining Agency (ANM), in February 2019 to visit and assess the risk categories, and potential damage associated with the disruption

levels of all Taboca Mineradora tailings dams in Pitinga.

The environmental problems resulting from mining reinforce the need to analyze the management of appropriation of assets found in nature. It can also be said that there are permanent impacts inherent to the activity, in the landscape and in the soil, and the environmental practice can be evidenced with a mechanism to prevent this degradation.

Given the importance of mineral extraction for the generation of direct and indirect jobs and its contribution to the national GDP caused by the development of such activities, it is stated the need to discuss the proposals of new legal framework and its regulatory diploma, directing to the concern. how companies seek to reduce impacts on communities and the environment around their business.

The integrated monitoring of dams is extremely important for analyzing their conditions. Human presence is indispensable for assessing the risk of dam failure. Therefore, 100% automated monitoring is not advisable, but the integration of periodic, special inspections with technology optimizing the safety level of a dam.

However, it was noted that there is still much to be developed with regard to protection against environmental damage, so that the inspection of licensing methods is more effective, the collective and / or individual participation of the Public Administration, the Public Prosecution Service is necessary. and Judiciary Power that as supervisory and responsible bodies are prevented crimes on environmental damage.

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# Water Distribution Uniformity in Dripping System Under Growing Pressures

**Jhonatan Cabrera Piazzentin; João Luis Zocoler; Camila Pires Cremasco; Alfredo Bonini Neto; Luís Roberto Almeida Gabriel Filho**

## Abstract

*Increasing water use efficiency in agricultural systems is critical as it results in economic and environmental cost reductions, especially in localized irrigation, which depends on a number of factors, especially the flow rate of the emitters and proper uniformity of water distribution, both with respect to direct with the pressure of the emitters. For this evaluation the use of coefficients of water uniformity, it is essential to indicate the best wetness management. The experiment was carried out in the Irrigation laboratory, in a test stand, using Christiansen uniformity coefficient - CUC, distribution uniformity coefficient - CUD and statistical uniformity coefficient - CUE. In the irrigation line, four pressures on the drip emitter (5, 10, 15 and 20 mca) were applied. The pressure variations obtained did not reduce the efficiency of the uniformity of water distribution by the drip system, falling into high efficiency ranges for all evaluated coefficients, representing adequate wetting rates.*

**Keywords:** self-compensating dripper; water distribution efficiency; localized irrigation;

## 1. Introduction

The use of irrigation techniques, especially localized irrigation, requires the application of evaluations that may indicate the efficient use of water by the system (uniformity of water distribution), which brings, among other benefits, lower cost of energy use or even reduction in environmental impact.

Uniformity of water distribution is an essential evaluation in localized irrigation systems, both in the initial phase of the project and in post-implementation performance [1], which is reinforced by the growth of areas irrigated by this system.

Several factors are responsible for the reduction or lack of uniformity in water distribution in localized irrigation systems, such as: pressure difference in the drip line, due to the resulting pressure losses and also the terrain unevenness, variation of the hydraulic characteristics involved in the irrigation, system, obstructions, clogging, poor quality control adequacy in the manufacturing uniformity of the emitters, place of water application, or also by the flow variation in the emitters [2] and [3].

In particular, the variation in the flow rate of the emitters is a major factor in the uniformity of water distribution, since according to [4], it is dependent on manufacturing variations, total use time, pressure and temperature. Therefore, it is essential to determine the flow rate of the emitters and their uniformity,

using coefficients such as the Christiansen - CUC uniformity coefficient, which adopts the average deviation for the dispersion measurement [5] and [6].

The variation of the drip flow rate is dependent on the inlet pressure in the lateral line emitters, which is regulated by the self-compensating system, thus the emitters tend to operate within the recommended limit, with a maximum drip flow variation of 10% [7].

In addition to CUC, water distribution uniformity can be expressed by some indices, such as distribution uniformity coefficient - CUD [8] and statistical uniformity coefficient – CUE [9], most commonly used to evaluate the uniformity of water application [10]. Thus, the objective was to determine the CUC, CUD and CUE in a drip irrigation system under increasing pressures.

## 2. Material and Methods

The experiment was carried out at the Irrigation Laboratory of the Department of Rural Engineering, Faculty of Agronomic Sciences FCA-UNESP Campus Botucatu, located at coordinates 22 ° 51'10 " S and 48 ° 25'51 " W, with Cfa climate. - humid warm (mesothermal) temperate climate, with the warmest month average temperature over 22 ° C [11] (Figure 1).

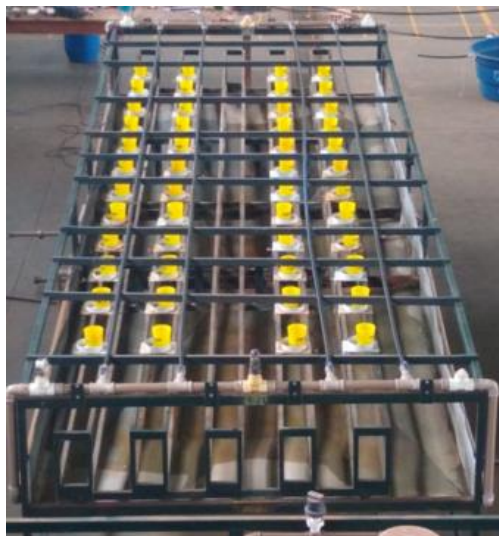


Figure 1. Irrigation Laboratory - Dripper test bench.

For dripper evaluation for CUC, CUD and CUE coefficients, the drip bench was used. This bench has a 300 liter capacity water tank and Schneider brand BC 92S AV 2CV three-phase 60 HZ 220/380 motorcycle pump set for pressurizing water through 1 ¼ inch PVC pipes with a filter. of 120 mesh discs.

The length of the lateral lines is 6m and the width 1.86 m having two air outlet valves and also two Bourdon pressure gauges (Figure 2) that were used to regulate the uniformity test pressures at 5, 10, 15 and 20 mca.



Figure 2. Bourdon type digital and analog pressure gauge.

During the dripper evaluation test, each dripper was strictly observed, so that there was no interference of flow from the connection. The flow was determined by the gravimetric method in order to obtain better accuracy in the volume measurements (ml) collected from each dripper. The volume of water emitted by the drippers was stored in collectors with a capacity of 300 ml for a period of four minutes and weighed in a FILIZOLA® precision scale as shown in Figure 3.



Figure 3. Weighing dripper uniformity test volume.

The percentages of CUC, CUD and CUE were estimated through equations (1), (2) and (3) and evaluated according to Table 1, Table 2 and Table 3 respectively.



### 2.1 Christiansen Uniformity Coefficient (CUC -%)

Such a coefficient may be expressed by the following mathematical expression:

$$CUC = 100 \left\{ 1 - \frac{\sum_{i=1}^n |x_i - x_{med}|}{n \cdot x_{med}} \right\} \quad (1)$$

where,

CUC - Christiansen uniformity coefficient (%);

n - number of samples in the lateral line;

$x_i$  - measured flow rate of each emitter ( $L \cdot h^{-1}$ );

$x_{med}$  - med - average drip flow ( $L \cdot h^{-1}$ ).

Table 1 presents the criteria for classification of the Christiansen uniformity coefficient in irrigation systems.

Table 1. Christiansen uniformity coefficient classification (CUC).

CUC (%)	Classification
> 90	Excellent
80 - 90	Good
70 - 80	Reasonable
60 - 70	Bad
< 60	Unacceptable

Source: [12].

### 2.2 Uniformity of distribution coefficient (CUD -%)

Proposed by [8], the distribution uniformity coefficient (CUD) is based on the ratio of 25% smaller experimentally measured flow values in relation to the average observed flow rates, being expressed by the following equation:

$$CUD = 100 \cdot \frac{q_n}{\bar{q}} \quad (2)$$

where,

CUD – Coefficient of distribution uniformity;

$q_n$  – Average of 25% lower flow rates values;

$\bar{q}$  – Average observed flow rates.

Table 2 presents the quantitative and qualitative classifications of the distribution uniformity coefficient.

Table 2. Classification of distribution uniformity coefficient (CUD).

CUD (%)	Classification
87-100	Excellent
75-87	Good
62-75	Reasonable
50-62	Bad
< 50	Unacceptable

Source: [13].

### 2.3 Coefficient of statistical uniformity (CUE - %)

The statistical uniformity coefficient (CUE) developed by [9] refers to the coefficient of variation of the applied water depth.

This model can be implemented for drip irrigation systems, provided that the values measured by the sprinklers are replaced by the values emitted by the emitters. Thus, the statistical uniformity coefficient can be expressed by the following mathematical equation:

$$CUE = \left(1 - \frac{\sigma}{\overline{q_m}}\right) \quad (3)$$

where,

*CUE* – Coefficient of statistical uniformity (%);

$\sigma$  – Standard deviation of the sample;

$\overline{q_m}$  – Mean observed flow rates ( $L \cdot h^{-1}$ ).

The Table 3 presents the statistical uniformity coefficient classifications.

Table 3. Classification of the statistical uniformity coefficient (CUE).

CUE (%)	Classification
90-100	Excellent
80-90	Good
70-80	Reasonable
60-70	Bad
< 60	Unacceptable

Source: [14].

## 3. Results and Discussion

The uniformity coefficients obtained by the dripper test are presented in Table 4. Four pressures (20, 15, 10 and 5 mca) were analyzed in the four lines as seen in Figure 1, seeking to verify the dripper evaluation at different service pressures.

Table 4. Dripper uniformity test under increasing pressures.

PRESSURE	LINE	CUC <sup>1</sup>	CUD <sup>2</sup>	CUE <sup>3</sup>
20	1	98,15	97,74	97,81
20	2	97,98	97,67	97,67
20	3	98,30	97,90	97,94
20	4	98,18	97,49	97,83
15	1	98,87	98,26	98,51
15	2	98,19	98,08	97,80
15	3	98,23	97,86	97,82
15	4	98,72	98,78	98,33
10	1	98,53	98,08	98,34
10	2	98,14	97,62	97,92
10	3	98,00	97,69	97,83
10	4	98,45	97,99	98,30
5	1	98,83	97,86	98,43
5	2	98,47	97,93	98,10
5	3	98,64	98,29	98,37
5	4	98,62	98,15	98,34

<sup>1</sup>Christiansen uniformity coefficient. <sup>2</sup>Efficiency of distribution uniformity. <sup>3</sup>Statistical uniformity coefficient.

The Table 5 shows the mean values resulting from each pressure in relation to the repetitions for the dripper uniformity test.

Table 5. Values of uniformity coefficients of water distribution of drippers under increasing pressures.

Pressure	CUC <sup>1</sup>	CUD <sup>2</sup>	CUE <sup>3</sup>
20	98,15	97,70	97,81
15	98,50	98,24	98,11
10	98,28	97,85	98,10
5	98,64	98,06	98,31

<sup>1</sup>Christiansen uniformity coefficient. <sup>2</sup>Efficiency of distribution uniformity. <sup>3</sup>Statistical uniformity coefficient.

For the four pressures established in the dripper test, the Christiansen uniformity coefficient (CUC) remained constant in the 98% range so in the range considered excellent according to [12]. CUC values between 84 and above 90% are considered to be adequate for irrigation systems [15] and [16].

For pressures of 10 and 20 mca the values obtained by the coefficient Uniformity of distribution (CUD) showed similar behavior, with values in the range of 97%, while for pressures of 5 and 15 mca the values are in the range of 98%.

All CUD values obtained are classified as excellent according to [13] as well as for [12] where values below 36% are considerable as unacceptable and over 84% as excellent. In addition, the CUD is the most widely used coefficient in system evaluation, as it has sensitivity, and allows better evaluation in irrigation systems considering the ratio between the lowest average quartile value and the average water depth collected [17] cited by [18]. The values observed for CUD, when low, may indicate water loss by

deep percolation, when the minimum applied blade is equivalent to the required blade, or even emitters unevenness [19] and [18].

For the pressures of 15, 10 and 5 mca, the values obtained by the statistical uniformity coefficient (CUE) presented similar behavior with values in the range of 98%, with no large variations, however, for the pressure 20 mca the behavior was in the range of 97%. % being lower than other pressures. In this work all values related to (CUE) are classified as excellent, since they are above 90% [10] and [14].

It is noteworthy that the uniformity of water distribution during the experiment remained with (CUC), (CUD) and (CUE) with values above 97%, thus being classified according to the literature as excellent [20], [21] and [12].

#### 4. Conclusion.

The pressure variations obtained did not reduce the efficiency of the uniformity of water distribution by the drip system, falling into high efficiency ranges for all evaluated coefficients, representing adequate wetting rates.

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# Preparation of a Matrix of Occupational Health and Safety Risks in a Wood Company

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## Abstract

*Logging companies are extremely important in the economy of the country, but the large number of occupational accidents is of concern in this sector. It is therefore essential to act preventively in the cause of these accidents by identifying and controlling hazards. Thus, the objective of this work was to elaborate an Occupational Health and Safety Risk Matrix in a logging plant in Criciúma - SC. To this end, the applied matrix is based on the requirements set forth in BS OHSAS 18001: 2007. As a result it was observed that the greatest risk is incorrect posture and intense physical effort, as well as noise and projection of wood residues in the eyes and skin. It was inferred that with the matrix it was possible to identify the points in which a company should seek quick solutions to minimize the risks to which its employees are subjected daily.*

**Keywords:** Loggers, matrix, accidents.

## 1. Introduction

Abundant in nature, wood is an irreplaceable resource, since the beginning, has always been within the reach of man, provided his defense, shelter and food. Planted forests follow the sustainable model of forest exploitation (VECHI & MAGALHÃES JÚNIOR, 2018). In Brazil, there are 7.84 million hectares of planted trees, which generate about 3.7 million direct and indirect jobs, besides being responsible for collecting R\$ 11.5 billion in federal, state and municipal taxes (IBA). 2017).

With the generation of so many jobs, the sector presents problems regarding job security. Souza et al. (2002) report that the wood industries present the third highest frequency coefficient of fatal accidents in Brazil, second only to mineral extraction and construction. The Digital Observatory on Health and Safety at Work set up by the Public Prosecutor's Office (MPT) in cooperation with the International Labor Organization (ILO) shows figures and statistics on occupational accidents in Brazil. According to the observatory, from 2012 to 2018 Brazil recorded about 4.2 million occupational accidents, of which 15,768 resulted in deaths. Estimates show that around R\$ 28.7 billion was spent from 2012 to 2018 on accidental benefits, including sickness benefits, disability retirement, death benefits and accident benefits. Almost 334 million working days were lost due to work accidents.

Given this scenario, the Ministry of Labor has intensified inspection in the sector, thus emerging a major concern in companies to adapt the current rules, prioritizing worker safety and obtaining safety

management systems. An example is the Occupational Safety and Health Management System (OSHAS 18001: 2007) and the mandates of Regulatory Standard 18 (NR 18), where companies need to establish measures to achieve and evidence solid and constant safety and health performance (CABRAL & RODRIGUES, 2015). This system enables any type of organization to more effectively control its occupational accident and disease risks and improve its occupational health and safety performance. One of its requirements is hazard identification, risk assessment and determination of control measures, these data can be obtained by elaborating the risk matrix. It is a useful tool for finding, storing and defining risk frequency and occurrence categories that helps in understanding the causes of occupational accidents so that action can be taken, always seeking to plan general and specific measures to prevent them.

## 2. Methodology

The research was carried out in a logging company in the city of Criciúma - SC, where technical visits were made to obtain data based on the physical arrangement of equipment and facilities. To improve the understanding of the process, the processing was divided into stages, which were the receipt of the raw material, processing of the raw material, storage and delivery of the processed wood, maintenance and cleaning, office and bathroom, in which the risks were observed. to which operators are exposed in each process.

The collected data were submitted to the analysis of which was elaborated a matrix of evaluation of risks associated to Occupational Health and Safety, whose purpose is to elaborate preventive actions prioritizing the activities that present higher risk.

### 2.1 Risk Assessment Parameters

To build the risk matrix associated with Occupational Safety and Health (OH&S), bibliographic research was performed and the model proposed by Meller (2011) and Bruch (2015) was adapted.

The first columns describe the activities performed and the agents, hazards and risks associated with it. To classify the risks, two parameters were considered: situation and incidence (Table 01).

Parameter	Classification	Symbology	Criterion
Situation	Normal	N	Routine activity
	Not normal	A	Non routine activity
Incidence	Direct	D	Direct Cause / Effect
	Indirect	I	Indirect Cause / Effect

Table 01 - Risk classification

Source: Authors (2019)

The situation is weighted to Normal (N) when activities are routine and Abnormal (A) when not associated with routine operations. The incidence may be Direct (D) when associated with the cause and effect relationship arising from the activity and Indirect (I) when associated with the cause and indirect



effect relationship and / or side effects of the activity.

To estimate the frequency at which a certain risk occurs, we used numbers from 01 to 03, as follows:

1. Sporadic: Exposure happens at most once a month;
2. Occasional: Exposure happens once or more a week;
3. Frequent: Exposure happens once or more a day;

The assessment is performed using frequency, duration, scale, duration and conduct parameters, with numerical values from 01 to 03, which are calculated and result in the significance of the risk to OHS (Table 02).

Parameter	1	2	3
Frequency	Sporadic	Occasional	Frequent
Duration	Max. 30 min.	Between 30 to 60 min.	Greater than 60 min.
Escale	Up to 3 people	4 to 10 people	Over 10 people
Conduct	Irrelevant	Relevant	Shocking

Table 02: Risk Assessment Parameters

Source: Authors (2019)

The scale parameter refers to the number of people at risk and is rated from 1 to 3; 2 - from 4 to 10; and 3 - with more than 10 of the employees exposed. The duration is represented by values from 1 to 30 minutes, 2 - between 30 to 60 minutes and 3 - over 60 minutes of the workday and indicates the exposure time of employees to risk. Conduct is associated with human behavior in the workplace. Bruch (2015) classifies it as irrelevant assigning value 1 when behavior does not interfere with worker safety during the execution of the activity, relevant (2) when worker conduct interferes with safety during the execution of the activity and Impactant (3) when the behavior It is crucial to the safety of the employee.

According to Bruch (2015), in the legislation, value 1 is assigned when there is legislation applicable to the identified risk and value 0 when none exists. Another factor analyzed is the work routine, being Routine (Value 0) for activities that occur daily in the sector, Non-Routine and Emergency (Value 1) for sporadically occurring activities or unplanned events that may cause significant incidents and damage to company personnel or infrastructure.

According to Berkenbrock (2010), the methodology for hazard identification is not standard due to differences in the production process. Each organization should carry out its own methodology, which meets the needs and characteristics in terms of detail, for these reasons not only the risk matrix, but other factors such as whether the company provides training, whether workers are trained for certain jobs, whether the use of personal and collective protective equipment (including site signage), cleaning and maintenance.

After collecting and analyzing all parameters, it is possible to calculate the probability of an occurrence, which is the number of times a hazardous situation can materialize as an accident, being the sum of the factors: exposure frequency, duration, scale, amount of exposed persons, human conduct, applicable law and routine work. The values and probability rating are low (4 to 8), medium (9 to 11) and high (12 to 14).

Another aspect to observe to analyze the risk is the severity that is defined in relation to the damage

caused due to the materialization of the risk, as follows:

Low: no personal injury, transient discomfort, minor injuries without any disability; average:

Medium: Minor occupational injury or illness with or without temporary disability, requiring medical assistance, but not on leave from work.

Discharge: Damages or serious occupational diseases, injuries with temporary or permanent disability, requiring medical assistance, with absence from work.

## **2.2 Risk assessment and classification**

Risk is the combination of the likelihood of a hazardous event or exposure occurring with the severity of the injury or disease that may be caused by the event or exposure (OHSAS 18001, 2007). It is classified according to the combination of severity and probability and forms the basis for deciding on the acceptability and controls required for risk reduction.

The higher the probability and severity, the greater the risk and the lower the probability and severity, the lower the risk. On what :

- Very Low: No intervention required, activity follows normally.
- Low: No additional risk control and mitigation measures are required.
- Moderate: Additional risk control and mitigation measures can be identified, but their implementation is conditional on cost-benefit analysis.
- High: The activity should not be started until the risk has been reduced. Control measures should be established to ensure the execution of the activity within a minimum risk of “Tolerable”.
- Not Tolerable: The activity should not be started until the risk has been reduced. Control measures should be established to ensure the execution of the activity within a minimum risk of “Tolerable”.

With the parameters properly evaluated, it was possible to analyze the risks associated with occupational safety and health.

The development of the research was elaborated through an existing method, adapted to the reality of the company and thus developed and introduced in the textile industry. The problem was related to the organization and layout to choose the appropriate final arrangement of the pilot parts. As it is a confection, it is used to follow in pilot parts, which serve as a sample of how the product should be manufactured.

Before the product is marketed, a line is developed with several product samples, which are sent to the customer. After placing the purchase orders, the customer sends only samples approved for manufacturing, which will be used as an example of the finished products. These approved samples are called pilot parts, and are important to the company during the manufacture of the product because if the batch of an order is different from the customer approved pilot part, it is cause for order disapproval and cancellation.

Over time, and due to high order demand, a large number of pilot parts were realized in stock. For in most cases, upon completion and shipment of orders, the pilot parts were left in boxes stored in the stock of raw materials. With the need for storage area, it was questioned the occupation of this space, bringing to light the decision about choosing a more suitable destination for these pilot parts. Thus, the best options for solving this problem were analyzed using the AHP method.

Based on the need for free stock space, three options have been suggested for solving this problem: disposal, sale of parts or archiving of pilot parts.

### **3. Results Analysis**

The timber production process has its risks, for a critical analysis, they were divided into activities and / or sectors, which are the receipt of raw material, processing of raw material, storage and delivery of the benefited wood, maintenance and cleaning, Office and bathroom.

In the receiving stage of the raw material the risks of being run over, breaking of the moorings and presence of venomous animals were considered moderate, as they do not occur frequently. In the company, there were no accidents with being run over, although they are not in accordance with current regulations, employees are aware of this risk and the truck has audible warning, but to avoid future accidents to the area should be delimited and signaled to performing these activities, whether by cones or color delimitation, and training of employees, especially the driver, as to the precautions that must be taken when transporting and unloading materials. Logs are well tied by employees, but there is a risk of breakage, it is recommended that the lashes be replaced when worn, the raw material arranged in the truck to prevent them from tipping over and the vehicle not to be overloaded. . Regarding the presence of venomous animals, employees reported that they have already found snakes, scorpions and spiders in the middle of the logs, but there have never been serious accidents, in which case it is indicated that the company should train employees on the associated risks and procedures to be taken. In the event of an accident and having the first-aid box available to employees, as well as the location and numbers of the hospitals and health posts near the company, which provide anti-fiduciary serum for emergency situations.

Incorrect posture and intense physical exertion to which these workers are subjected were considered non-tolerable risks, as these activities are performed incorrectly, are frequent, long-lasting and routine. Although the assistants and the driver use ankle boots, proper clothing and leather shaving gloves, the physical effort is intense and can pose serious health risks, it is advisable that the company purchase auxiliary machinery, train the employees and adopt a postural correction strap. column, both for unloading activity, as for storage, unloading and delivery of wood pieces, as they presented the same classification and are activities performed by the same employees.

In the Raw Material Processing activity, it shows that 33% of the activities presented moderate risk, and refer to the detachment of the machine saw and the incorrect operation of the chainsaw. According to employees, these risks occurred a few years ago and both caused limb amputation. The accident caused by the chainsaw was due to recklessness of the employee, who did not use the safety equipment provided by the company and did not operate the equipment correctly, the chainsaw used in the company has safety devices in accordance with NR 12 Annex V. This is due to the lack of periodic maintenance and cleaning of the machinery, which will be addressed in the next paragraphs. These activities were considered moderate, as the danger is not frequent.

In wood processing, there is noise generation and projection of saw dust into the saws' eyes and skin, so they use appropriate clothing, boot, leather shaving glove, transparent face visor, ear protector and face respirator. This risk could be low, because in addition to sawmills using personal protective equipment,

the company has an exhaust fan that aspirates the saw dust to a closed place where it is stored, but there is no cleaning and maintenance of PPE, and some already are worn and the face respirator filters are not changed periodically as instructed by the manufacturer. Another activity that accounts for 17% of the risks is the incorrect operation of various machinery, which can cause injury, cuts, limb amputation and even death. The necessary precautions for the handling of the saws are indispensable for the reduction of accidents and greater gain in productivity. The company could be regularized according to NR 12, which provides for protective measures on machines and equipment. This was the sector that was most in contradiction with the legislation, the area of circulation of the machinery sheds was not demarcated, there were also some obstructions, the harvester; tupia; thickener; The trimmer and performer do not have safety and emergency system to stop in case of failures or abnormal situations, there are no safety signs, nor instruction manuals, yet there is a lack of investments in side guards that prevent involuntary contact with the saws.

Incorrect posture and intense physical exertion of the sawmills were considered Not tolerable risk.

Stocking, unloading and delivery of the raw material was the activity that presented the highest risk, 60%, and is due to the fact that the helpers remove the wood from the mat without ear protector and face respirator, which is a routine activity, usual and long lasting. In this case, it is recommended that the company provide the appropriate personal protective equipment to the auxiliaries. At this stage, activities with moderate risk corresponded to 40% and refer to the possible breaking of the moorings and running over.

In maintenance and cleaning the results indicate that it is one with moderate risks, but it was observed in the logging that this step can not be neglected, and this is due to the fact that the maintenance of the machines and equipment is done by the sawers themselves, who do not have adequate training. In addition, the company does not have a checklist for periodic maintenance, they are made when the sawmill deems it necessary. Materials such as oils, greases and broken parts from maintenance are left in the company's own backyard and are not properly disposed of.

The office and bathroom are the areas that need little modification. The company must provide a clean and organized environment, always seeking to comply with safety standards. For the office it is recommended that the company provide postural correctors and employees take breaks of 15 minutes every 1 hour for stretching and resting the lower back.

Logging activities need further adjustments and controls, with 55% of total risks being moderate and the implementation of protective measures conditional on cost-benefit analysis. Still, 36% and 9% of the activities were classified as non-tolerable and high risks, respectively. These categories should not be started until the risk has been reduced.

## **4. Conclusion**

Small industries have greater difficulty in meeting safety standards due to the costs related to the implementation of new machinery in accordance with NR 12. Given this scenario, the risk matrix facilitates the identification of sectors / activities that need specific measures, being a great tool to assist in decision making.

With the matrix it was observed that despite the costs to adapt the machinery to the legislation, some simple and low cost measures can be taken to improve the productivity and quality of life of employees. Measures include cleanliness and environmental organization. It is suggested that the company demarcate hazardous areas, remove obstacles that may cause falls and keep the environment always clean and organized. Another simple measure refers to the maintenance step of both personal protective equipment and machinery. This step is fundamental and is not performed correctly by the company, it is necessary to adopt measures such as checklist with scheduled dates for maintenance of machinery and PPE's.

In addition, the company must not only provide PPE's but also require employees to use them, as well as appropriate and periodic training for their employees.

Therefore, it is inferred that the risk and hazard matrix is a tool for the recognition, prevention and reduction of accidents in companies, but each organization must carry out its own methodology that meets the needs and characteristics in terms of details. Therefore, it is important to analyze other factors for risk assessment, such as continuing education and training, personal and collective protective equipment, site signage, cleaning, maintenance and others.

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# Proposal for an Araçá-Boi Fruit Mead Factory in the Amazon Region

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## Abstract

*The present work is intended to present a proposal for the construction of a factory, which will produce handcrafted mead with exotic fruit from the Amazon region, Araçá-Boi. It will be shown in a very relevant way the importance in the valorization of the fruit, little used in the local cuisine, its nutrients and the commercialization of the drink in the region. The work will enable the recognition of this drink from ancient times, much appreciated in the Nordic culture, made with the fermentation in honey base, which gave rise to an alcoholic beverage, still so little explored in Brazil.*

**Keywords:** Mead Factory; Araçá-boi; Artisanal Production;

## 1. Introduction

Due to the great competition of the Brazilian beverage market, among them beer and wine, one of the most sold in all trade, thus opening new trends in the new drinks market, despite the great domination of the first places of the most consumed beverages in the country. remember other types of drinks that are consumed, such as rum, rum, whiskey and etc. Sales of these types of beverages are growing increasingly, considering wholesale and retail thus reaching high sales.

Mead is not prominent in the beverage market, with an alcohol content of 4 to 14% °GL, its main base is the ingredient honey, obtained from fermentation and diluted with drinking water. This basic process may vary depending on the addition of ingredients for better variation of the beverage, cereals and / or fruits, thus varying in color and flavors. The chemical composition of mead should comply with the limits of total acidity, fixed acidity, volatile acidity and dry extract [1].

Objective is to design a factory of Handcrafted Mead in the Amazon region, using a regional fruit the

araçá-boi, which has a bit of acidity and very nutritious. It aims to expand the beverage market for future ventures, thus bringing this market product little explored in Brazil, through market research of alcoholic beverages, and the production process and investments needed to prepare the project.

## **2. Theoretical revision**

### **2.1 Flowchart**

Flowcharts are ways of representing, through graphic symbols, the sequence of steps of a work to facilitate its analysis. A flowchart is a visual resource used by production managers to analyze production systems, seeking to identify opportunities to improve process efficiency [2]. The Flowchart makes it easy to view tasks in graphical forms to show information in clear and objective ways that the procedure can be understood in just a few small steps.

### **2.2 Gantt Chart**

The Gantt chart is a simple tool that uses horizontal bars to show which tasks can be performed simultaneously throughout the execution of the job. Activities are listed vertically, dates horizontally and duration are represented in the form of the length of the bars [2]. Understanding the graph shows the progress of the process, so that each activity must follow to reach each stage of the process, as it is widely applied by companies that seek to understand the best production process, one of the most used fermentation by engineers.

### **2.3 Factory Design and Layout**

The purpose of the factory and layout design and to develop the concepts of integrating techniques and decisions, to approach new methodologies, having to provide an integrated view of services and logistics procedures. Based on dimensions and facets, the layout types of all procedures and equipment locations can be studied to facilitate understanding of the process and impact on performance and behavior results [3].

### **2.4 Google Sketch Up**

A tool for practicing dimension studies, for floor plan projections and even volumetric objects, being a system that facilitates the spatial vision of a project, and easy to manipulate the tools, with excellent graphic performances. According to NETO, GOMES AND SOUZA (2010), an interactive computer system should allow the user's work to be facilitated by the availability of tools and resources on the monitor, which can be represented in text or icon representations.

### **2.5 Consumer Market**

A drink of undefined origin, plus the highlight of its substance made up of honey, water and yeast, has been gaining more attention in series and films of Viking and Nordic cultures, as one of the first drinks that has a history of being very popular by ancient peoples, well-known as Mead, due to its honey-based fermentation.



Archaeological data reveals that the drink consisted of wild grapes, honey and rice, the so-called wine-mead-sake, which is the oldest record of any alcohol-containing drink. Later, mead was produced in ancient Egypt, Greece, the Roman Empire, and medieval Europe. [5]

The drink has a very sweet taste, being dry, frothy and liqueur, being very easy to make, but having a very long fermentation time, to reach the required alcohol content. According to RIBEIRO JUNIOR (2015), in addition to ethanol, other important substances for the characterization of the fermented are produced, such as aromatic compounds, according to the origin of the honey, that is, the floral species where the bees collected nectar.

Current macroeconomic scenario continues to challenge Brazilians' consumption patterns and continues to compromise disposable income in most households [7]. Due to the great trend in alcoholic beverages, the diversity among beverages such as beer and wine gaining prominence in the international and national trade markets, their new versions of fruit, seeds and etc. compositions. Mead was no exception, having several recipes in its composition in order to reach new market trends, being very popular today.

Mead already attracts looks for future endeavors, as it is not a very traditional drink in the market, but being popular among young Nerd culture lovers, lovers of alcoholic and curious, assign a new substance in the drink, further grow the curiosity of try, and give a historical value of new recipes for producing this drink.

### **3. Methodology**

Approach to factory design research was done through reading articles and books related to the production process, as well as honey and Mead, having research through e-mails with Mead producers and beekeepers, on ways for preparation. the equipment and methods needed to begin small-scale artisanal production.

### **4. Study Application: Mead Production Process**

#### **4.1 Raw Material:**

##### **4.1.1 Honey**

Honey is a natural product used since the dawn of mankind in traditional medicine, having gained popularity among the Egyptians, Arabs, Greeks and other civilizations [8]. Honey is considered a viscous, aromatic and sweet fluid made from flower nectar and secretions of live parts of certain plants or excretions of plant-sucking insects, in which honey bees collect, transform, combine and mature in beehives [9]. Being a sweet made by the nectar of flowers contains its physical and chemical characteristics, a food that should be consumed every day complete and nutritious has several benefits full of vitamins and minerals, depending on its shape, honey can vary from its color, taste, consistency and time to crystallize.

##### **4.1.2 Araçá - Boi**

The guava tree is an exotic and delicious fruit and little known in the regions of Brazil, in which fruit tree

of the Western Amazon cultivated in small scale in some countries like Peru, Bolivia, Ecuador, Colombia and some North and South regions in the interior of Brazil [ 10]. The pulp is juicy and very acidic, so it is not suitable for natural consumption, being used for the preparation of juices, ice cream and jellies for the production of nectar, being very useful in mixing with low acidity fruit pulp [11]. With guinea-ox is no different, has a very good nutritional value, bringing improvements in the body, being rich in nutrients, bringing health benefits. Because it is little known, its traditional recipes are the preparation of sweets and desserts, and very few in drinks.

#### **4.1.3 Yeast**

The definition of yeast is important for the industrial sector, and is well known in the area of beverage production, for fermentation of alcoholic beverages, as they help in the production of alcohol.

#### **4.1.4 Nutrients and Energizer**

They are types of nutrients that keep fermentation active by providing nitrogen for rigorous fermentation, and energizer provides vitamins. Thus acting quickly in the production of sugar breakage for alcohol transformation. Since honey has little nitrogen, nutrients and energizer help to reduce fermentation time, thus avoiding the development of contaminating microorganism.

#### **4.2 Equipment**



Figure 01: Equipment for Craft Production

Source: BREJABOX '

- Kit Combo Equipment for home beverage production (10 Liters).
  - Digital Scale, Disc Grinder, 15 lt mashing pan with  $\frac{1}{2}$  extraction valve, Grain bag filter, 15 lt boiling pan with  $\frac{1}{2}$  extraction valve, Thermometer, Density meter, 250 ml beaker, Fermenters 12 liters with Airlock (2 units) and extraction tap, Bottle Stopper, 1 liter Glass Bottles (2 units), Auto Siphon (1 units), Silicone Tube (1 units).

#### **4.3 Production Methods**

##### **4.3.1 Determine the level of sweetness**

Mead being a beverage known as extremely sweet, its most traditional production being dry, taking into

consideration the level of sweetness cannot vary according to personal preference. Measurement at the present level of sweetness is done by scaling the densimeter, in which we determine the level of its specific gravity, relative to determining the degrees of sweetness.

- Dry: 0.998 - 1.010, Semi-dry: 1.011 - 1.020, Mild: 1.021 - 1.030, Dessert: 1.031 and above.

#### **4.3.2 Density Reading**

The densimeter is very familiar among artisan beverage producers, as it has a purpose to measure the density difference between pure water and sugar water dissolved in it. The hydrometer makes this reading floating in the liquid. To make the measurement, a plastic or glass tube is required to take samples and test to analyze the density of the liquid present, thus determining the reading. In the case of Mead, every time a density test sample is taken, it has a chance to introduce the most viable possibility of infection and to make the samples at the beginning and end of the fermentation cycle.

#### **4.3.3 Sanitation**

All materials need to be extremely hygienic, and worked with great care, as with not very clean materials, they can vary measurements and introduce possible probabilities of infection. The environment where Mead production is done needs to be very clean and places where materials will be exposed.

All material should be thoroughly washed and sanitized with clean cloths, immediately during production and good if gloves and apron are used for handling the densimeter and other equipment, so as not to contaminate external media, wash your hands with soap following the instructions. cleaning procedures on the palms and nails.

#### **4.3.4 Definition of Specific Gravity and Alcohol Content**

It is the relationship between the densities of water and honey, in which the ratio between the masses of water and honey is determined by reference to the same volume, thus assigning a fixed value, the specific density (SG) of the mixture, in this case the Mead. Specific density of mead made by the ratio of Initial Gravity (GI) by subtraction of Final Gravity (GF).

Equation 01 - Determine Specified Density of Mead.

$$SG = GI - GF$$

To determine the Alcohol Content (TA) of a drink, and to know the relationship between alcohol and sugar density, since the standard measure of how much alcohol is contained in a given volume. Mead typically being measured more specifically by specific gravity and can be calculated by the constant of 131.25 between the ratio of alcohol and sugar densities to multiply by specific gravity and thus obtain as a percentage of the alcohol content present in the fermentation of the beverage.

Equation 02 - Determine the Alcohol Content.

$$AT = (GI - GF) \times 131.25$$

#### **4.3.4 Process description**

In general, the production of Mead, having a very low complexity and considering its relevant investments to produce with quality, faces its difficulties in its production, since the fermentation time is very long until it is ready for consumption. For small-scale production it will take a lot of preparation to

serve markets in commercial areas of small and large enterprises in the city of Manaus.

The production process of Mead is very distinct, because it has a remarkable feature in its production flow, because it is discontinued in different stages, because due to its time can vary the times of honey fermentation and must preparation. There are a number of operations to perform the production segment, so if there are possibilities to do joint operations or continue, the steps follow as follows Figure (Table 01).

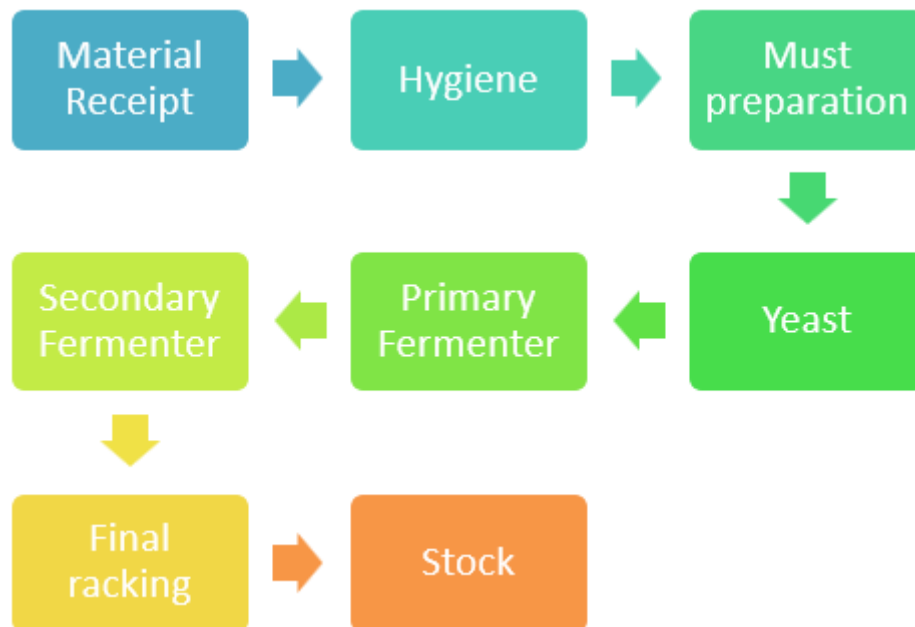


Figure 02: Flowchart of the Mead Production Process

Source: Author

#### 4.5 Production Process

The process for the production of Mead must have the minimum essential care, since a fineness to produce, due to being a craft drink, presents its risks of preparation. Sanitation of all equipment is necessary for preparation as a probability of is subject to risks of contamination.

##### 4.5.1 Receipt of Material

The process of receiving the material, is established by the division of the products that will be used in the consumption of the production from the preparation of the must and the quantity of ingredients to prepare the yeast. The remaining materials are stored in refrigerated places.

##### 4.5.2 Essential Care - Hygiene

- i. Keep your hands clean and disinfect them with gel alcohol
- ii. Wash equipment and materials that will come in contact with the mead.
- iii. Store appropriate place the juice of the guava tree
- iv. Follow the procedure carefully, to let the fermentation process act naturally.

##### 4.5.3 Must Preparation

v. Prepare equipment and materials will be used:

1. 15 liter pan
2. Sanitized Cloth
3. 12 Liter Fermenter Bucket
4. Big Elastic
5. Thermometer
6. Densimeter

In this stage the must must be prepared, since the initial mixture of the production process, we must first establish how much water, juice of the guava and honey we will use, in this case we will use 3 liters of water, 1 liter of guava juice and 1 kg of honey. Soon we will use only 1 liter of water in the first steps to boil in the preparation of the must.

First place 1 liter of water in the pan over low heat until it begins to boil, and then when water starts to show signs of steam, turn off the heat, and then add 1 kg of honey during it and also add 1 liter of the juice of guava and 2 liters of water bringing more volume, and with it mix until it dissolves the honey, thus becoming the must that is homogeneous compound.

Then proceed to let the wort cool until it reaches a room temperature, use the thermometer and then immediately take a wort sample and read Initial Gravity (GI), and note the density readings of the substance, and then put the wort already cooled in the fermenter bucket, sealing with the clean cloth and securing it with a rubber band to await the preparation of the yeast.

#### **4.5.4 Yeast Preparation**

saw. Prepare equipment and materials will be used:

1. Digital scale
2. Thermometer

The preparation of yeast and the process of the ability to break down sugar into alcohol, making transformation of the prepared must to perform the fermentation faster for consumption. This step takes a lot of use of the digital scale to determine the amount needed to prepare yeast, for this reaction to react in the mixture, and to be able to achieve what we are aiming for.

vii. Quantity prepared:

1. 50 g of hot water
2. 2.5 g of fermenter (Nutrients)
3. 2.0 g of ICV-D47

First we must mix the amount of hot water with fermenter, so mix until it dissolves, and allow to cool to a temperature of 40°C with the aid of the thermometer, or can wait approximately 10 minutes. Then add the amount of ICV-D47 and mix until completely dissolved in water, and wait about 20 to 15 minutes for the yeast reaction to be ready.

#### **4.5.5 Primary Fermenter**

The process in which yeast will be mixed with the must, being one of the steps, but prolonged and that requires more attention over time. By adding yeast to the fermentation to begin the fermentation, we close the lid-fermenter bucket with Airlock, monitoring the mash fermentation for about 72 hours. During the time, stirring is done manually with a closed bucket for about 10 minutes during the days so that fermentation reacts with oxygen.

#### **4.5.6 Secondary Fermenter**

This step consists of transferring the Mead to the glass bottle with the substances Sodium Metabisulfite and Potassium Sorbate, causing chemical agents to kill the living microorganisms, thus ending the sugar breakdown. Prior to performing the procedure, a Final Gravity (GF) sampling was taken, thus performing the formula to determine the sweetness level of the Mead.

The Beverage Racking Process can be performed with auto siphon and silicone tube, or use fermenter bucket tap if so, transfer Mead to glass bottle and leave sealed with Airlock silicone cap. The Mead being in the glass bottle with chemical agents is followed up for 24 hours after transferring the Mead until it is lighter in color.

#### **4.5.7 Final Racking**

Where the Mead is transferred to a specific bottle, in the case of a 1 liter bottle, in which it will be a final container, where it will be left to age for 1 week so that it is ready for consumption, resting for a while until that is sufficient to lighten the drink.

#### **4.5.8 Stock**

Storage Step Mead, in a place out of contact with the sun, preferably in places with room temperature under shade, and can store in refrigerators or freezer at very low temperatures, so that does not change the taste.

### **4.6 Production Volume**

Table 01: Mead Processing Control.

<b>Service Control Planning: Mead Processing</b>		
services	unity	Time
Must Preparation	5 Kg/L	20 to 25 minutes
Yeast Preparation	54 g	35 to 40 minutes
Primary Fermenter	5 Kg/L	42 to 72 hours
Secondary Fermenter	5 Kg/L	24 hours
Final Traffic	5 Kg/L	1 week or more

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Source: Author

According to Table 01 the production of Mead in the preparation of 5 liters, the primary fermentation takes around 1 hour and 5 minutes, if we apply the production in liters per day we can prepare in a 6 hour shift with 5 fermenter buckets, we will have approximately 30 liters in the first stages of the production process (Table 02). The services, but need to be aware are fermentation from primary to secondary, requires great attention and monitoring, because its total duration can take 3 to 4 days until the final traffic, where we let the Mead grow old over time. Production Rate: The preparation of 5 Liters of Mead takes around 1 week and 4 days (Table 02).

Table 02: 30 Liters Rate per day

30 Liter Production Level (Per Day)						Weekly Total
Weeks	Monday	Tuesday	Wednesday	Thursday	Friday	
1°	30	30	30	30	30	150
2°	30	30	30	30	30	150
3°	30	30	30	30	30	150
4°	30	30	30	30	30	150
						600

Source: Author

The factory production will operate with 10 fermenter buckets, with production level of which every 1 hour and 5 minutes, will produce 10 liters of must preparation, which will ferment in the buckets, in case of 2 buckets per hour. To monitor the production processing control, we aim at the tasks per step, following the Gantt chart, how long the service will be performed.

Table 03: Production Control

Gantt Chart - Production Control											
Step	Time in days										
	1	2	3	4	5	6	7	8	9	10	11
Must Preparation	X										
Yeast Preparation	X										
Primary Fermenter	X	X	X								
Secondary Fermenter			X	X							
Final Process				X	X	X	X	X	X	X	X
Stock											X

Source: Author

#### 4.7 Industrial Costs

Elaboration for the necessary costs to manufacture the Handcrafted Mead with araçá-boi fruit, and how much we can produce a unit of 1 liter or 700 ml, however the factory needs to have a good investment in order to be able to produce better performance. Spreadsheet of the costs that will be spent to produce a 700 ml unit Table 04, in which it is more commercially prepared, in which we will see how much each raw material and input cost will come out.

Table 04: Cost Worksheet of a unit.

Cost sheet		
Descriptive		Unitary value
Sale value	Market Value (from 50,00 to 150,00 reais)	R\$ 100,00
Feedstock	Honey (1kg)	R\$ 25,00
Feedstock	Mangrove Juice (1 Liter)	R\$ 5,00
Feedstock	Yeast (5g)	R\$ 22,00
Feedstock	Nutrients and Energizer (20g)	R\$ 10,00
Packing	700 ml bottle	R\$ 3,00
Total cost		R\$ 65,00
Total profit		R\$ 35,00

Source: Author

The profit obtained is very relevant and has an added value, being a very flexible but not cheap production level, a good start for a small-scale venture, where we can get approximately a monthly profit of 21,000.00 R \$, with a production of 3 weeks per month. With this the project budget worksheet for its elaboration and value investment that will need for the project Table 05.

Table 05: Budget Worksheet.

Project Budget			
Description of costs	Category	Pk	Total
Shed Rent	Input	1	R\$ 4.000,00
Layout Preparation	Input	1	R\$ 4.000,00
Company	Input	-	R\$ 1.500,00



Documentation			
Honey	Consumption	450 (kg)	R\$ 11.250,00
Squawk Juice	Consumption	450 (L)	R\$ 2.250,00
Yeast 5g	Consumption	225 (Packages)	R\$ 4.950,00
Nutrients and Energizer 20g	Consumption	180 (Packages)	R\$ 1.800,00
700 ml bottle	Consumption	600	R\$ 1.800,00
Homemade Production KIT	Consumption	4	R\$ 3.200,00
Office material	Input	-	R\$ 13.000,00
Total			R\$ 47.750,00

Source: Author

#### **4.8 Location**

The location chosen to design the factory was Avenida Govenador José, 830 Aleixo Manaus Amazonas Zip Code 69055-010, where they have warehouses for sale, with the total area dimensioning 300 m<sup>2</sup>, due to the location is located among other areas of industrial factories, has great Route routes access the main avenues, making it located in large commercial areas, making it easy to find customers, and reducing transportation costs.

#### **4.9 Layout**

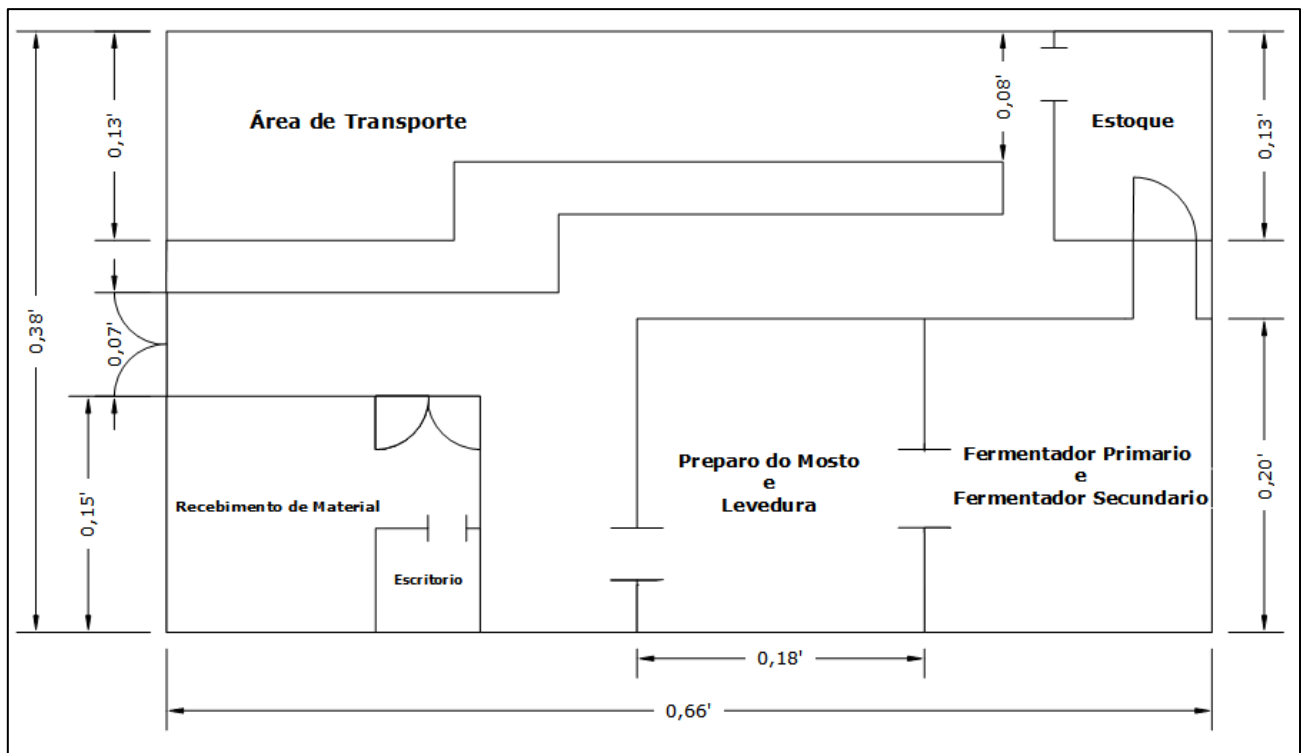


Figure 03: Layout Process

Source: Author

In the Layout model, the receipt of the material is near the entrance, where the office is located, where it will download the purchase materials received, shortly after that the material is stored, and another part goes to the must preparation room. and yeast, which follows the next step through the primary and secondary fermentation room, right after preparation and sending it to the stock in which it expects production unloading and ready for customer demand.

## 5. Results and Speeches

The factory project proved to have a good profit, but with very significant investment to prepare for production, however the processing of Mead has its complexity due to the long fermentation time, since in itself, the production volume must be prepared for demand. , being applied a pull production system. One of its difficulties, and in production, in controlling demand for the amount of Mead prepared for planned delivery, among some fermentations can vary the time it is ready for consumption.

Being a promising venture to expand, but the market for alcoholic beverages in Brazil, as a few producers of Mead, who work in the area. Due to the project being applied in the Amazon, to large producers of honey and guava in the region, having local suppliers reduces the cost, and may even improve the price of the costs of purchasing large quantities wholesale. Thus generating economy in the region and more jobs in order to add cultural value of Honey and Amazon fruits.

## 6. Final Considerations

Being a very relevant production process, it can still generate new business opportunities with other fruits and even seeds, for being a very old drink and cheering for the young culture that seek new trends and curiosities, to try a new alcoholic beverage for the region. With the implementation of the pull production system, you can work the processing control of Mead and prepare new demands for new flavors.

This factory was designed to be a model for entrepreneurs interested in creating an alcoholic beverage market in the region, as it has a responsive sequencing concept focused on specific fruit and honey production, and may vary between stages. And determine which operations can improve and minimize set up time.

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## **Violence against elderly: An integrative review**

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### **Abstract**

*This study aimed to conduct an integrative review of scientific knowledge produced in Brazil between 2013 and 2017, emphasizing the descriptors violence and the elderly. The scientific productions were*

*selected in the SciELO database with crossings of the descriptors used in the title of the articles, available online in full form, with the period limitation from 2014 to 2018, in Brazil collections and Portuguese language. The search in the database generated 26 articles, and ten of them were chosen for the final analysis after applying the inclusion and exclusion criteria. The present integrative review showed that the central violence suffered was psychological, along with physical violence, with the elderly being the main victims. The findings related to violence against the elderly and associated factors reveal a scenario that is most prevalent in the home, an environment where the belief of a welcoming, loving and protective nature of external violence is deposited. In contrast, the intrafamilial relationship emerges concomitantly as a generator of conflicts that expose the elderly to the risk of violence of a character veiled, caused by the constituents themselves, which requires high vigilance and notification. Violence is a social challenge. We must prioritize research, work, and discuss the abuse of older people in political circles and understand the best way to prevent and help implement the necessary measures.*

**Keywords:** elderly; violence; integrative review.

## 1. Introduction

One of the most significant cultural achievements of a people in its humanization process is the aging of its population, reflecting an improvement in living conditions. Aging is a universal process that characterizes a stage of life permeated by social, psychic, environmental, and biological changes that make up the regular and integral development of man [1].

Given this context, it becomes evident the health condition of the elderly, contextualized by Pitanga [2] as a multiplicity of aspects of human behavior aimed at a complete physical, mental, and social well-being. It can be divided into positive or negative health associated with the human condition represented by physical, social, and psychological dimensions. Positive health would be related to the ability to enjoy life and overcome daily challenges, and negative health would be associated with morbidity and mortality.

Regarding the aging process, Debert [3] reflects on the reinvention of old age as a set of interfaces, alluding to old age as a reality with their stories and experiences. Here represented by stories and unique life experiences, lived in the socioeconomic, cultural, and ethnic context in which each one is inserted.

Population aging has become a worldwide reality and, in Brazil, it has been accelerated, imposing changes in social policies and new challenges for public health. Among these, violence against the elderly stands out, since it affects all social levels and can cause emotional disturbances, isolation, feelings of guilt and denial, physical trauma, and death. Elder abuse refers to physical, psychological, sexual, abandonment, neglect, financial abuse, and self-neglect [4].

Violence against the elderly is the outbreak of any act or omission, whether intentional or involuntary, that causes physical, psychological, financial, or material harm. It is the representation of the loss or violation of human rights that results in unnecessary suffering, injury or pain, with the consequent reduction in the quality of life of individuals [5].

Violence against the elderly is present at various social levels and has relevant consequences on the health of this population. Violence impacts negatively on the physical and mental health conditions of older people, as it has social impacts contributing to low self-esteem, social isolation, feelings of insecurity and it also reinforces the negative aspects of old age. Thus, it is a challenge for public health, as it imposes the need for specific social policies and new directions for full health care attention for the elderly [6].

Internationally and in Brazil, according to Minayo and Souza [7], some categories have been used to classify the different types of violence of which the elderly are victims. Physical abuse, mistreatment or physical violence are expressions that refer to the use of physical force to compel older people to do what they do not want to, to hurt them, to cause them pain, disability or death. Psychological abuse, psychological violence, or mistreatment are verbal or gestural aggressions aimed at terrorizing the elderly, humiliating them, restricting their freedom or isolating them from social life. Sexual abuse and sexual violence are terms that refer to homosexual or hetero-related sexual acts or games that use older people to obtain arousal, sexual intercourse, or erotic practices through grooming, physical violence, or threats. Abandonment is a form of violence that manifests itself in the absence or defection of governmental, institutional, or family leaders to provide relief to an older person in need of protection. Negligence refers to the refusal or omission of due and necessary care for the elderly by family or institutional leaders. Neglect is one of the most prevalent forms of violence against the elderly in the country. It is often associated with other forms of violence that generate physical, emotional, and social injuries and trauma for the elderly, in particular for those who find themselves in a situation of multiple dependency or disability. Financial and economic abuse is the improper or illegal exploitation of the elderly or the unauthorized use of their financial and patrimonial resources. This type of violence occurs mainly in the family environment. Self-neglect refers to the conduct of the elderly who threatens their own health or safety by refusing to provide necessary care to themselves.

Violence against the elderly is part of social violence, that is, in Brazil and the world, it is expressed in how society organizes its relations of class, gender, ethnicity and age groups, and how power is exercised in the macro and micropolitical, and institutional spheres. In this specific case, relationships within the family institution have peculiar relevance [7].

Family violence is emphasized as the most frequent form of abuse that older people suffer. Researches show that about 2/3 of the perpetrators are children, relatives, and spouses. The abuses and neglect that are perpetuated by the clash of generations, problems of crowding people in households or lack of conditions and willingness to care for them are particularly relevant [8, 3].

Given the above, this study aims to perform an integrative review and analyze the Brazilian scientific production of the descriptors violence and elderly available in the SciELO database.

## **2. Methodology**

It is an integrative review, whose purpose is to gather and synthesize research results on a delimited theme or issue, in a systematic and orderly manner, contributing to the deepening of the knowledge of the investigated theme. For the development of the study, the methodological steps,

constituted from the identification of the theme, were followed, together with the elaboration of the research questions, establishment of the inclusion and exclusion criteria, sample selection, definition of the information to be extracted from the selected studies, organization and presentation of the studies in table format, description of results and discussion [9].

The research of the articles was carried out from June 16 to July 17, 2018, online, using the scientific productions selected in the SciELO database and the descriptors crossing in the title of the articles: violence and the elderly. The criteria for the inclusion of articles were: papers published in the format of scientific articles that had the descriptors in the title, available online in full, with the period limitation from 2014 to 2018, in collections Brazil and in the Portuguese language. Studies in which the information contained in the abstract showed no relation to the theme were excluded. The search in the database generated 26 articles, available online in the SciELO database. After applying the inclusion and exclusion criteria, thirteen articles approached the theme. However, considering the methodological context of the studies, ten articles were chosen for final analysis.

### 3. Results

The selected articles were analyzed in full, in order to respond to the objective of this study and grouped by themes in the Execution Matrix (Chart 1).

1. Execution Matrix

Title/Author/Journal/Year	Objectives
1. Violence against the elderly in three Brazilian municipalities. RODRIGUES, R. A. P. et al. Rev. Bras. Enferm., 2017. [10]	Identifying violence against the elderly in different regions of the country. This study brings an analysis of the bulletins registered by seniors at the Police Station for the Elderly, in three Brazilian municipalities.
2. Mistreatment of the elderly in Porto Alegre, Rio Grande do Sul: a documentary study. IRIGARAY, T. Q. et al. Estud. psicol. (Campinas), 2016. [11]	Verifying the prevalence and types of abuse suffered by the elderly in the city of Porto Alegre (RS), registered at the Police Station for the Elderly. Describe the profile of the victim and the perpetrator and identify the reported reasons related to the occurrence of abuse in this age group.
3. Violence Against the Elderly in the Family: Motivations, Feelings, and Needs of the Aggressor. SILVA, C. F. S.; DIAS, C. M. S. B. Psicol. Cienc. Prof., 2016. [12]	Investigating violence against the elderly in the family, from the perpetrator's perspective, specifically the motivations that drove them to violence, the feelings and needs felt by them.
4. Prevalence of violence against the elderly and associated factors, a population-based study in Florianópolis, SC. BOLSONI, C. C. et al., Rev. Bras. Geriatr. Gerontol., 2016. [13]	Estimating the prevalence of violence against the elderly and analyzing its association with demographic and socioeconomic factors and health conditions.
5. Elderly victims of abuse: five years of documentary analysis. GARBIN, C. A. S. et al. Rev. Bras.	Verifying the occurrence of abuse against the elderly and its characteristics (location, type, reason, alcohol/drug involvement, profile and kinship among victims and

Geriatr. Gerontol., 2016. [14]	aggressors), based on the police records of a specialized police station, over five years.
6. Physical and psychological violence against the elderly: prevalence and associated factors. PAIVA, M. M.; TAVARES, D. M. S. Rev. Bras. Enferm., 2015. [4]	Verifying the prevalence and factors associated with physical and psychological violence against the elderly and tracing the sociodemographic profile and clinical indicators of this population.
7. Physical and sexual assaults on elderly reported in the city of São Paulo. RODRIGUES, C. L.; ARMOND, J. E.; GORIOS, C. Rev. Bras. Geriatr. Gerontol., 2015 [15].	Characterizing the elderly population that suffered physical and sexual violence and describing the characteristics of this aggression, based on the Violence and Accident Surveillance Information System (VASIS), of the Municipal Health Secretary of the city of São Paulo.
8. Violence against the elderly: description of cases in the city of Aracaju, Sergipe, Brazil. AGUIAR, M. P. C. et al., Esc. Anna Nery, 2015. [16]	Characterizing violence against the elderly, identifying the socio-demographic profile of the victim and their aggressors, as well as knowing the conduct applied by professionals after identifying the elderly victim of abuse.
9. Functional capacity and situations of violence in the elderly. FAUSTINO, A. M.; GANDOLFI, L.; MOURA, L. B. A. Acta paul. enferm., 2014. [17]	Verifying if there is a relationship between the functional capacity of the elderly and the presence of situations of violence in their daily lives.
10. Expression of intrafamily violence against the elderly. REIS, L. A. et al., Acta paul. enferm., 2014. [18]	Unveiling the forms of expression of intrafamily violence experienced by the elderly with impaired functional capacity

According to the investigation of violence against the elderly carried out by Rodrigues et al. [10] in the municipalities of Ribeirão Preto (SP), Teresina (PI) and João Pessoa (PB), the results revealed a predominant age of 60 to 69 years old, mostly women and married. The perpetrators were mostly adults, men, and relatives of the victim, living or not with the older person. In Teresina, there were some cases where the aggressor lived with the elderly. In this study, the offender's use of alcohol and drugs was also highlighted, indicating that the use of illicit substances impairs their health and brings consequences to other family members, thus being a significant risk factor against the elderly in three Brazilian municipalities in the analysis of violence. The records analyzed contained more than one type of violence by the elderly, but the predominant one was psychological, in their residence. This data allows us to understand the map of family relationships and the reasons for this violence. This view contributes to intervention projects for family members of the elderly. In the city of Ribeirão Preto, the second most frequent type of violence was physical, and in the cities of Teresina and João Pessoa, the financial one. These findings are significant because they are two capitals whose populations have low incomes. Most older people receive social benefits and suffer this kind of problem, including with family members.

The results of the study by Irigaray et al. [11] showed that, among the police reports analyzed, the prevalence and types of abuse suffered by the elderly in the city of Porto Alegre (RS) were, mostly,



situations of abuse, being the most frequent the psychological abuse committed by family members within the home of the elderly. Regarding the victim's profile, in most cases, it is female, with advanced age, without a partner (widow, single or separated) and with low education. In general, the mistreatment was mainly committed by middle-aged male children who had a financial interest in the victim.

In the study by Silva and Dias [12], from the city of Recife, the verbal and physical aggressions, that occurred concurrently in the disputes, prevailed. Generally, the situations that culminated in violence began with verbal aggression and later the physical one. The main motivations that drove violence were: alcohol abuse; physical proximity, in the sense of lack of physical space making it difficult for privacy; the aggressor's financial dependence on the elderly; relationship permeated with violence due to the occurrence, or not, of aggression suffered in the family, especially by the elderly. In this study, there have also been portrayed the feelings experienced by the elderly and their families, evidencing frequent mention of sadness, disappointment, impatience, anger, injustice, anguish, resulting in difficulty sleeping, crying, anger, loneliness.

In the study by Bolsoni et al. [13], held in Florianópolis, SC, showed that approximately 12.4% of participants reported having suffered some violence. The prevalence found is twice that estimated by the WHO for the elderly population. Among the types of violence, the psychological one was more prevalent. Financial violence ranked second among the most frequent. Women reported suffering more violence compared to men, a recurring finding in studies of violence. The elderly who live with children and grandchildren are the most abused, as are women, low education, single/divorced, and those with functional dependence.

In the study by Garbin et al. [14], the rate of cases of elder abuse registered in the police unit studied was 4.62%, and that can be considered low when compared to all occurrences recorded in this police unit. The most prevalent age group of the victim was from 60 to 65 years old, indicating that the degree of independence of the elderly is directly related to age, facilitating the search for help. Most of the victims were married and homemakers. Regarding the profile of the aggressor, most were male and had a close relationship with the victim. The fragility of family relationships can explain this situation, worn out by routine problems because the main reason that led to the aggression was the discussions and disagreements.

In the study by Paiva and Tavares [4], carried out in the city of Uberaba, MG, the most significant proportion of elderly people submitted to physical and psychological violence refers to those who lived with their spouse; had adverse self-rated health; were hospitalized in the last year; and had a higher number of morbidities compared to those who were not victims of violence. Physical and psychological violence was associated with the age group of 60-80 years old, women, living with their spouse, and being dependent for Instrumental Activities of Daily Living (IADL).

The reported cases of physical aggression in the study by Rodrigues, Armond, and Gorios [15], in the city of São Paulo, SP, were higher in the elderly male (52.3%), with the use of body strength, predominant in the age group between 60 and 64 years old, committed by relatives and/or acquaintances of the victims. Sexual assault was predominant in females. Most of these aggressions (physical and sexual) occurred in the residence of the elderly. According to data collected from the Violence and

Accident Surveillance Information System, the main diagnosis was head trauma, and 65.0% of the cases were immediately discharged.

The findings found in the city of Aracaju, Sergipe, in a study by Aguiar et al. [16] showed that retired women are the most frequently assaulted in their homes by their male children, over 40 years old and who are unemployed. These men had no more than elementary school, were under suspicion of drug use and were charged in most cases. Moreover, the study shows that, despite the predominance of psychological violence, it occurs in an associated way, due to the overlap of sociodemographic factors.

A study by Faustino, Gandolfi, and Moura [17], conducted in the city of Brasilia (DF), Midwest region of Brazil, showed a statistically significant association between being dependent on basic self-care activities and suffering physical violence, that is, the more the elderly needs help to perform body hygiene activities, transfers, food aid, among others, the higher the chance of exposure to the situation of physical abuse.

The narratives of the elderly interviewed in a municipality located in the southwest region of the state of Bahia, in the study by Reis et al. [18] points out that they realize that dependence on others exposes them to situations of violence, expressed here by neglect, psychological violence, and financial exploitation, especially through the misappropriation of assets.

#### **4. Discussion**

The studies of this review showed that the most elderly who suffered aggression is represented by women, which denotes a gender cut in the violence suffered by older people. This result corroborates data from the National Health Survey conducted in 2013, which identified, among the cases of violence against people aged 60 and over, that 61.3% were against females [19]. This occurrence portrays the woman as a vulnerable member to physical and psychological violence within the family environment.

Another factor observed about violence against the elderly was the close relationship between the victim and the aggressor. The occurrence of violence against the elderly is more frequent in the family environment. This relationship can be intensified when the elderly have their autonomy impaired by illness and disability, and family members acquire the role of caregivers. The National Health Survey, conducted in 2013, found that of the aggressions suffered by the elderly, 70.1% were performed at their residence (BRAZIL, 2015). Among the reasons related to this proximity to aggression, the family context is highlighted, which is often stressful and contains the presence of unprepared or overwhelmed caregivers, or even the dependence relationship (physical, emotional, cognitive and financial) that leads vulnerability during the aging process[20].

The studies of this review showed remarkable results related to psychological violence, since the elderly often feel depressed by the powerlessness in the face of the situation, triggering an avalanche of losses related to financial, psychological and physical aspects, often irreversible [21]. Older people become more vulnerable to violence as they are more dependent due to the physical, emotional, and cognitive limitations inherent in the aging process. Stressful family life and unprepared or overwhelmed caregivers tend to aggravate this situation [20].

Financial violence, the use of drugs or alcohol by the aggressor are among the reasons portrayed in studies that lead to aggression, constituting a risk factor evidenced in the studies, with children and grandchildren as the main agents of this type of violence. This scenario may be related to dependence on the family member, the income of the elderly, or the inability of the elderly to manage their own financial lives. This type of mistreatment is not related to the social class of the victim, as it occurs in both the most privileged and those with the least possessions [21].

Through this integrative review it was also possible to verify situations of violence and mistreatment associated with increased dependence, that is, elderly who need help for self-care or to perform more complex daily activities, mainly due to physical disabilities, have higher risk, especially when there is not a good relationship between the elderly and family or caregiver. According to Reis et al. [18], old age carries the stigma of the functional and social disability of the individual, reducing the elderly, often, to a burden to their guardians, thus contributing to family and social exclusion, and intrafamily violence.

Concern about violence against the elderly, as well as the demand for public policies to fight it, certainly require a review of this glamorous perception of the most advanced stages of life. For some authors, the view of old age as a situation of loss and dependence has been replaced by a more positive view of aging. It is, however, necessary to note the coexistence of these distinct stages of old age and how public policies notice one or the other of these stages. Debert and Oliveira [22] emphasize that a more positive view of aging needs to be addressed, signaling the situation of violence against this older person and its struggle along with public policies. This view should be in order to create mechanisms capable of strengthening and stimulating the family and its members to perform their roles, thus giving specific impetus to the functioning of police stations, the complaints presented there, the profile of the victims and the identification of their aggressors.

## **5. Conclusion**

The findings related to violence against the elderly and associated factors reveal a scenario that is most prevalent in the home, an environment where the belief of a welcoming, loving and protective nature of external violence is deposited. In contrast, the intrafamilial relationship emerges concomitantly as a generator of conflicts that expose the elderly to the risk of violence of a character veiled by the constituents themselves, which requires high vigilance and notification.

Despite the existence of laws that guarantee the defense of dignity and well-being in old age, many efforts still need to be made to fulfill them. A stimulus is needed so that the public power, together with health professionals and the general population, will discuss this issue and develop public policies that reduce the rate of violence against the elderly. Violence is a social challenge. We must prioritize research, work, and discuss the abuse of older people in political circles to understand the best way to prevent and help implement the necessary measures.

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# **Application of Reverse Logistics of Waste Tires and their Proper Destination**

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## **Abstract**

*Increased solid waste generation has become a major concern for society. Among the many types of waste, the tire stands out because of its worldwide consumption and because it is a threat to the environment. With the need to reduce improper tire disposal, several solutions have been developed to reduce or reuse this material. Many countries are creating new technologies and processes that can be used to recycle tires. Governmental actions have also been manifesting in the face of the situation, with the creation of legislation for both the corporate level and society in general, together with environmental inspection agencies to control this waste. The present work consists in making an analysis about the application of the reverse logistics of the waste tires, with the objective mainly in the issues that correspond to the proper disposal or the reuse of waste tires. Also present possible tire reuse alternatives, processes that can be applied to these wastes and show how harmful they are to the environment.*

**Keywords:** Reverse logistic; Waste tires; Tire destination;

## **1. Introduction**

With the economic and population increase, there is a great growth in the consumption of cars and companies working in the logistics sector. This causes an excessive increase in tires, which over time become unusable. Unfortunately, many do not properly dispose of this waste, depositing in inappropriate

places and consequently causing environmental problems.

Created by Charles Goodyear, the tire, known as a tire, is an air-filled rubber tube placed at the rim of the vehicle's wheel, enabling vehicle traction. It can be inflated with air or water, and even be massive. The tire is commonly used in cars, bicycles, trucks, tractors and etc. It has a black color due to the addition of carbon black during the manufacturing process. A tire has a durability of 25,000 to 70,000 kilometers driven, depending on how it is used.

According to Gardin et al. (2010) gradually, waste tires cause problems of environmental hazards when improperly disposed of. The author highlights the need for society to be aware of its actions, correctly disposing of viable initiatives, because currently there are several suitable alternatives for the final disposal of waste tires. Thus, it is essential that corporations and society become aware of and act responsibly and ecologically correctly with regard to tire disposal, thus contributing to the biotic and anthropic environment.

Data released by the National Tire Industry Association (ANIP, 2014) show that in the first half of 2014, Brazil broke a record tire recycling rate, with more than 223,000 tons, which is equal to around 45 million tires. automobiles. This result was only possible because in 1999 a proposal was introduced to regulate solid waste in Brazil, through the National Policy on Solid Waste (PNRS), which results in a change in the National Environment Council (CONAMA) in relation to the standardization in Brazil. waste treatment. A work started in 1998 by CONAMA regulated waste treatment of various products, including batteries, tires, batteries, fluorescent lamps, among others.

According to BRAZIL, the National Environmental Council, based on CONAMA Resolution No. 416/2009 (2017), provides for the prevention and environmental degradation caused by waste tires, obliging companies, manufacturers and importers to dispose of tires in a to collect and dispose of in an ecologically sound manner. Thus, industry and companies working in the tire industry are responsible for the LR of the post-consumer waste tires to prevent the degradation of the environment in which they are inserted.

However, the objective of this paper is to approach bibliographical references about the process of application of the reverse logistics of the tire and the proper destination for it, presenting applications, developments and data made in relation to waste tires, so that it is necessary to raising awareness among the population and authorities of environmental preservation.

## **2. Theoretical References**

### ***2.1. Origin of Tire and its Composition***

In 1839, Charles Goodyear casually discovered the process of rubber vulcanization, so in 1845 taking advantage of this discovery, R. W. Thomson created the rubber tire. For decades many experiments have been carried out to improve the properties of natural rubber. From World War I, in Germany a new technology was created for the manufacture of synthetic rubber, since until this period the tires depended entirely on the raw material natural rubber for its manufacture. (RAMOS, 2005).

Today, in addition to synthetic rubber, tires have several components, as it is a product that aims for a long service life, as they are “designed and manufactured to last in extreme physical, chemical and

thermal situations. It presents a complex structure, with the objective of giving them the characteristics necessary for their performance and safety, made to be indestructible ”(KAMIMURA, 2002).

A tire is composed of different materials such as: steel frame, nylon, aramide fiber, rayon, fiberglass / polyester; natural and synthetic rubber and various types of polymers; chemical reinforcers such as black carbon, silica and resins; anti-degradants (antioxidant paraffin waxes and ozone gas inhibitors); adhesion promoters (cobalt salts, metal wire baths and resins); curing agents (curing accelerators, activators, sulfur) and auxiliary products (PIRELLI, 2007).

### **2.1. Tire Recycling**

According to Rodrigues and Henkes (2015), the reuse of tires is old, but its procedure occurred after World War II due to the complication in obtaining raw material for the production of new tires. Tires, when replaced with new ones, are discarded after the end of use. This disposal may occur in rivers, landfills and general waste collection sites. Proper disposal of the tire is the responsibility of all consumers, manufacturers, distributors, dealers and importers (BRAZIL, 2010). Proper destination will bring benefits to public health and the environment.

For Roy, Nollet and Beaulieu (2006), tire recycling is not profitable for tire manufacturers, as the government did not think of internalizing costs for manufacturers, but rather finding a solution to the ecological crisis that the industry was experiencing. passing and contribute to the development of waste tire recycling as a new industrial sector. Tire recycling can be done in a variety of ways, from the use of its casing to shredding for use in the production of various products and materials. The evaluation of the tires for correct destination goes through a screening of the carcasses and if they are able to be used they are sent to companies specialized in retreading, remolding or retreading (RESENDE, 2004).

According to Bertollo and Fernandes Júnior (2002), the reuse process of waste tires has a high cost due to the cutting and grinding process through which it is separated to allow the recovery of materials initially used in its manufacture. Rubber extracted by grinding waste tires can be reused to make slippers, automotive mats, industrial floors, shoe soles, rubber seals, sports courts, asphalt and concrete composition and also as an energy matrix in cement industries (RECICLANIP, 2015).

### **2.3. Reverse Logistic**

According to Leite (2003), the Reverse Logistics method has developed since its inception in the 1980s. It began with the need for organizations that tried to return defective products to the factory. The milestone grew throughout the emergence of the environmental agreement in the world, when companies realized the economic benefits achieved by using this process.

According to PEREIRA (2014), Reverse Logistics is established in a wide area of business logistics that involves the classic concept of logistics, adding a set of operations and related acts, from the reduction of the use of raw materials to the disposal. final and correct use of products, materials and packaging with their continuous reuse, in recycling and / or energy production. Reverse logistics also receives titles of full logistics or reverse logistics.

According to LIZARNHOS; TENÓRIO, 2013, reverse logistics has been dated since the 1970s, where definitions such as reverse channels or reverse flows, mainly related to recycling, appeared. In Brazil, the



term associated with companies emerged in the 1990s and was linked to logistics through raw materials, components and supplies that showed significant costs and which should be properly conducted when returning from after-sales or after-sales. consumption.

Conceptually, Reverse Logistics is the area of business logistics that designs, acts and controls the course of the corresponding information on the return of after-sales and post-consumer goods to the trade cycle or productivity cycle through the reverse distribution channels. , adding value to them of various natures, such as: economic, ecological, legal, logistic, corporate image, among others. (LEITE, 2009).

According to TEPPRASIT and YUVANONT (2015) with increasing concern about the environment, several countries enact laws in order to reduce the ecological problem of logistics that is linked to climate change, air pollution, waste, among others. In the recycling chain, reverse logistics is one of the important processes that makes the entire chain economically viable, whether in the process of reuse, recycling or energy recovery. This allows organizations to do the best from an economic, environmental and community point of view (TEPPRASIT; YUVANONT, 2015). In the case of tires, the process becomes challenging with regard to economic viability, as their transportation from collection points to recycling sites becomes high and is not advantageous for industry, distributors and traders (CHAN; CHAN; JAIN, 2012).

For Lacerda (2002), among the critical factors that influence the efficiency of reverse logistics are: the high index of activity informality and the lack of standardization and mapping of production processes. On the other hand, reverse logistics has been strengthened not only by concern for the environment, but also by pressure from environmental legislation and the pursuit of ISO 14001 certification by many companies.

#### **2.4. Reverse Tire Logistics**

Reverse logistics is a new field of business logistics. Under federal law No. 12,305, the business sector that markets packaging products must enable packaging recovery in a manner commensurate with the amount placed on the market annually through the structuring of reverse packaging logistics systems.

According to the Corporate Commitment to Recycling (CEMPRE, 2008), tires and inner tubes consume around 70% of national rubber production. In 2006 Brazil produced almost 55 million tires, where approximately one third of these are exported to more than 85 countries and the remainder serves to supply the domestic market.

On August 26, 1999, CONAMA Resolution No. 258/99 was approved, which set the targets and required manufacturers and importers to dispose of waste tires. Since 2002, tire manufacturers and importers must collect and dispose of waste tires. In addition, distributors, dealers, retreaders and end consumers are responsible for collecting used tires. Prior to the approval of Brazilian law, only 10% of the tires were recycled.

After the approval of the legislation, the number of companies registered to collect and destroy waste tires, which are in accordance with Normative Instruction No. 008/02 of the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), went from 4 to 65. In 2010, there are 124 companies registered with IBAMA for the reuse, recycling and energy recovery of tires.

Companies are experiencing economic changes, which change the rules of wealth in conjunction with

advances in awareness in a process of structural transformation of companies that accompany globalization (ROCHA, 2015). Growth is unprecedented in the evolution of technology that encompasses raw materials, manufactured goods, agricultural products, services of all kinds, labor, among others, making capital turnover work every day of the year. It is due to this evolution that companies make competitiveness the necessary supplement for the adoption of Reverse Logistics of their products.

### 3. Methodology

The methodology of this article was based on bibliographic and documentary research of national experiences, being sources for the elaboration of the review articles in scientific journals, books, theses, dissertations and congress abstracts. Websites related to tire production and collection were consulted, in order to present how the reverse logistics of waste tires are applied in the country and also to study possible ways of reusing and recycling them.

### 4. Application of Study and Results

In the study by Goto and Souza (2008), they evaluated the benefits of reverse logistics applied under solid waste, especially in the pneumatic sector. The authors collected data on tire reformers, dealers and consumers of the product. For the analysis, a solid waste management and reverse tire logistics management model was used to assess reuse, retreading, tire burnout and unsuitable tire problems in inadequate locations.

For the examination and data collection to take place, they used a schematic representation of reverse logistics processes, as illustrated in Figure 1.

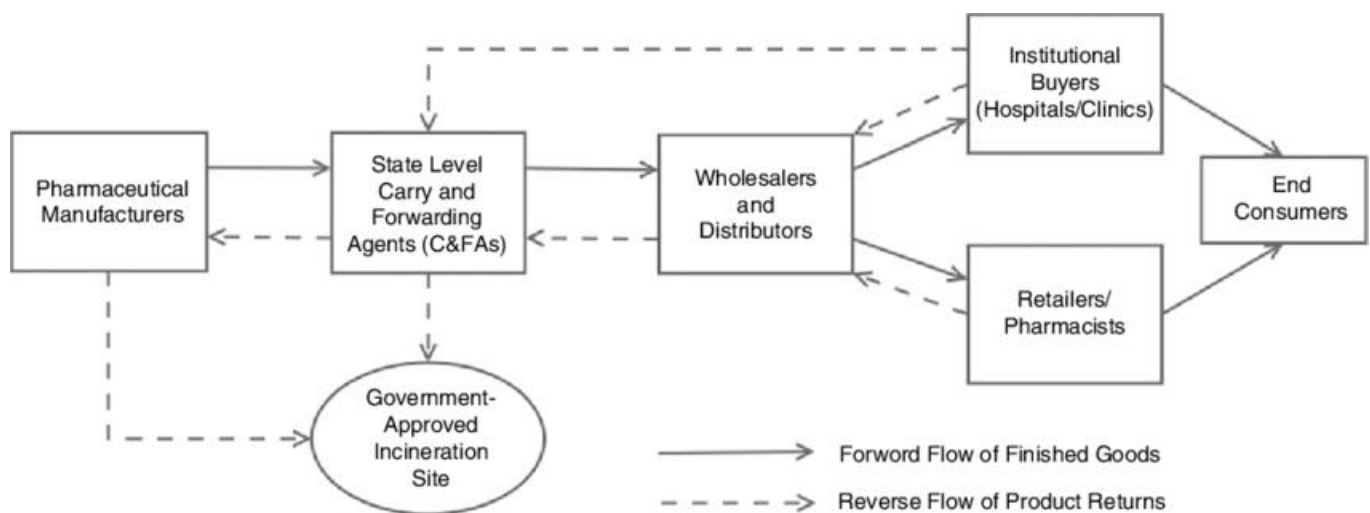


Figure 1 - Schematic representation of reverse logistics processes

Source: NARAYANA, 2014.

Regarding the reuse of the tire, found that consumers have been interested in buying used tires in good condition, thus taking advantage of the limit of life. Regarding tire retreading, although some retreaders have the INMETRO certificate, some consumers doubt the quality of the retreaded tire and the companies

that perform this service (retreading) are required by CONAMA Resolution 258/99 to give a destination tires for recycling or incineration.

FLORIANI, Marco, et.al, (2016), presented in their study, the Reciclanip entity that developed a sustainable method of tire disposal. One of the main developments of the company has been creating wasteful tire collection points, which became known as Ecopoints. This method was done in partnership between the company and the city hall. Tires destined by tire repairers, refills, carriers were also linked to these locations, awaiting withdrawal. Reciclanip is responsible for logistics from the removal of tires from collection points to the final disposal, environmentally appropriate. In 2013, the company totaled 824 collection points, illustrated in the table below.

Table 1 - Collection Points Per Year

Yeas	Collection Points
2013	824
2012	743
2011	726
2010	578
2009	437
2008	339
2007	270
2006	220
2005	135
2004	85

Source: Floriani, Furlanetto and Sehnem.

The government has designated a covered and protected area to function as a tire depot, with the tires being collected by Reciclanip or authorized partners. The action was seen as a great initiative by the government, encouraging sustainable development for their region, and could increase the use of these points, adding other recyclable products that cause problems to the environment.

In SIMONETTI's study, Camila (2018) addressed an environmental issue, highlighting the problems caused by improper tire disposal and the legislation on disposal. He pointed to the durability of the decomposition of the tires that did not have time to occur, showing that the tires are the main breeding grounds of the *Aedes aegypti* mosquito that is responsible not only for the transmission of dengue virus, but also for Zika and Chikungunya. They concluded that by consolidating CONAMA Resolutions, tire manufacturers and society are more responsible for the proper disposal of waste tires, helping to combat environmental problems.

According to data collected by the Ministry of Health (2012) from January to April 2011 and 2012, there was a decrease from 507,798 cases of dengue in this period of 2011 to 286,011 cases in the same period

of 2012, from the increase in contribution of the final destination of waste tires, which went from 84.73% to 95.75%. However, based on data updated by the Ministry of Health (2014) for 2013, there was a large increase in dengue cases registered compared to the previous year, a 3.89% drop in the final destination rate of waste tires which contributed to a jump from 286,011 in the first quarter of 2012 to 1,111,003 in the same period of 2013 (BRASIL, 2012b; BRASIL, 2014b).

There are many options on how to reuse tires after their end of life. Many applications are being performed successfully, either by the collection points, the use of waste added in concrete and asphalts and the use of materials from them. Among so many applications and developments, stand out:

- Soil erosion containment, where whole tires, associated with large root plants, can be used to contain soil erosion (CARVALHO, 2004);
  - Production of t-shirts (RECAUFAIR, 2004);
  - Composting, where the use of crushed tires assists in the aeration of organic compounds (CARVALHO, 2004);
  - Kiln fuel for cement, lime, paper and pulp production, where the replacement of coal by the tire has a great advantage, since the tire has a higher calorific value than the coal used in these processes (ANDRADE; PACHIEGA; EL-KHATIB, 2003 ).
  - Road pavements, where tires are ground and mixed with asphalt, increasing their elasticity and durability (KAMIMURA, 2002);
  - Artificial reefs for reproduction of marine animals, where the tires become an environment conducive to the development of fauna and flora (SANTOS 2002);
  - Inertial barriers, where sand-filled whole tires are used to reduce vehicle impacts (KAMIMURA, 2002);
- All of these developments applied to waste tires can be classified into the following applications: the use of crushed tires for construction or road paving, for energy production and for the production of new rubber products.

## 5. Final Considerations

With the bibliographic survey of this article, found that the tire is a common product worldwide and when it reaches the end of its life, can become a big problem if it is not properly disposed, causing threats to the environment and consequently health. public Therefore, it is important to comply with the laws imposed on the proper disposal of tires.

We have seen that there are ways to combat the incorrect disposal of this waste, as presented in the study by FLORIANI, Marco, et al. The Reciclanip entity has created waste collection points that since 2004 the points have grown gradually each year and will also increase. extend these points to collect other waste that causes damage to the environment.

Legislation created by government agencies regarding the incorrect disposal of solid waste was of great importance, as consumers, companies and tire importers are responsible for giving the correct disposal of the waste, whether to reformers or recycling companies, and also making the general population aware.

We also had big names from authors who developed important end-of-life tire applications, who came to

serve as models for other authors and applications, such as durability-shredded paving, also for construction, production of fabric and among others.

The presented alternatives of reuse, new processes and technologies for waste tires is a great economic and ecological advantage, because with the great consumption of this waste can become raw material of new products.

In addition, the tire can be a major breeding ground for the dengue mosquito, a disease that is responsible for the high mortality rate in Brazil, where the Ministry of Environment and Public Health has been battling this problem for years with campaigns, awareness and lectures. . The important thing is that the destination of the tires show evolution, because a small amount of tires discarded improperly enough for the mosquito to proliferate. Burning this product can also cause serious health problems.

Awareness and disclosure among tire importing and producing companies is required to be responsible for the final disposal, creating collection points facilitating the disposal of this waste for other purposes. It is also noteworthy that it can be beneficial for companies as tires can be raw material for other processes. The government could further encourage companies and even society to practice tire collection and recycling, as well as to create or update laws involving the proper disposal of solid waste. All this would make it possible to develop research and technologies for the reuse of this waste so that it would no longer be a threat to the environment.

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# Mechanization of the 18ct Gold Ring Manufacturing Process

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## Abstract

*The process of manufacturing handcrafted 18ct gold wedding rings is a method widely used by small scale and self-employed manufacturers, this manufacturing method has low investment in labor, equipment, tools and physical space, but this method becomes a both outdated when improvements are needed, in this case the alliance manufacturing process through micro-casting and machining is considered to be one of the efficient ways to produce on a medium scale and requires a slightly larger investment in equipment, and tools that eliminate some processes. idle, generating a higher production volume and a superior finish compared to the artisanal production method.*

**Keywords:** Wedding Ring Manufacturing; 18ct Gold; Handcrafted Process; Micro Casting, Machining;

## 1. Introduction

According to [1], the artisan process of making wedding rings is a process that does not require a high financial investment in tools, equipment and physical space. It is possible to manufacture these parts in a physical space of at least 2m<sup>2</sup>, and can hold all the material and equipment in a special furniture for goldsmith called bench. The necessary tools are considered conventional tools in the jewelry industry, some can even be found in hardware stores, such as files, files, drills etc ...

However this craft process is advisable only for a small factory is limited to an average production of a maximum of 20 pieces produced daily by each professional, because this process requires a manual finishing, which no matter how skillful the goldsmith has, is limited due to the time devoted to finishing an alliance.



According to [2] this process of micro casting and machining for alliances is already considered old, but still widely used by medium-sized companies and some self-employed professionals because it does not require a large amount of raw material to make the rings and to It is a much faster and more practical process, with a much higher production volume, while still allowing a high quality final product, without welds and without sandpaper finish on some models. This process is very simple because its tools and manufacturing method are also simple and very efficient. However, its investment in equipment is not very expensive, compared to the large-scale production process, because it is durable equipment, simple maintenance and because it is aimed at a very small audience. 18 carat gold is the main raw material used in this process.

First of all, the whole structure for the workshop should be assembled in a large and airy place, because it is working with high temperatures and with pyrophoric and flammable materials. Safety equipment should be worn such as: scrape apron, scrape gloves or heat resistant fabric, goggles, ear protector and boots with protection at the foot of the shoe. Basic knowledge of mechanical lathe operation, use of calipers, micrometer, gauge, gas torch handling, casting knowledge and precision balance handling is also required.

## **2 Bibliographic Review**

### ***2.1. Foundation for the Preparation of Languages***

This process is standard for craft production, micro casting and machining. According to [3], the trader receives a certain amount of 18 karat gold material, duly checked in relation to the quantity and quality of the material and then will be melted in a crucible (ceramic container that can withstand temperatures above 1,000°C), the material will be placed inside this tool and with the use of a blowtorch will be melted or melted at a temperature of approximately 1,000°C. Material deposited inside the crucible will continue to receive this torch heat for approximately 10 minutes until it reaches its full melting point and is in its liquid state where it will be poured or deposited on a tool called billet which has a rectangular shape to the extent determined. by the professional. Material poured into the billet hardens in a short time of approximately 10 seconds and the billet is ready.

According to [4], NR-32, occupational safety is very important in this process. The following PPE must also be worn: Leather scrape apron, dark goggles, leather boots and leather scrape gloves. Some professional skill is also required after having undergone all tool and material handling training.

### ***2.2. Lamination Process***

After the manufacture of ingots, comes this rolling phase, which according to [5] is a mechanical forming process most used in the industry because it has high productivity, precision and low cost. In this process the ingot or bar passes through a rolling mill which is an equipment with 2 opposite steel rollers or rollers, mounted in a cage driven by a strong electric motor, which compresses the ingot until it reaches its desired thickness. strips) in order to adjust it to the desired measures. In this process the use of leather scrap gloves is indispensable, because despite this process being called cold rolling, the material becomes very hot because it is suffering high compressive stresses resulting from the pressing action of the rollers.

Attention is also important in this process as the rolling mill is a device that has great traction capacity that can mutilate if the operator does not take proper care of its handling.

### **2.3 Craft Manufacturing Process**

At this stage of the process, according to [6] the laminated material will be worked on a goldsmith's bench that has a drawer only to collect the gold residues that remain after cutting, with the help of a ruler the material is cut to the desired extent by the professional with the aid of a hand saw for metals, as this tool does not throw gold residue or dust if a power saw is used, and can be further purified and reused for another jewelry. According to [1] after cutting, these rectangular pieces in their certain measurements will be manually bent with the help of pliers in the shape of a circle, tightly joining the ends of the piece. Now these joined ends will be fixed by welding. The next step is the performance of the formed ring, with the aid of a goldsmith's hammer and a tool called tribulé, the professional turns this ring into a perfect circle. Now with the use of a specific file the professional will shape this ring until forming the alliance in its shape, size and approximate weight, then the piece is finished using a mini rectify or known in jewelry as "whip motor", A small fine metal sandpaper roll is fitted to its mandrel, removing the marks left by the file and adjusting the weight and exact measurement of the ring. Then using a polishing machine and its tools, according to [7] the alliances go through the polishing process to completely remove the sandpaper marks and let them shine. In this process of sanded alliances, there is a small loss of material in the process of removing the sandpaper marks, but some of this material can be recovered using purification.

### **2.4 Mechanization of the 18ct Gold Alliance Manufacturing Process**

According to [2] using more, relatively modern equipment, this process previously done by hand, or by hand, is being improved with regard to the quantity produced, quality of finished parts and better use of raw materials. In this process a centrifuge will be used to manufacture the rings, billets to determine their initial dimensions, a specific lathe for the machining of rings and their locking and cutting tools (tweezers and glass).

For this process is still used the rolling of the bars that will be cut with the help of scissors or small guillotine and form small plates, these will have their weight determined on a precision scale before being turned into rings. According to [8] with a blowtorch the plates will be melted inside a crucible that is in the centrifuge, when it is melted, the centrifuge will be turned on and the metal will be poured into the billet assuming its circular shape and two respective measures.

Ready for the ring, according to [9] this will be finished in a jewelry-specific mechanical lathe, this equipment has the functions of a traditional mechanical lathe, but with faster cutting adjustments and quick coupling tools, this makes the cutting of the rings much faster and snapping in and out of these parts. The cutting tools are also specific for gold machining, they are made of a special alloy steel that make the rings shine, and this means that the parts will not suffer major wear in the polishing process resulting in labor savings, loss of material caused by the sanding process throughout the part and less material to be purified, because according to [10] chips may be easier to purify because they are larger particles than the sandpaper residues.

The alliance mechanical lathe has an average production capacity of 200 alliances per day, depending on

the complexity or not of the model, may be able to produce even more parts. It is in the machining process that alliances will receive their definitive measurements and forms.

### **3. Tools and Methods**

This work was performed in a jewelry manufacturing company located in Manaus - AM, where in addition to rings and pendants, 18 carat gold wedding rings are manufactured, which is the object of the study where information about the manufacturing process was acquired, but , capturing images was not allowed for security reasons to employees and in relation to company policy. It was also researched all existing theoretical material on the subject cited in the bibliography from which were collected the images that are faithful to the theme.

In the analysis of the artisanal process, data were collected from the company's reports on all parts manufactured during one week in May 2019, as well as a daily monitoring of production during the one-week study period. During this period, production capacity averaged 20 alliances per professional per day.

In the analysis of the production process by micro casting and machining, data were collected from the company's reports from all units manufactured in one week in September 2019, and this new process was monitored, the maximum production capacity reached by a professional, was an average of 200 pieces daily. Then, information was collected from the professionals in the production area for analysis and comparison between the two production processes. During the research period, the processes were monitored and mapped through visits directly to the alliance manufacturing sector. There were interviews with the goldsmiths and the professionals responsible for controlling the production and quality of the finished products.

### **4. Application of Study**

This project aims to present the advantages of replacing the handcrafted or manual alliance manufacturing process by the mechanized process of micro casting and machining increasing the production capacity, using new tools and production techniques, improving the quality of the manufactured product, and reducing costs. . After studying the processes and analyzing the process performance indicators mentioned here, it is evident that replacing the artisanal production process with the process by micro casting and machining is very advantageous, because the investment in these equipments will bring great results to the professional who opts. for this change.

In figure 1 follows the main steps of the craft process:

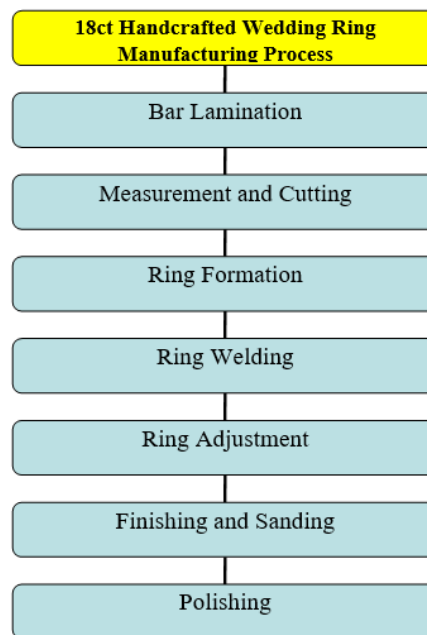


Figure 1: Organograph of the Artisan Process Steps.

Source: Author

Much of this process is carried out on a goldsmith's bench with the tools available or needed to make handcrafted wedding rings as shown in Figure 2.



Figure 2: Golden Workbase With Tools.

Source: [11]

#### **4.1.1 Bar Lamination**

In bar rolling, the trader adjusts this material to the desired dimensions on a 2-roll electric rolling mill, as shown in Figure 3, which will compress the bar until it becomes a strip in the dimensions desired by the trader. This rolling mill has some slits at the ends, with different sizes on both rolls, specific to perform the lamination reaching the desired shape and measurements in this process.

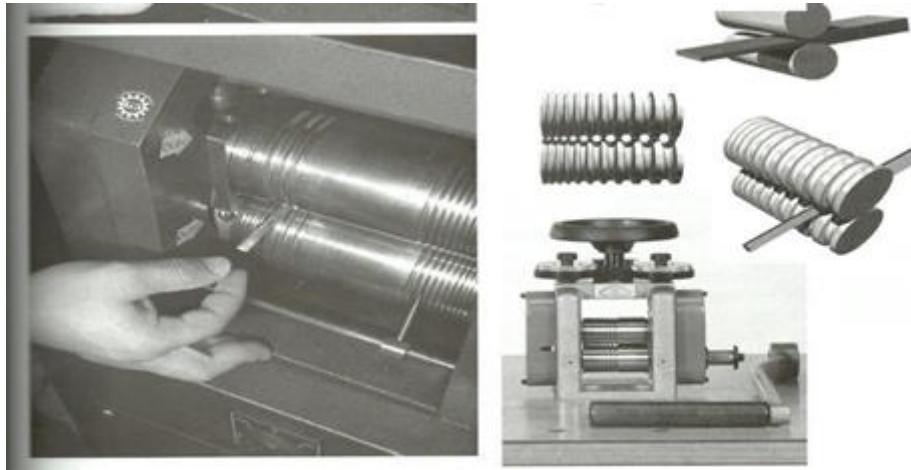


Figure 3: Bar Laminator.

Source: [6]

#### **4.1.2 Measurement and cutting**

In the measurement and cutting step, the professional will cut the previously laminated material to the desired measurements, with the help of a ruler or caliper will make the measurement and with a specific saw for goldsmith will perform the cut, as shown in figure 4.



Figure 4: Laminated and Cut Bar.

Source: [2]

#### **4.1.3 Ring Formation**

With the material in the desired dimensions, according to figure 5. Now it will be bent with the help of a tribulé and pliers. The goal here is to make this material rounded.



Figure 5: Ring Being Adjusted.

Source: [2]

#### **4.1.4 Ring Welding**

In the next step this ring design will have its ends joined by the welding process, using a gas torch and a specific metal alloy, to perform 18 carat gold welding, as shown in Figure 6.



Figure 6: Ring Receiving Welding.

Source: [2]

#### **4.1.5 Ring Adjustment**

As shown in figure 7, the adjustment of the ring after welding is intended to make this ring as round as possible using a wooden treble and hammer.





Figure 7: Folding Ring.

Source: [12]

#### ***4.1.6 Finishing and Sanding***

In this process of finishing by grinding and sanding, is where the alliance will have its final shape defined, as shown in figure 8, this is a longer part of the process, where it requires a lot of skill of the professional, both for the quality of the part, as to be careful about the loss of material that will be reused.



Figure 8: Cleaning and Sanding Finish.

Source: [2]

This process requires great skill from the professional, so as not to lose the dimensions of the pieces, it is also important to be careful with the material being removed from the rings, because it is a raw material of great value, and the material needs to be reused to the maximum. On the workbench the goldsmith has a lined drawer for the allocation of all the waste removed from the rings, to be later purified and reused, as shown in figure 9.



Figure 9: Residue of Resource Material.

Source: [2]

#### **4.1.7 Polishing**

Finally comes the polishing process, according to figure 10, the piece is polished with a wear wax on a felt cone inside, then polished on the side gear and everywhere by a felt wheel. then it is cleaned by a cloth wheel and finally polished with a polishing wax with another cloth wheel.



Figure 10: Alliance Being Polished.

Source: [2]

This process ensures the brilliance of ready-made wedding rings. In the case of handcrafted pieces, a slightly more intense polishing is necessary, as all sanding marks left on the pieces must be removed, as a result of this, a greater loss of material in the wedding ring.

In figure 11, follows the main steps of the mechanized process:



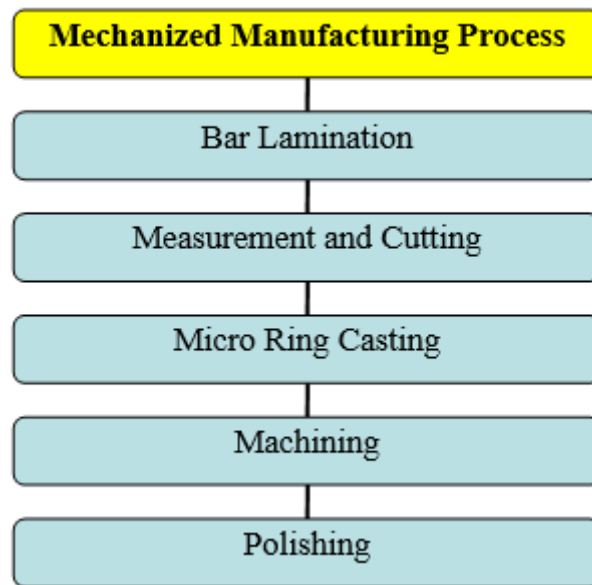


Figure 11: Organogram of Steps of Mechanized Process.

Source: Author

The mechanized process was the main study material here, it is in this process that there is a medium investment in equipment (lathe for rings and centrifuge for rings) as shown in Figure 12, compared to the artisanal process, but there is a great evolution in the process in which it concerns the quantity produced, product quality, labor economy and raw material economy. Following are the process steps for machining and micro casting.

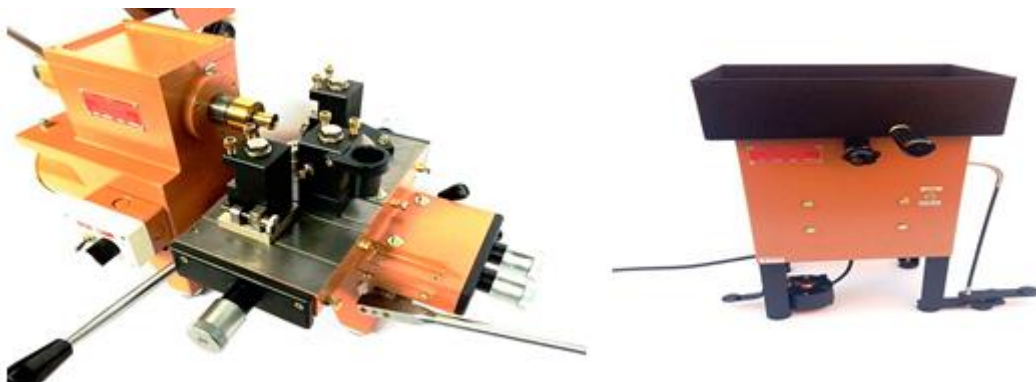


Figure 12: Mechanical Make and Centrifuga.

Source: [11]

#### 4.2.1 Bar Lamination

As the bars are already ready-made as 18K gold in the process, our process already begins to laminate the bars, with the intention of making them thinner for easier cutting and adjusting the small plates formed to the correct weight. In this case the dimensions of the laminated strip do not need to be exact, because in this case, the important thing will be the weight that the pieces will be cut. The bars will be rolled between two rollers of the electric rolling mill shown in figure 13, the smooth part of the rollers will be used in the middle part.



Figure 13: Laminator and Laminda Plate.

Source: [12]

#### **4.2.2 Measurement and Cutting**

In this process the laminated bar that is in the shape of a large strip will be cut and with the help of scissors or a small guillotine shown in figure 14. A precision balance will also be used to measure the weight of the plates to be transformed into hoops in the next process.



Figure 14: Cutting Scissors for Sheets.

Source: Mechanic 2019 Store

#### **4.2.3 Micro Ring Casting**

This process is where the previously cut plates will be fused into a crucible in the centrifuge, the torch is used to melt the sheet metal when it is melted, the centrifuge is turned on and the molten metal is thrown into the billets, where it will receive the ring shape as shown in figure 15, in their respective measurements. The advantages of this process are that the rings are produced faster, with a perfect shape, where no adjustments will be necessary, no imperfections in the molten metal (pores) and no welding required.



Figure 15: Centrifugal ring cast.

SOURCE: [2]

As shown in figure 16, billets are small iron blocks in circular shapes that have different sizes, where the trader uses the extent to which the alliance will be made. A cup called a shell is also used, which is fitted to the top of the billet that serves to channel the molten metal, shape the side of the piece and is where the finished ring is removed.



Figure 16: Turbs and Shells.

Source: [2]

#### **4.2.4 Machining**

The process in which the rings are made by machining, the ring that was produced in the previous process will now be worked on a specific lathe for machining these rings, as shown in figure 17, it will first be fitted to the outer collet for wear. The inner part of the ring, with the intention of roughing the piece, is then cut by a video on the side to determine its dimensions, then the internal cut is made to leave the piece in the right shape and size of the ring and then cut. by a video on the side to determine its dimensions, then the internal cut is made to leave the piece in the right shape and size of the ring.



Figure 17: External Pipe and Ring on the Pipe.

Source: [2]

Ready this step of machining, now this ring will be fitted into an internal clamp to do the work on its outside, where it will receive its weight and final shape. An external video will be used to cut this part as shown in Figure 18. A precision scale will be used to measure the weight of this ring.

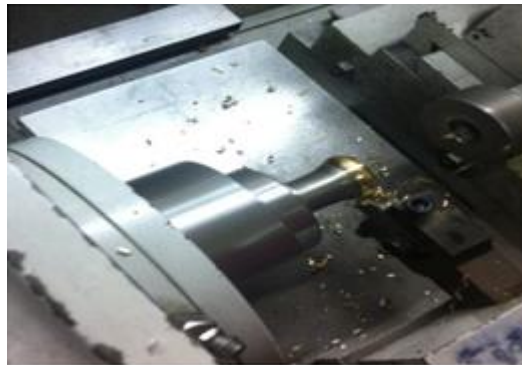


Figure 18: External Videos and Internal Pins.

Source: [2]

As we can see in figure 19, the machining process also allows the professional to perform more uniform finishes on alliances such as channels or combinations of shapes that in the artisanal process, are even possible, but do not have the same aesthetic quality and the execution time is longer. much longer.



Figure 19: Ring Being Machined.

Source: [2]

#### 4.2.5 Polishing

The polishing process here is not very different from the piece that is manufactured in handcrafted format, because the same tools and techniques will be used to perform this process, as we can see in figure 20.



Figure 20: Alliance Being Polished.

Source: [2]

The machined alliance has the advantage of not being sanded and requires less intense polishing, which means that the loss of matter will be shorter and the work execution time will be shorter.

## 5. Results and Discussions

The results obtained during the study period were evaluated the performance indicators of each process compared and analyzed, and this work aims, through these process indicators, to highlight the advantages obtained in the mechanized production process compared to the artisanal process, with respect to the quality of parts, quantity produced, raw material savings and process costs. The results were acquired from the research cited here, books and a jewelry company. Analyzes and comparisons of both processes, manufacturing time, tools used, tool investment, quality of parts manufactured, and economy of raw material.

The mechanization of the 18ct gold ring manufacturing process proved to be very positive, regardless of whether the investment value is somewhat higher compared to the artisan process, the return is a short time given its advantages, because with the use From this new technique it was possible to increase the production of wedding rings from an average of 20 pieces to 200 pieces manufactured daily by each person over a period of 8 hours as shown by a chrono analysis performed within a week of production. Alliances that once had a solder point now do not have this need, even because a solder point, with the wearing time of the alliance, tends to be a different color from the rest of the piece because its alloy is different from 18k gold alloy. Another positive point is that the machining of the rings leave chip-like residues that are easier to reuse the material, since in the process of grinding and sanding, the residues are more difficult to recover and have a definite loss of material much higher than in the process. Machining Another point is the advantage of eliminating the use of sandpaper on the parts because the cutting tools already let these rings shine, which will facilitate the process of polishing in relation to process and International Educative Research Foundation and Publisher © 2019

material loss.

A comparison of both methods of producing the alliances was performed over a week, and the result represented by a graph was obtained.

Table 1: Manufacturing Time by Craft Process per Minute Each 20 Pieces.

CRAFT PROCESS	QUANTITY OF PARTS	PROCESS TIME FOR MINUTES
LAMINATION	20 PCS	40 MINUTES
MEASUREMENT AND CUTTING	20 PCS	20 MINUTES
RING FORMATION	20 PCS	40 MINUTES
WELDING	20 PCS	30 MINUTES
RING ADJUSTMENT	20 PCS	60 MINUTES
CLEANING AND SANDING	20 PCS	260 MINUTES
POLISHING	20 PCS	30 MINUTES
7 PROCESSES	20 PCS	480 MINUTES

Source: Author

Table 2: Manufacturing Time by Process Mechanized For Minutes Each 200 Pieces.

CRAFT PROCESS	QUANTITY OF PARTS	PROCESS TIME FOR MINUTES
LAMINATION OF BARS	200 PCS	50 MINUTES
MEASUREMENT AND CUTTING	200 PCS	60 MINUTES
MICRO FOUNDRY	200 PCS	90 MINUTES
MACHINING	200 PCS	100 MINUTES
POLISHING	200 PCS	180 MINUTES
5 PROCESSES	200 PCS	480 MINUTES

Source: Author

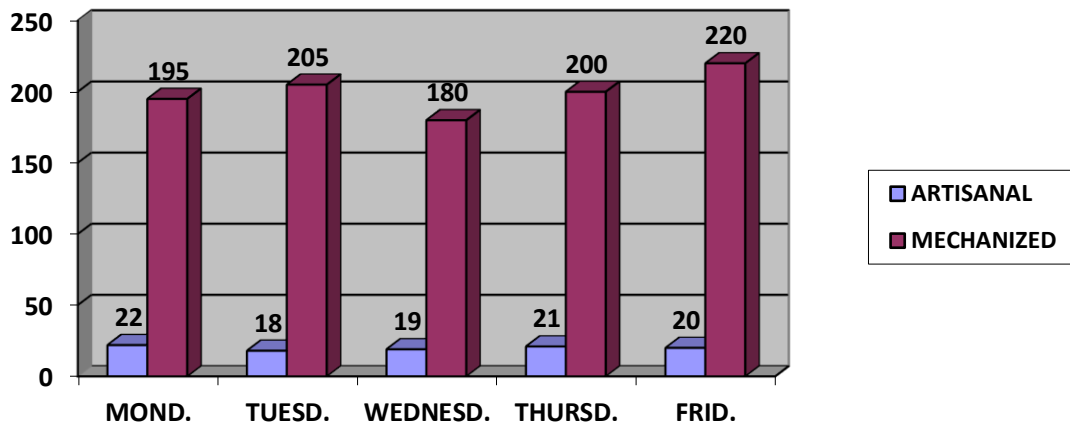
The table 3 below represents the handmade and mechanized comparison of the production of 18ct gold wedding rings in the period of 1 week. From then on the average was taken from the weekly production, and the result of the comparison by the handmade process of 20 pieces daily and the mechanized of 200 pieces daily.

Table 2: Production week

METHOD	DAY 1	DAY 2	DAY 3	DAY 4	TOTAL WEEK	AVERAGE
	MOND.	TUESD.	WEDNESD.	THURSD.		
ARTISANAL	22 PCS	18 PCS	19 PCS	21 PCS	100 PCS	20 PCS
MECHANIZED	195 PCS	205 PCS	180 PCS	200 PCS	1,000 PC	200 PCS

In graph 1, it is possible to verify the comparison of both production methods, a big difference that brings a productive result, very positive for the company.





Graph 1: Comparative Between Daily Production in Artisanal and Macanized Methods.

Source: Author

In addition to the production capacity, a comparison was also made using the 5W2H tool between the improvements that the mechanized process brought to the manufactured alliances.

DEFECTS AND IMPROVEMENTS	ARTISANAL	MECHANIZED
Welding mark	It has	Don't have
Sanding	Need	It is not necessary
Irregularity in the part	It has	Don't have
Good quality finish	Don't have	It has
Quantity produced	Low	High
Tool Investment	Low	Medium
Professional Skill	High	Medium

Table 4: Comparative Of The 2 Alliance Manufacturing Methods.

Source: Author

## 6. Final Considerations

Most of the time a large jewelry factory starts as a small artisan workshop, and most of the time this workshop starts in a small space at the professional's own residence, depending on the acceptance of his work in the market, this small workshop becomes a small business, and hence the need for investment in better equipment and improved techniques for the development of activities, aiming at process improvement, product quality and profitability of the company.

A small workshop usually does not have a large investment in tools, but as the business grows, new technologies and tools are adopted as the need for increased production and quality of jewelry.

In this case here, artisanal manufacturing is being replaced by a mechanized process that increases the production capacity, and with a higher quality the alliances produced by handcraft. There are more modern equipment that perform the same process as mechanized, but are much more expensive equipment and require a greater amount of raw material than the tools used in the mechanized process. Because 18k gold is a very expensive material, the use of certain equipment would not be feasible for the

manufacturing process in a midsize business.

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# Prevalence of Musculoskeletal Symptoms Related to Work in Dental Surgeons: A Wide Review of Current Medical Literature

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## ABSTRACT

**Introduction:** Repetitive Strain Injury (RSI) and Work-Related Musculoskeletal Disorders (WRMSD) are considered a public health problem because of their high prevalence in various professions, including dental professionals. Because of poor posture and organization at work, for example, dental surgeons occupy the top spot on sick leave due to temporary or permanent disability, accounting for approximately 30% of the causes of premature abandonment between medical activities.

**Objectives:** To identify the prevalence of musculoskeletal symptoms and their relationship with dentist activity and to evaluate the relationship between symptomatology and laboratory test results.

**Methodology:** A scan was performed, but Scopus, Web of Sciences and Google Scholar indexing databases were used to unite musculoskeletal disorders, dental surgeons, prevalence, laboratory tests. We found 15,000 articles, of which 56 were selected based on the best h index score or Qualis rating on the Sucupira platform.

**Conclusion:** The relationship between musculoskeletal pain and dentist activity is strong and in some cases these disorders can be detected on laboratory tests.

**Keywords:** Musculoskeletal disorders, dentists, prevalence, laboratory tests.

## INTRODUCTION

Repetitive Strain Injury (RSI) and Work-Related Musculoskeletal Disorders (WRMSD) have been a major public health problem in many industrialized countries because of their high prevalence in various occupations (VERONESI-JÚNIOR JR, 2008). According to Mascarenhas and Miranda (2011), the symptoms caused by musculoskeletal disorders are important work-related problems worldwide, being observed in individuals with different occupations, including health professionals. Because of poor posture and organization at work, for example, dental surgeons (CD) occupy the top spot on sick leave due to temporary or permanent disability, accounting for approximately 30% of the causes of premature abandonment between medical activities. (RASIA; DENISE, 2004).

Injuries caused by these disorders can lead to changes in the performance of daily activities, being a common cause of absence from work and with significant financial consequences due to workers' compensation and medical expenses, as well as prejudice to society and quality of life (VITTA). et al., 2007). Muscle pain, tiredness, difficulty sleeping, poor concentration, decreased production, dissatisfaction, discouragement are some of the symptoms. The most frequent disorders are tendonitis, low back pain and myalgia. Studies show that this group of injuries affects the quality of life of affected workers as they are limited to perform their daily activities, such as work, leisure, domestic activities and daily life, in addition to the various problems they face in the workplace. social and family life (SCHNEIDER, E. and IRASTORZA, X., 2010). This reality, however, remains underestimated and the lack of concern with prevention, the delay and the difficulty in identification is one of the biggest challenges to change this situation.

## **HISTORY, CONCEPTS AND USE OF THE TERM READ / DORT.**

Repetitive work has been around for a long time, with reports from the mid-1700s. Japan was one of the first countries to recognize this pathology as a result of the work. Around the 1980s, the first cases of RSI began to appear in Brazil, and they were linked to the profession of typists (BRASIL, 2001).

The first name used in Brazil was the term Repetitive Strain Injury (RSI), translated from the English name Repetitive Strain Injuries, and thus recognized by the National Institute of Social Security (INSS) of the Ministry of Social Security and Welfare (MPAS).

Work-related musculoskeletal disorders (WRMS) were initially referred to as repetitive strain injuries (RSI) because they present a casual factor related to the higher speed and repetition of movements performed during the workday (BRASIL, 2012).

However, this term suggested that this group of diseases encompass only those generated by repetitions of cumulative movements, not including other aspects involved, such as vibration, improper postures, pressure on the work tool or static overload. In addition, RSI are not always related to work practices (PARAGUASSU e LACERDA, 2019).

Due to these considerations, a name change occurred in 1998 for Work-Related Musculoskeletal Disorders (WMSD).

The term was changed because most workers with symptoms in the musculoskeletal system have no evidence of injury in any structure; and also because in addition to repetitive stress (dynamic overload), other factors at work may be harmful to the worker such as static overload (use of muscle contraction for prolonged periods to maintain posture); excess force employed to perform tasks; use of instruments that transmit excessive vibration; works performed with inappropriate postures (BRASIL, 2003).

On August 5, 1998, the Ministry of Welfare and Social Assistance (MPAS) issued Work Order 606 - Standard for Disability Assessment for Social Security Benefits - which uses the acronym DORT (Work-Related Musculoskeletal Disorders). rather than the acronym RSI (Repetitive Strain Injury), to "prevent defined causes from being named" (BRASIL, 2012).

According to the National Institute of Social Security (INSS, 2003), conceptually, it can be understood: WMSD as a work-related syndrome, characterized by the occurrence of various concomitant or not

concomitant symptoms, such as: pain, paraesthesia, heaviness, fatigue, insidious onset, usually in the upper limbs, but may affect lower limbs. In addition to physical symptoms, there is the emergence of psychological impairment, reflected in stress and the emergence of psychosomatic problems.

Garbin et al. (2001) defines them as disorders of muscles, tendons, synovias, nerves, fascias and ligaments, isolated or combined, with or without tissue degeneration. They mainly reach the upper limbs, and the scapular and cervical region. It has an occupational origin, resulting from the repeated and excessive use of certain muscles and the maintenance of inadequate posture.

According to the National Institute for Occupational Safety and Health (NIOSH) (1997), the term work-related musculoskeletal disorders refers to conditions involving the nerves, tendons, muscles, and support structures of the body; which are not caused by an acute event, but rather by chronic deviation, where work environment and performance contribute to these symptoms.

For Veronesi Junior (2008) such injuries are defined as a work-related syndrome, characterized by the occurrence of several concomitant symptoms or not, such as pain, paraesthesia, heaviness and fatigue of insidious appearance usually in the upper limbs, but may also affect lower members.

The definition applied by Helfenstein and Feldman (2001) represents the scenario in a didactic way, as follows: repetitive strain injuries (RSI) are not a disease or a nosological entity. In fact, RSI represent a heterogeneous set of musculoskeletal system disorders that are related to the work environment. There is a broad nomenclature in the literature to name RSI: Cumulative Trauma Disorders or Disorders, Occupational Overload Syndrome, Repetitive Stress Syndrome, Occupational Musculoskeletal Disorders, Upper Arm Syndrome, Occupational Cervicobrachial Syndrome, Hypersolicitation Syndrome, Chronic Upper Limb Pain Syndrome, Repetitive Injuries, Occupational Overload Injuries, Repetitive Stress Occupational Injuries, Work-Related Upper Limb Disorders.

According to Gonzalez LR et al. (2008) the term RSI / WMSD should not be used as a diagnosis since it refers to a group of musculoskeletal disorders, already described in the medical literature. In using the term, one must not forget to mention the diagnostic hypothesis. It is good practice to cite the diagnosis and, in addition, the designation RSI / WRMSD. Examples include RSI / WRMD-compatible right spinal tendonitis, RSI / WRD-compatible right carpal tunnel syndrome.

## **DIAGNOSIS.**

RSI / WMSD are pathologies that are difficult to diagnose since they depend on the subjective report of those who have them, as well as on psychological aspects and individual susceptibility (BRASIL, 2001).

The diagnosis of RSI / WRMSD involves complicated aspects because it addresses the conduct that must be taken, not only in the clinical area, but also in the social security, labor, civil liability and sometimes even criminal areas. The first complicating aspect stems from the characteristics of the clinical picture and the multiple factors that trigger it. In the case of RSI / WRMSD, the clinical picture is heterogeneous, with multiple faces. The cause-effect relationship is not direct (BRASIL, 2001).

Individual susceptibility to musculoskeletal system disorders can be discussed by variables such as age, gender, anatomical differences, tissue type, alcoholism and smoking, personality, psychiatric disorders,

general inflammatory diseases, neuromuscular diseases, metabolic diseases, and neoplasms ( BRAZIL, 2001).

There may be predisposing conditions for RSI WMSD cases, but it is important to emphasize that the labor factor does not decrease, it only reminds us that the symptoms may be the result of factors other than labor. (BRAZIL, 2001)

It is important to investigate in all cases in clinical investigation of RSI / WMSD the possibility of other diagnoses. It is crucial to recognize that many of these individuals may not have musculoskeletal injuries. A considerable proportion of these patients may have other diseases, and delayed diagnosis leads to major costs for the patient and society. (GONZALEZ, et al., 2008)

Depending on the stage of the disease, the additional tests requested may be within normal limits.

For example: tendonitis or spinal degeneration in early or late phase of tendon regeneration (GONZALEZ LR. ET AL, 2008).

Complementary exams should be ordered according to their diagnostic hypothesis and the need to establish possible differential diagnoses, as well as for the correct establishment of the causal link with the work (GONZALEZ L.R. et al, 2008).

Occupational psychosocial factors such as a pleasant working environment, good interpersonal relationships, and job satisfaction tend to minimize the onset of these organic changes regardless of one's personality profile, while stress, depression, anxiety, and excessive worry are related to a higher frequency of disease development (MEDEIROS and SEGATTO, 2012)

It is worth mentioning that the epidemiological data deserves to be researched. Since there are many other workers performing the same activity with similar complaints in that sector of the company, this data will be of great value when sustaining the nexus with work.

First, however, consideration should be given to establishing a work-related etiological diagnosis. Therefore, it is important to know not only the work environment, but how your patient relates to his or her work.

## **RISK FACTORS**

According to the Ministry of Health Normative Instruction No. 98 of December 5, 2003: the development of RSI / WRMSD is multi-causal, and it is important to analyze the risk factors directly or indirectly involved. The term "risk factor" generally means work factors related to RSI / WRMSD. Factors were established in most cases through empirical observations and then confirmed with epidemiological studies.

Risk factors are not independent. In practice, there is the interaction of these factors in the workplace. In identifying risk factors, the various information should be integrated.

In characterizing exposure to risk factors, some elements are important, among others:

- a) the anatomical region exposed to risk factors;
- b) the intensity of the risk factors;
- c) the temporal organization of the activity (for example, the duration of the work cycle, the breakdown of breaks or the timetable structure);

d) the time of exposure to risk factors.

The risk factor groups of RSI can be related to (Kuorinka and Forcier, 1995):

a) the degree of suitability of the workplace to the attention zone and vision. The size of the workplace may force individuals to adopt postures or work methods that cause or aggravate musculoskeletal injuries;

b) the cold, the vibrations and the local pressures on the tissues. Localized mechanical pressure is caused by the physical contact of straight or pointed corners of an object or tools with body soft tissue and nerve pathways;

c) inappropriate postures. Regarding posture there are three mechanisms that can cause RSI:

c.1) the limits of joint amplitude;

c.2) the force of gravity providing an extra load on the joints and muscles;

c.3) mechanical injuries to different tissues;

d) the musculoskeletal load. Musculoskeletal load can be understood as the mechanical load resulting from:

d.1) a tension (for example, the biceps tension);

d.2) a pressure (for example, the pressure on the carpal canal);

d.3) of a friction (for example, the friction of a tendon over its sheath);

d.4) of an irritation (for example, irritation of a nerve).

Among the factors that influence musculoskeletal load, we found: strength, repeatability, duration of load, type of grip, wrist posture and working method;

e) the static charge. Static loading is present when a limb is held in a position that goes against gravity. In such cases, muscle activity cannot revert to zero (static effort). Three aspects serve to characterize the presence of static postures: the observed postural fixation, the tensions related to the work, its organization and content;

f) the invariability of the task. The invariability of the task implies physiological and / or psychological monotony;

g) cognitive requirements. Cognitive demands can play a role in the onset of RSI, either causing increased muscle tension or causing a more general stress reaction;

h) work-related organizational and psychosocial factors. The psychosocial factors of work are the subjective perceptions that the worker has of the factors of work organization. As an example of psychosocial factors we can cite: considerations regarding career, workload and pace and the social and technical environment of work. The individual's psychological "perception" of the demands of work is the result of the physical characteristics of the workload, the personality of the individual, previous experiences, and the social situation of the work.

## **READ / DORT AND THE ACTIVITIES OF DENTAL SURGEON.**

Dentistry has been considered a profession often associated with occupational diseases (Alexandre et al, 2011), with a direct relationship between high stress and physical pain indices and irregular ergonomic

aspects, which is expressed through inadequate postures, tiredness, as well as pathological conditions such as WRMSD and stress-acquired diseases (MIYAMOTO et al, 1999).

Musculoskeletal disorders are common and prominent complaints among the DCs and reveal the close relationship between dental practice and the development of RSI / WRMSD due to the physical and psychological distress to which the professional is subjected in his daily work (MEDEIROS and SEGATTO, 2012).

The practice of repetitive movements in performing dental procedures has been documented as a strong risk factor for different types of pain. Time constraints and environmental issues are aggravating to professional stress. Mental overload and possible pre-existing conditions may contribute to these conditions (RISING DW, 2005).

The dental practice provides the exposure of professionals to the risk of contracting occupational diseases, because the discomfort and inadequate posture of dentists during work, performing repetitive movements, and the existence of prolonged working hours associated with stress and fatigue, are some of the determining factors for the appearance of musculoskeletal disorders and diseases (BERNARDI and LOPES, 2016).

Bernardi and Lopes (2016) reinforce that the dentist belongs to a professional group exposed to a considerable risk of acquiring some type of RSI, provided that certain factors inherent to the performed tasks are present, such as: excessive force, incorrect postures, repetition of the same movement and mechanical compression of the tissues. They also point out that dental surgeons end up adopting inappropriate or vicious positions, which may cause harm to their health and that the lack of in-depth knowledge about RSI / WMSD leads the professional not to seek medical assistance in face of symptoms related to the position of the patient. job.

For Barbosa et al (2004), the physical discomfort and poor posture of the dental professional are determining factors for the appearance of occupational injuries, bothering and sometimes incapacitating the professional to perform his task.

According to Finsen, Christensen and Bakke (1998), the clinical activity of dentists has as its peculiarity the execution of their craft in an area restricted to a few tens of millimeters: the oral cavity. This fact demands that these professionals require postural invariability which can generate unhealthy working conditions.

The sitting position, which is the main one adopted by this professional class, in turn, is defined as the situation in which the body weight is transferred to the seat of the chair through the sciatic tuberosity, the soft tissues of the gluteal region and the thigh, as well as to the ground through the feet (PYNT; HIGGS; MACKEY, 2001). Thus, maintaining this posture for prolonged periods may lead to biomechanical changes, such as mechanical compression of these regions, muscle imbalance between trunk extensor and flexor force and decreased stability and mobility of the lumbar-pelvis-hip complex, thus contributing to the onset of musculoskeletal symptoms in these regions (BARROS; ANGELO; UCHÔA, 2011).

Dentistry is a profession in which its clinical performance is restricted to a specific area, the mouth, and requires repeated applications of precise force. These situations require a fixed posture that can create occupational hazards for both dentists and dental students. In addition, technological advances have led to

a higher workload and although such technologies simplify and improve dental care, optimal handling is often overlooked (GARBIN et al. 2001).

An interaction of several factors is necessary to trigger these disorders, especially those related to the lack of ergonomics, orientation or lack of attention in their use, such as anatomical and physiological fatigue (due to muscle tension), wrong work posture, repetitive movements, poorly designed workstations, and long hours of work. Once the risks are identified, steps should be taken to decrease the likelihood of this disease manifesting. (Carvalho et al., 2009)

The traditional dentistry job market has undergone radical changes that would make the profession stressful and often associated with certain health problems (KOTLIARENKO, 2005).

For Freitas (2004), there was a significant increase of dentists in the public service network due to the growing demand. Also according to the author, there were changes in the dental labor market from the 90's, where the public sector began to have relevance to dentists.

Santos, F. and Barreto S. (2001) point out that systematic studies on musculoskeletal disorders in dentists (DCs) have been carried out since the 1950s and are responsible for the first proposals for changes in the work process of dentists, including the shift from work from standing to sitting. However, knowledge about these problems is still incipient, leaving gaps in the understanding of the natural history of clinical conditions.

According to Regis Filho (2006), only a few authors in the last three decades have related dental procedures with the emergence of RSI / WMSDs in dental surgeons and dental hygienists.

Corroborating this information, Medeiros and Segatto (2012) state that in the literature there are few studies related to musculoskeletal disorders related to dental work, as well as their prevention. For Ferreira et al (2018), however, dental professionals are very susceptible to these pathologies and there is a need to inform and raise awareness.

### 1.5 OCCUPATIONAL RISKS OF ODONTOLOGICAL PRACTICE.

In their literature review work, Nogueira, Bastos and Costa (2010) present as main occupational risks of dental practice:

- Physical Hazard: noise, vibration, ionizing and non-ionizing radiation, extreme temperatures, poor or excessive lighting and humidity.
- Chemical Risk: dust, mists, vapors, gases, mercury, chemicals in general, among others.
- Ergonomic Risk: incorrect posture; absence of the assistant professional, or lack of training; lack of planning; excessive work rate; repetitive acts; among others.
- Biological Risk: bacteria, fungi, bacilli, parasites, protozoa, viruses, among others that, due to their nature, concentration or intensity of exposure, are capable of causing damage to the health of the worker. Accidents can occur causing the transmission of these agents through direct contact with the lesion, secretions or blood, or aerosols, needles or scalpels and inadequately sterilized instruments.

For Barbosa, G. et al (2000), the risk factors considered for RSI / WRMSD are repetitive movements, the use of non-ergonomic appliances, inadequate work posture, the use of excessive force in procedures, insufficient rest, lack of physical fitness, psychological pressure for results and productivity goals, among others.

Rossetitni (1986) points out that "... the details of the dental surgeon's clinical act require permanent attention and constant alertness, making this professional often work under emotional stress and increased stress.

And Matias (2004), states that stress usually translates into somatic manifestations such as body aches mainly in the hands and arms and also, general physical tiredness. Souza (1998) adds that in addition to the tensions of the clinical environment within the office, stressors of modern life contribute as an emotional overload.

## EPIDEMIOLOGY

Musculoskeletal conditions affect lifelong people in all regions of the world and were the leading cause of disability in four of the six World Health Organization (WHO) regions in 2017 (second in the Eastern Mediterranean region and third in the region of Africa).

The Global Burden of Disease (CGD) study provides evidence of the impact of musculoskeletal conditions, highlighting the significant disability burden associated with these conditions. In the 2017 CGD study, musculoskeletal conditions were the second largest contributor to global disability (representing 16% of all disability years), and low back pain has remained the leading cause of disability since it was measured in 1990. James, SL (2018). Although the prevalence of musculoskeletal conditions varies by age and diagnosis, between 20% and 33% of people worldwide live with a painful musculoskeletal conditions (PARAGUASSU et al., 2019).

Repetitive Strain Injury (RSI) and Work-Related Musculoskeletal Disorders (WRMSD) are the diseases that most affect Brazilian workers. The finding is from the Health Brazil 2018 study, from the Ministry of Health. Using data from the Notification Disease Information System (Sinan), the survey points out that between 2007 and 2016, 67,599 cases of RSI / WRMSD were reported to the folder. In this period, the total of registrations grew 184%. Both the volume and the increase in cases in this period signal warning regarding the health of workers (LEMOS, DUQUE e MACHADO, 2019).

Regarding dental professionals, one of the most affected classes with RSI / WRMSD, La Rochelle (2017) conducted in the United States, a study with 1000 generalist dentists and 2300 orthodontists using a 33-question assessment instrument addressing general demographics, volume and work habits, physical activity, and prevalence and severity of WMSDs. As for the prevalence of WMSD, the results were significantly different between the two specialties. For general dentists, 64% reported at least one symptom, compared to 41% of orthodontists, but reported similar rates of WRMD in each area except the shoulder, which was significantly lower in generalist dentists than in orthodontists (38% vs. 79%, respectively) (ARADA e PEREZ, 2019).

In a survey of public service dentists in the cities of Dammam and Riyadh in Saudi Arabia, of the 140 dentists who answered the adapted "Nordic Musculoskeletal Questionnaire" (QNSO), 82.9% of dentists (63 men and 77 women) presented one or more symptoms in the musculoskeletal system, which include pain (59.3%) as the most severe symptom in the neck and shoulders region followed by headache (28.6%), then weakness (15.7%). Dentists had a significantly higher frequency of pain, headache, and weakness than their male counterparts. Eighty-three dentists (59%) had pain and discomfort in different



parts of the locomotor system in the last 12 months. The highest percentage of dentists had neck pain and discomfort (67.9%), followed by the lumbar region (52.1%). Symptoms were more pronounced among female dentists. Dentists who reported symptoms in the last seven days had a higher frequency of pain and discomfort in the neck, shoulders, lower back and / or headache. (ABDULJABBAR, T.A., 2008).

The QNSO modified by the Taiwan Institute of Occupational Safety and Health was also answered by 197 dentists, 146 men and 51 women, members of three groups: the Association of Oral and Maxillofacial Surgeons, the Family Dentistry Association and the County Dental Association. from Taichung. The reported symptoms compared using the chi-square test had the following results: More than half of respondents had symptoms in the shoulders (75%), neck (72%) and lower back (66%) in the year prior to the survey. . The three body parts with the lowest prevalence (13 and 15%) of disorder were hips / thighs / buttocks, knees and ankles / feet. Seven percent of respondents indicated no problems anywhere in their bodies. (LIN, T-H., 2012)

The same questionnaire when used to determine the prevalence of musculoskeletal symptoms in 73 dentists in a city in southern Andhra Pradesh, India, revealed that seventy-eight percent (78%) had a prevalence of at least one symptom in the last twelve months. . The most common areas affected in order of magnitude were neck (52%), lumbar region (41%), shoulders (29%) and wrist (26%). One third of practitioners (40%) required sick leave during the previous twelve months. The conclusion was that the high prevalence of musculoskeletal symptoms affects the daily practice of more than one third of these professionals. (Muralidharan, Fareed, and Shanthi., 2013).

Using another protocol called “Socio / Sanitary Survey” adapted from Lech and Hoefel, which also aims to investigate the manifestations related to RSI / WRMS, as well as the socioeconomic profile, Regis Filho (2006) after research with 771 Santa dentists Catarina reached the following results: When asked if they had any painful manifestation in the upper limbs, shoulder girdle or neck, due to the repetition of the same movement pattern in the profession, 437 (56.68%) answered yes , and 334 (43.32%) had negative answers. Values similar to those found by Santos Filho (1998), with 58% of dentists complaining of musculoskeletal pain in one or more regions of the upper body segment. Kosmann (2000) found 81.51% of these professionals complaining of some kind of physical pain or discomfort.

In São Bernardo do Campo, using QSNO with a sample of 100 public dentists, Bachiega, J.C. (2009), obtained in their results 97% of professionals reporting some type of sign or symptom of WMSD such as pain, discomfort or numbness. Regarding the anatomical location of the musculoskeletal symptom, the most reported region was the neck (81%), followed by the lumbar region (78%), shoulders (70%), wrist (67%), dorsal region (65%), hips (51%), arms (53%), forearm (36%) and elbows (33%).

In the Midwest region of Santa Catarina State, the QNSO, together with the SRQ-20 “Self-Reported Questionnaire” that characterizes the mental health of respondents, were answered by 153 dentists. Of the total dental surgeons interviewed, 142 (93%) reported having had musculoskeletal disorders in at least one body part in the last year as a result of their professional activity. The most prevalent regions reported by professionals were cervical spine and shoulder pain, affecting 107 (70%) and 99 (65%) of professionals, respectively. (KOTLIARENKO et al, 2009)

In a survey conducted by the Regional Council of Dentistry of Roraima with dental surgeons, in the 12 months prior to the survey, only 20% reported no pain, 34% of respondents did not seek help, 20% had a

diagnosis of low back pain, 13% received Dort diagnosis, 7% percent with herniated disc and 6% had not yet completed a diagnosis.

In a study by Pereira et al. (2004), both general dentists (40.71%) and specialists (43.57%) reported the presence of WMSD.

In the study by Santos, L. et al (2013) conducted with 44 dentists of the Pernambuco Military Police, the majority (84.1%) said they felt some pain and among those who were in pain the most mentioned regions were, back (75.7%), neck (45.9%), hand (40.5%) and shoulder (40.5%) and approximately half (51.4%) had moderate pain and 45.9% had pain Light.

Studies conducted in several countries converge to a strong relationship between the activity of the dentist and the symptoms of RSI / WRMSD. According to Casarin (2008), 60% of dentists present some type of musculoskeletal pain in the workplace, with the neck, back, shoulders and upper limbs being the most referred sites of pain.

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# **Implementation of the OEE Indicator in the Welding Process in an Air Conditioning Factory in Manaus City**

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## **Abstract**

*Factories are continually looking for new ways to produce more at lower cost and fewer failures, thus preventing scrap or production losses. Given this, increasingly effective means of measuring performance are used so that other details can be studied that lead to difficulties and bottlenecks in production. Overall Equipment Effectiveness - OEE is a calculation that provides knowledge of machine availability, production performance, and the quality with which parts are assembled or made. This paper is a case study carried out in an air conditioning factory, with the main objective the implementation of the monthly OEE; as specific objectives, present the concepts and their applicability within a company; analyze the welding process of the factory; present a proposal for improvement through the result obtained. As expected results, the OEE can provide the information needed for internal improvement and thus, correction and prevention of failures and economic losses for the organization.*

**Keywords:** Production; Availability; Quality; Performance; Industry;

## **1. Introduction**

The demand for increased production that can offer the market a product that can offer satisfaction has become one of today's main challenges for the industrial sector. This is because these industries are increasingly investing in machinery that can increase the amount of products that can be assembled and

offered to consumers.

The industry has been looking for ways to increase its productivity and reduce its errors or failures, making it increasingly competitive. To this end, the OEE indicator helps by highlighting machine availability, process performance and quality, which involves the ability to produce with the smallest possible error or failure.

This paper is a case study of a 7,500, 10,000 and 12,000 Btus split window and split air conditioner assembly plant. Where were used as methodology, the exploratory research, descriptive character. Using observations, Cause and Effect diagram and 5W2H to offer a proposal that can offer improvements in the welding industry.

The main objective was the implementation of the monthly OEE; as specific objectives, present the concept of OEE and its applicability within a company; analyze the welding process of the factory; submit a proposal for improvement through the result obtained by the OEE.

The lack of OEE application makes the industry vulnerable to product losses, time and reduced revenues. Compromising the entire production process in the long term, preventing them from achieving more sales and offering more satisfaction to their end customers. Given this, the question is: How can OEE help in the internal improvement of the production process of an air conditioning assembly company?

## **2. Theoretical Referential**

### **2.1 Total Productive Maintenance (TPM)**

With the high degree of competitiveness in the market, it has become extremely important for companies to seek to improve the efficiency of their products and their production processes so that costs are reduced as best as possible by identifying and eliminating losses and targeting the best sustainability proposals [1]. The Total Productive Maintenance (TPM) methodology proposes the overall effectiveness of the equipment, promoting the reduction of the largest waste in the production processes. This system brings improvements to the organization and equipment, as well as internal operational processes, with a focus on problem prevention.

Following the technological trajectory, currently the OEE is a new trend launched in current companies and has been widely used, and is currently being treated as the most widely accepted indicator for performance evaluation. Thus, the OEE formula is used to find where they are inserted to find the areas that will provide the highest return on assets. The OEE will identify improvements in sectors such as quality, reliability, tradeoffs, setups, and other factors that influence production [2].

### **2.2 OEE indicator**

Turning to the measurement of improvements that are made by TPM, one can cite the tool popularly known as OEE (Overall Equipment Effectiveness), within the first methodology, with OEE it is possible to detect the equipment of the productive sector with less efficiency and performance in order to make them act more efficiently and improve them [1].

The OEE indicator can be classified according to the three indices that verify its efficiency: first, availability; second, performance; The third index that makes up the OEE is the machine analyzed is

producing to the correct specifications, generating better quality parts [3].

It is noteworthy that the use of the OEE tool favors an extended view of the life of the equipment and attributes that the conditions of use are essentially influenced by its availability, performance and quality of compliance. By indicating the measurement of losses that may occur even when equipment is working, the OEE promotes problem and root cause analysis to make process improvement actions more efficient and increase equipment capacity utilization.

Thus, the OEE is also considered as a definitive indicator for measuring equipment performance, that is, a tool that assists in the planning of productive capacity, process control and improvement and the cost calculation of production losses [4]. Also regarding the definition, the OEE is an equipment loss detection system, not a fault assessment system [5]. It expresses the efficiency of the equipment in a reduced metric, allows evaluation of the effects of the improvement actions developed and the identification and quantification of the detected problems in a standardized way. The OEE shows the hidden factory that exists inside the factories, showing the costs that the waste incurs.

However, it should be noted that there are many challenges associated with implementing OEE to monitor and manage production performance, for example: How it is defined, interpreted and compared; How OEE data are collected and analyzed; how it is monitored and by whom; Its alignment with the overall production strategy; how it could be used for sustainability [6].

Thus, it is possible to relate the six major losses mentioned in the TPM to the OEE factors. As for the types, they are classified in 3 indices, known as: Availability, Performance and Quality [7]. Where calculations are made differently, the availability present in the formula is calculated by dividing the actual time required for production by the time available for production. Performance is calculated by dividing the speed at which the equipment requires to be ready by the nominal speed on the process sheet [8]. Thus, it is added that quality is calculated by the ratio of the quantity of products in good condition to the total quantity of products produced. The complete formula is represented by Figure 1.

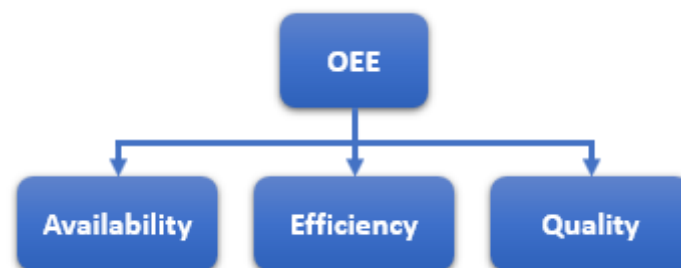


Figure 1: Formula for calculating OEE

Source: Koda (2013).

### **2.3 The use of OEE in the refrigeration industry**

In the application of OEE in refrigeration, the injection of polyurethanes was used, an idea proposed by the company's manager. His goal was that after one year of the OEE utilization period, the company would have an efficiency performance of 85% per month compared to the OEE non-utilization period. It was concluded from Lima's experience that the study generated positive feedback, as it contained the 85% target, that is, the use of the OEE indicator provided success [2].



In order to be deployed in a refrigeration industry, the equipment that most causes delays or bottlenecks in production needs to be analyzed by checking its availability [10] and its efficiency in the production process [11], as shown in Figure 2.

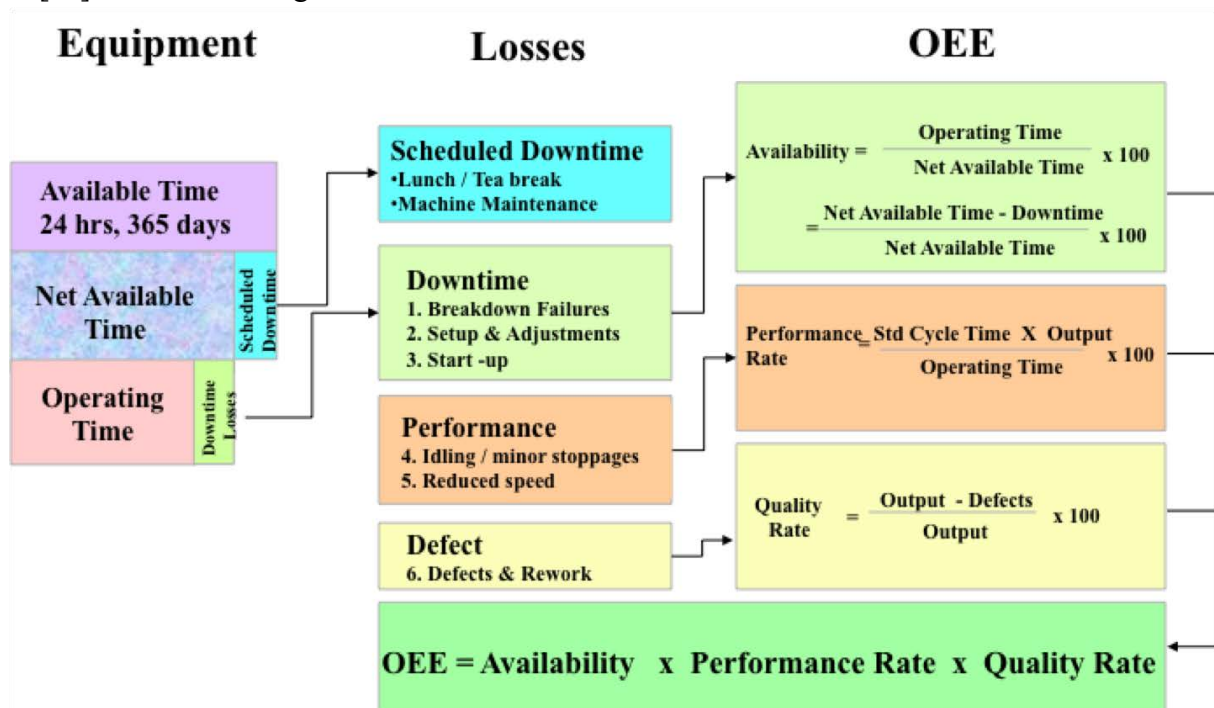


Figure 2: OEE Deployment Process

Source: Rodrigues et al. (2013).

### 3. Methodology

The company studied is an assembly plant for air conditioning parts. The knowledge of the difficulty presented in the factory was discriminated from the visit that was made to the place where the subassembly of the parts is made. For in-depth knowledge of the procedures performed, observations and interviews were conducted with the responsible leader and welding operators to know the time used in the process.

In order to know the welding process of the parts and the bottleneck that is hindering the efficiency of the production process, it was necessary to perform mappings directed to the obstacles of a fast and efficient production [12]. Thus it was obtained the knowledge that the parts that are assembled in the welding sector are fitted in the converter and air evaporator, are small irons that are joined through a process called brazing.

### 4. Applied Studies

The sector with a delay within the factory is welding. This sector consists of 06 stations, which work daily in two 10h shifts. The site consists of a support table where each operator feeds his station with the parts that need to be welded. It is used a device that is changed after the welding of three pieces that compose the process. These parts are part of the internal structure of the air conditioner.

The welding process is carried out by torch, using LPG gas to ignite the flame, along with oxygen. As a

necessary utensil and assembly, a welding rod is used. In this way, the parts are assembled, boxed and directed to the warehouse, then the parts will be redirected to other sectors that will use these parts to assemble the 7.500, 10 thousand and 12 window and split model air conditioner. thousand Btus.

For the realization of the bottlenecks presented in this sector it was necessary to make an in-depth observation of the procedures performed by the operators at the time of welding of the parts, for this it was necessary to use the cause and effect diagram and the action plan and storm of ideas.

#### 4.1 Problems Identified

The welding process of the air conditioning factory currently has 06 stations, with two shifts daily, 10h each. Each station has a number of welded parts according to the model of the air conditioner. For window models, the established production average is 123 pieces / hour per shift. For split models, 87 pieces / hour per shift were set.

Assuming that it is 10h each shift, then the production projection is: For window models it is 1,230 per shift; for split 870 shift welded parts. According to documentary analysis performed at the post observed, at the end of each shift the operators are presenting as average quantity produced for each model: 84 pieces per hour, for the window model, 847 pieces per shift, a difference of 360 pieces. For split models the output is 455 pieces, a difference of 415 pieces.

These differences are known to have a significant impact on process performance, where efficiency contributes to the agility and manufacturing of larger quantities of the product. Thus, analyzing the availability of the equipment found the following characteristics:

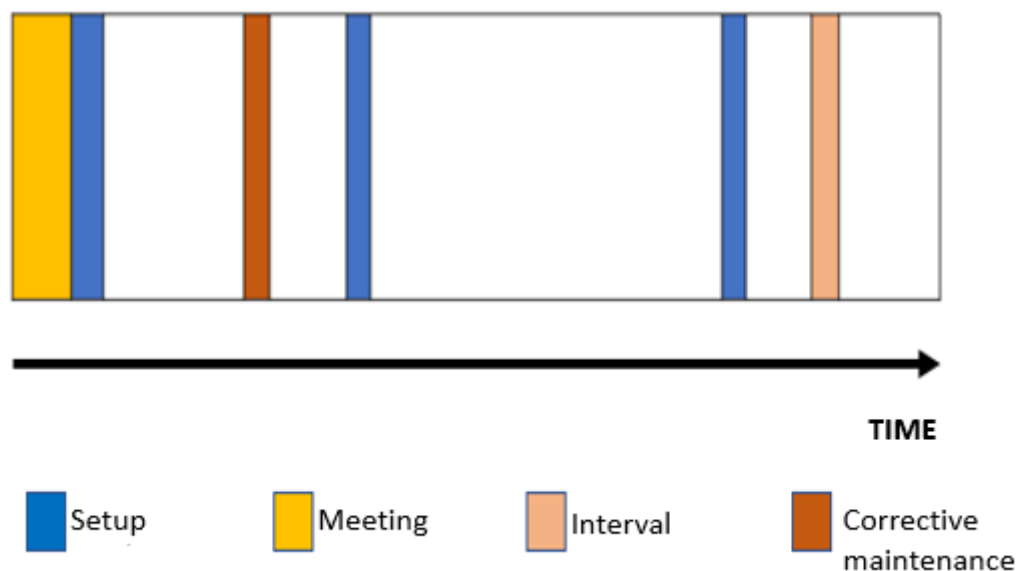


Figure 3: Timeline demonstrating equipment availability

Source: Author, 2019.

The figure above shows the availability of welding equipment, as well as the losses suffered by the intervals that occur during the shift. The blank space corresponds to the production time the equipment is actually being used, the colored gaps show the stops that prevent the equipment from being fully available and make the number of welded parts smaller.

## 5. Results and Discussions

According to the mapping performed in the parts welding industry, the production leader with the responsible for quality and performance needs to implement the OEE to be aware of the availability, performance and quality of available equipment.

Once the proposal for the verification of the important percentages for decision making power in the production line was accepted. Calculations were made for measurement and knowledge of the numbers that will allow the welding process to have continuous improvements.

Thus, considering that the company has two shifts of 10h each, and currently has 50 minutes of scheduled shutdown in each of the shifts and 20 minutes of maintenance at the end of both shifts, it can then be developed to calculate the percentage of availability of the system. equipment within the industry:

### 5.1 Calculation Availability

Scheduled time =  $(20 \times 60) - 100 \text{ min} = 1,100 \text{ min}$

Time available for production =  $1,100 - 20 \text{ min} = 1,080 \text{ min}$

$1,080 \text{ min} / 1,100 \text{ min} = 0.98\% = 98\%$

NOTE: The average according to Word Class is 90%.

The speed at which production is performing the welding process can be represented by calculating Performance. Considering that in the shift that was observed, at the end of the observation it was verified that the quantity produced was 762 pieces, considering that in average it gets to produce 60 pieces / hour, when it takes an average between the quantity hourly output of the two models mentioned above. It is understood that it is one piece per minute. Performance can be ascertained as follows:

### 5.2 Performance Calculation

Scheduled time = 1,100 min

Production Time Available = 1,080 min

Time that should produce 762 pieces = 762 min

$762 \text{ min} / 1,080 \text{ min} = 0.70 = 70\%$

NOTE: The default by Word Class is 95%.

Some details negatively impact the company's performance, one of them is the employee's ability to perform their activities more efficiently using the full capacity of the equipment. However, the lack of skill acquired by the employee's ability to perform the activities faster makes the company obtain a reduced percentage compared to the Word Class standard.

Next, quality is geared towards production with minimal errors, faults that generate scrap. During the

observation and visit at the company, it was found that at the end of the shift visited, 11 refuses were obtained. Based on this information the quality was calculated:

### **5.3 Quality Calculation**

$$\text{Quantity} = 762 - 7/762 = 0.98 = 98\%$$

It can be observed that the materials that are distributed for welding are of quality, the attention given to the process is made with quality because the losses are small compared to the amount produced in the established conformities. Based on these three results, the OEE calculation can be performed, as shown below:

### **5.4 OEE Calculation**

$$\text{OEE} = 0.98 \times 0.70 \times 0.98 = 0.67 = 67\%$$

As can be seen, the implementation of the OEE to measure availability, performance and quality analysis provides information on what can be improved to make the company obtain even higher revenues than in the previous period. You may find that the company can still improve the welding process of parts. The smallest item is performance, which shows that although the company has a projected production of parts per hour, operators are still not being able to reach enough speed to produce this quantity even if the equipment has good availability.

However, based on these data, the main focus for performance improvement allowed an analysis of the stops performed in the shift, seeking a way to reduce the 50 minutes of scheduled shutdown. Setup only takes 20 minutes and 10 minutes for corrective maintenance for the welding machine. For this an analysis was developed from the cause and effect diagram and the 5W2H.

### **5.5 Storm of Ideas**

From the information gathering and interview with the welding operators, it was attributed to this difficulty in the speed of production to: the lack of manpower, lack of parts to supply the table, need to dedicate this same person to forward the assembled parts up to the warehouse.

### **5.6 Cause and Effect Diagram**

From the information provided by the collaborators themselves, it was possible to trace the main causes that may have led the industry not to reach the quantity of parts produced at a considerable speed.

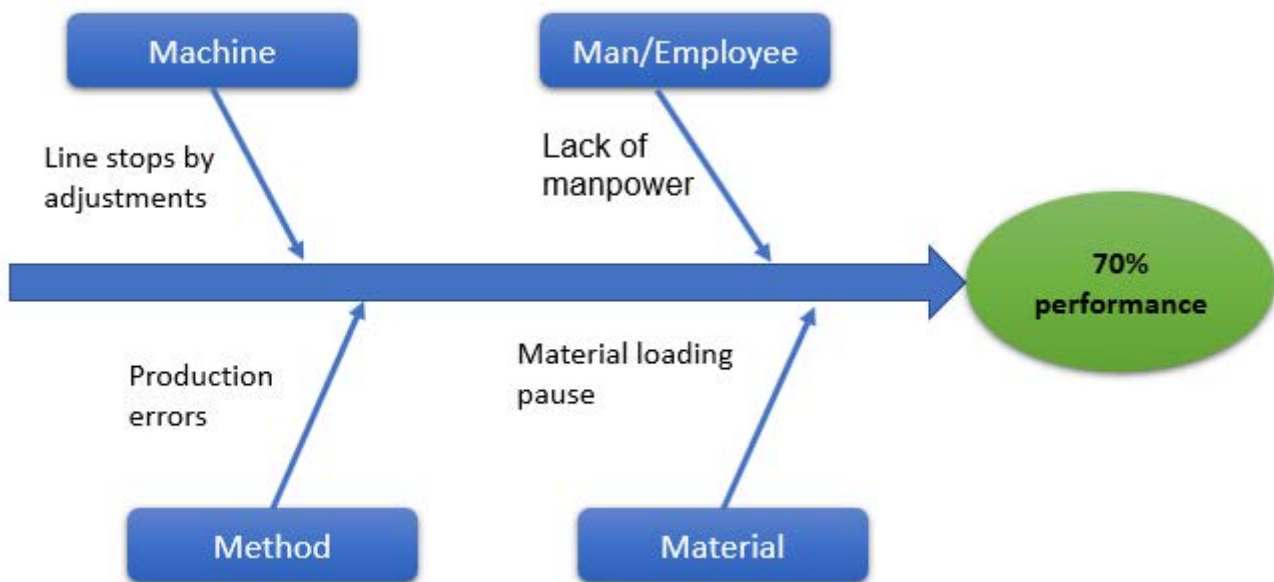


Figure 4: Cause and Effect Diagram of the Welding Process

Source: Author, 2019.

### 5.7 5W2H

Following the survey of the Cause and Effect Diagram, it was possible to develop an action plan aimed at continuous improvement in performance, so that this percentage known through the OEE is gradually increased and the performance measurement is performed monthly as a means of analyzing the difficulties or bottlenecks of production and, solved in a timely manner so that it has no effect on revenues.

Table 1 - 5W2H focused on improving OEE performance results

What	Why	Where	When	Who	How
Development of welding employee activities	Step by step training	Welding Sector	15 days	Leader of production	Free
Welding Machine Maintenance Scheduling	Weekly Inspection	Welding Sector	weekly	Machine Maintenance	R\$ 1500,00
Welding Machine Maintenance Scheduling	Add another operator in the process	Welding and Storeroom Sector	30 days	Additional labor	Free

Source: Author, 2019.

## 6. Final Considerations

With the technological advancements of the market, the industries are every day looking to satisfy the needs of the customers, with this more and more products focused on the welfare and practicality of the company is launched in the commerce. The air conditioner, in turn, is an appliance of utmost need in most homes, so its demand becomes increasingly constant.

Being a continuous scale of production, measuring the quality, availability and performance of a machine process makes the bottlenecks and difficulties pertinent to a production process known.

In the case study of this article, it is noted that the welding plant had almost full availability of equipment to produce full capacity, but it is impossible for machinery to be available 100% due to the required and required shutdowns, considering also in this range breaks for the operator to go to the toilet. However, this performance can be improved by taking advantage of time by preventing unnecessary downtime.

Thus, further studies are focused on the impacts that such procedures may have on the long term for the factory, considering the quality of the final product and market satisfaction.

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## Reducing Process Setup in a Smart TV Card Factory

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### Abstract

*Companies are looking for new ways to carry out their processes automatically and accurately. Thus, the machines that are part of the process need to be stopped, called setup, so that they are prepared to continue producing other products on the production line. This work was developed with the main objective of showing the effect of reducing the setup time in a television factory, and as specific objectives to present the concept of Fast Tool Change; present the negative effects of a production that has a lengthy setup; punctuate the benefits of reducing setup time in a factory. The methodology used is focused on exploratory research where it was necessary to visit the production line of a 32 ", 42", 50 "and 55" Smart TV board manufacturing company, in order to apply the data collection instruments. To verify the failures resulting from the shutdowns and the problems that are related to the production setup time, quality tools such as Ishikawa Diagram, 5W2H and before and after study flowchart were used. As expected results, the company was able to reduce machine preparation delays, batch delays became minimal.*

**Keywords:** Production; Setup Time Reduction;

### 1. Introduction

Globalization, market friendliness, and technological advances are increasing the demands of factories to increase their production, this market behavior forces companies to improve their processes as a means of reducing time to increase production efficiency, making it competitive in the market.



Thus, industries make efforts to reduce machine time to make production not stand still, and have no production delays or bottlenecks, so the shorter the machine's production time, the shorter the batch produced and This impacts the processes.

Being aware of the relevance of reducing the setup time, this paper aims to highlight the effect of reducing the setup time in a television factory, and as specific objectives to present the concept of Quick Tool Change; present the negative effects of a production that has a lengthy setup; punctuate the benefits of reducing setup time in a factory.

As a methodology, an exploratory research was applied in a television factory of the Manaus industrial pole, where internal visits were made to find the bottlenecks that hinder the delivery time of the lot. The company in turn has been active in the market for over 10 years. And manufactures televisions of various brands, manufactures parts for models from 32 to 55 inches smart.

The justification of the work is around the time the company wastes with the setup time, and how much this procedure hinders the delivery of batches in a timely manner.

Given these characteristics, the guiding question arises: How can reducing setup time contribute to a plant's efficiency?

## **2. Theoretical Referential**

### **2.1 Quick Tool Change - TRF**

More and more companies need to look for new resources and skills to survive in the market. In general, the movement for more quality in processes and products, faster production and order fulfillment, and adequate price offer to the market without increasing manufacturing costs [1] is visible and constant. To meet customer demands, companies need to continually invest in concepts, techniques and tools that aim to improve their production systems, as well as methods that enable production flexibility and optimization of activities that do not add value to the final product.

One of the techniques that has changed thinking about production systems is Fast Tool Change (TRF) or Single Minute Exchange of Die (SMED). Viewed as one of the central elements in the implementation of lean production, the SMED system developed by Shigeo Shingo considers that any preparation time should be completed in less than ten minutes. Lean production is an integrated system that performs the production of products and services using the least costly inventory [2].

The history of the TRF or SMED system developed by Shigeo Shingo was based on three crucial experiences: the first in 1950, in the study of efficiency improvement at Mazda's Toyo Kogyo plant; later in 1957 at the Mitsubishi Shipbuilding shipyard located in Hiroshima; and in 1969, at Toyota Motors'

main plant. These works have proven the impact on reducing setup time and improving overall activities. Thus, the TRF system makes it possible to reduce setup times, making small batch production feasible, thus obtaining greater flexibility in introducing changes in product structure and faster responses to market changes. In addition, it provides a reduction in crossing times; reduction of inventory levels in process and finished products; cost reduction; reduction of worker efforts; reduction of errors due to machine adjustments and consequently reduction of defects and rework; and increased production capacity in critical resources [3].

## ***2.2 Efficiency in the production process***

This efficiency increase can be achieved by applying some tools or techniques. One way to increase efficiency is by reducing the machine setup time. Setup is a machine preparation activity before starting production of any product, but as long as it is not completed, the process remains stalled, thus inefficient [4].

Thus, setup is a typical example of waste with no added value and therefore should be reduced to the lowest possible value. Thus, the shorter the machine preparation time, the smaller the batch size produced, the higher the efficiency [5].

Setup is also known to be all the necessary tasks between when the last part of the previous batch has been completed and when the first part of the next batch is completed. Traditionally, the time involved in these tasks is long, which encourages production in larger batches, and consequently overproduction and increased waste.

Thus, the setup is classified into two basic categories of activities, defined by: internal and external. The routines that occur when the equipment is not in operation are those called internal, the activities performed while the equipment is working is called external. In practice it is possible to identify ways to reduce the time required to perform the setup, you can determine all process steps such as material preparation time for feeding and machine adjustment before starting operations for the next model [6] . Train the team that will provide all necessary activities before the start of the setup, and the knowledge of the type of equipment and the estimated time to perform the maneuver.

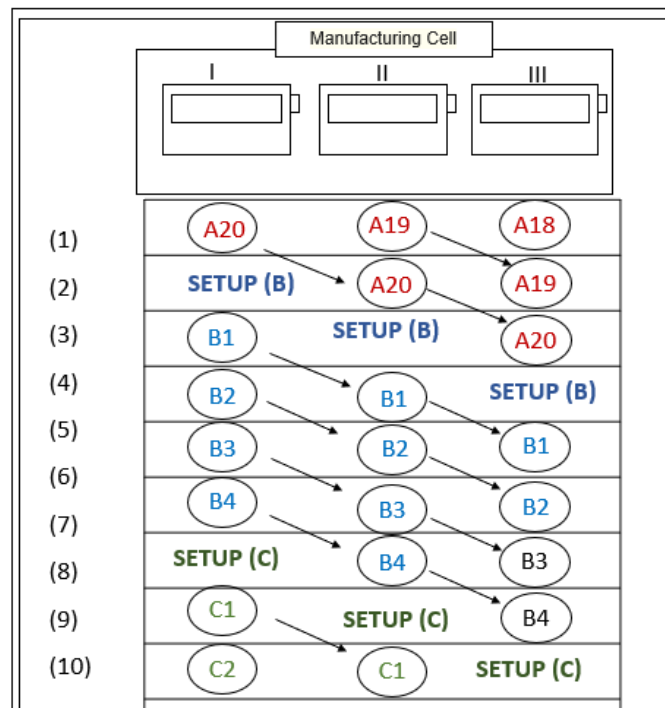


Figure 1: represents the production sequence and where setups are installed

Source: Jesus et al. (2018)

It is observed that the training of operators also contributes to reduce the total time that is used to perform the setup. Studying and balancing component distribution is an important factor in reducing waste and improving the process. Updating programs also contributes to the reduction of setup time, thereby increasing the time available for production [6].

Linked to the production and process of SETUP, in an electronic board assembling company comes a series of assembly challenges that require a lot of knowledge of process, materials and physical and chemical phenomena related to the welding process. The main challenge of these companies is to assemble the electronic boards with maximum efficiency which means to have the minimum rework and to guarantee quality assemblies [7].

### 3. Methodology

The choice of the critical area of the company came from a visit to a television card factory, observatory research and data collection with interviewing of the production leader, for information on the history of previous stops so that could be done. stipulated the average time that the machines are stopped in the production of the plates; knowledge of the quantity required

For the accuracy of the information it was also necessary mappings focused on the process, to check the stops and the activities developed by the collaborators when the setups happen. Like participation in processes with cell phones and cameras to record information, observations were made preceded by notes of what was being seen in real time.

## 4. Applied Studies

The production line for the manufacture of slabs uses three types of machines: Panasonic CM602, Fuji NXT and Fuji XP. Where they are placed in cells for harmony and in accordance with regulatory standards involving contact with handlers. In order to find the flaws arising from the setup time, the quality tools were applied: Ishikawa diagram and 5W2H.

### 4.1 Problems Identified

With the application of the instruments of collection, interview and observation, it was possible to verify that the setup time varies from 50 min for the Panasonic CM602 machine; 45 min for the Fuji NXT machine; 60min for the Fuji XP machine, making production standstill for up to 1h for preparation. The time expected by the organization is up to 30 min. This causes some corrections to be made to reach this margin.

Another relevant factor, the number of employees for the activities is 18 employees, it was observed that while the machine is stopped some processes can be performed externally, external setup.

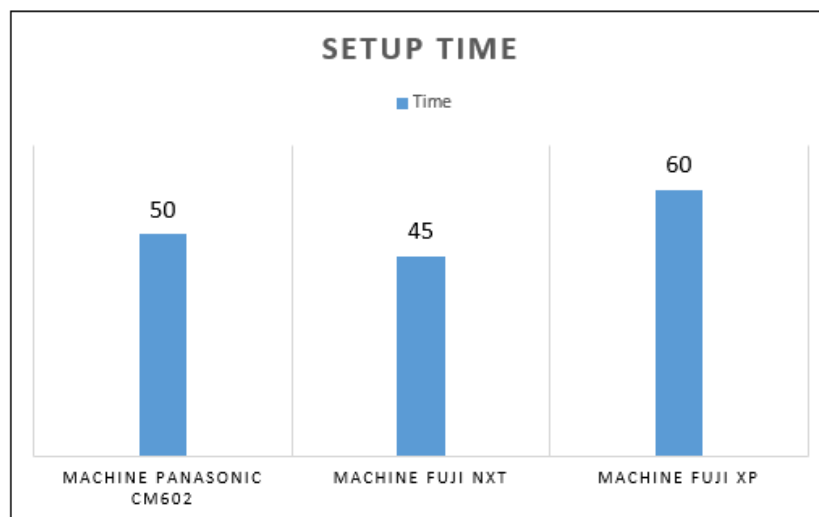


Figure 2 - Setup time with non-detailed timing

Source: author, 2019.

We considered past history of the time from which it was possible to average the time that was intended for the stops. It was observed that with the presence of observation the operators sought to perform their processes more efficiently for fear of being evaluated before their functions. Therefore, the time that was timed directly on the production line was influenced by the presence of observation.

The company has 2 shifts, where each shift consists of 08 hours. For the 32 "and 42" TV cards the target of 194 cards per hour was set, 1,552 mounted per shift; for the 50 "and 55" models it has a target of 178 per hour, 1,424 plates per shift. Based on the assumption that the 32 "and 42" plates can be sold for R \$ 145.00 and the 50 "and 55" plates for R \$ 210.00. Considering that each in turn, the machines have a stop where the maximum time is 60 minutes: the machine of the models of 32 "and 42" stop producing 388

plates per day, leaving to produce 8,536 plates per month, losing about R \$ 1,237,720.00. For the other models of 50 "and 55", it ceases to produce 356 per day, ceasing to produce 7,832 plates, ceasing to receive R \$ 1,644,720.00.

#### 4.2 Ishikawa Diagram

When observing the factors that motivated the lengthy setup, it was found that the stops also happen to be made adjustments, these stops for adjustments are made due to the lack of knowledge about the possibility of the stoppage being only focused on preparation. The methods that are performed for mounting the boards do not take into account the activities that employees can do while in setup, thus performing an external or internal setup.

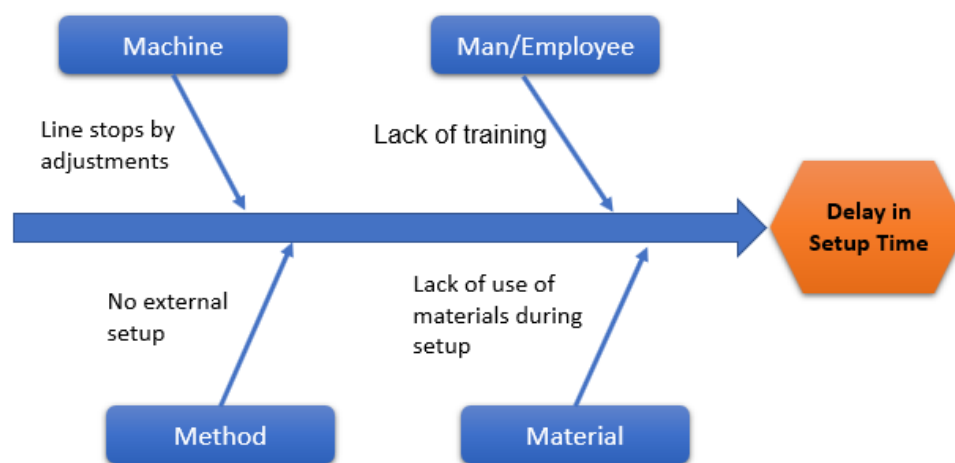


Figure 3 - Diagram of Causes and Effects

Source: Author, 2019.

It was observed that the delay of the setup time is being caused due to the lack of knowledge of the leader in using strategies aimed at taking advantage of the machine uptime. Thus, it also corroborates the lack of use of materials during setup, which could be external setup. It has also been found that the machine has adjustment stops along with setup intervals.

#### 4.3 Action Plan - 5W2H

To develop a study aimed at reducing downtime, observations were made during production regarding the activities related to downtime of each machine. For this it was necessary to travel to the assembly line of the assembly of the components of the boards, having as responsible to guide the visit the leader. After that, it was necessary to divide what is internal activity from external activity. This divided the tasks that operators can continue to perform even with machine down. From these analyzes it was possible to develop the actions to be initiated to reduce the setup time in the factory, as shown in Table 1.

Table 1 - Action Plan

What	Why	Who	When	Where	How	How Much
Quick Setup and Tool Change Training - TRF	Increased knowledge by operators	Operators	15 days	In the company itself	In the company's own sector	R\$ 600,00
Separation of internal and external setup	Taking advantage of the stop	Operators	CM602 and Fuji XP Machine 1st Stop	Board Production Line	Standardization	Free
Assembly product preparation	Increase efficiency	Operators	Before the stops	Board Production Line	of activities;	Free

Source: Author, 2019.

## 5. Results and Discussions

The mappings performed in the production line allowed the analysis involving the procedures of the machine operators, where the time counts for the setups were performed. As a result, the proposal was created to separate activities that can be performed while the machine is running, which previously were only performed while the machine was idle. These activities involve leaving the materials to assemble the components separate while the plate is manufactured by the machines, making the internal setup to be external and thus reducing the time to stop separating the parts, as the parts will already be separated simultaneously. Relating to the settings, which also cause setups to occur. The suggestion turned to predictive maintenance, that is, an inspector can analyze the machines to predict the expected maintenance time, and then schedule activities, not allowing them to stop unnecessarily.

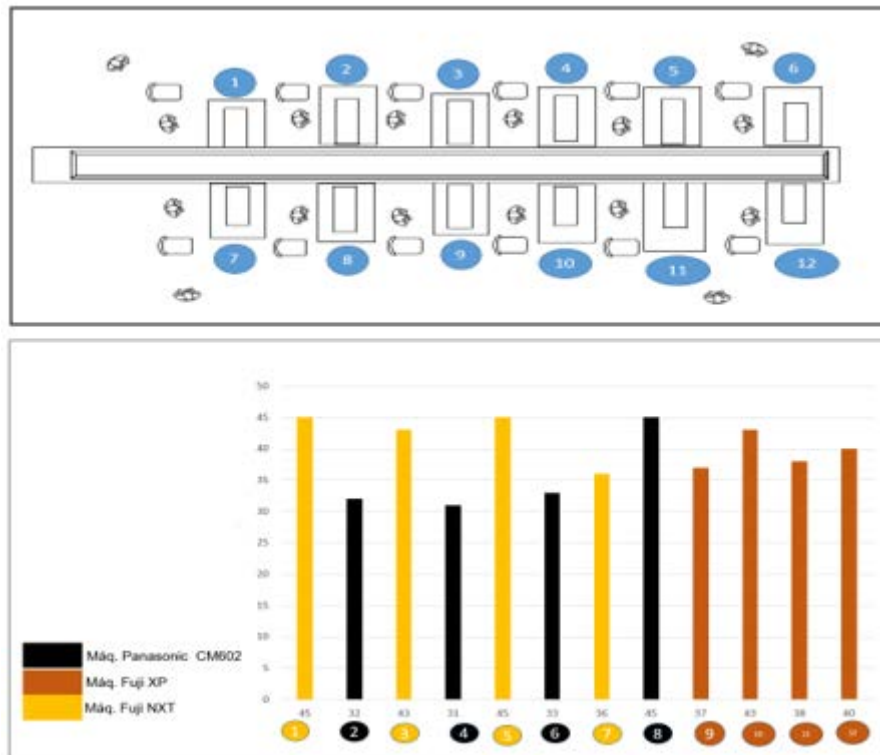


Figure 4 - Statement of timed minutes after proposal

Source: Author, 2019.

It can be observed according to figure 3 that after the implementation of the setup, where the suggested proposals were applied, there was a reduction regarding the setup time according to the machine model. On the Panasonic CM602 machine, which before the proposal had a history of 50 minutes on average after the proposal, with the insertion of the carts with parts to facilitate the operators, the time for this machine model on the line reduced to an average of 35 min., 30% reduction. For machines of the Fuji XP model, which previously had an average history of 60 min, after the changes presented an average of 39 min, a reduction of 35% of the time. For the other Fuji NXT model, the previous average was 45 min, after SMED implementation the setup time reduced to 42 min., It decreased by 6.67%.

The results were impacted by the degree of training and involvement of the operator with the result, it was found that the operators of the machines CM602 and XP showed more relevant results from the presence of observers regarding the procedures performed during production. In contrast, the results were lower when operators performed the activities without the presence of an observer on the production line, because the result was determined by information from the machine itself.

Thus, it is known that what makes the setup time longer is the employee's participation so that the procedures are more efficient and can corroborate the economic and financial impacts of the company. In order for the procedures to be performed successfully, the leader must set a time target and be responsible for verifying that the operators are being quick and wasting time, causing the setups to become external in their most.

Adjustments that caused machine shutdowns were now scheduled, making it possible to use efficient mechanisms with the application of SMED to make the preparation time on average 30 minutes. Future studies need to be applied to the 9 minute time range to make the company's losses as small as possible.

## 6. Final Considerations

The setup of a machine is considered a downtime to prepare for the manufacture of a new product. However, with research into the production of a TV card manufacturing company, it was possible to understand that downtime can be reversed, and activities that were only performed with downtime machines can be done while the machine is running. shutdown to perform a particular procedure. Including a cart with parts to assemble the board while machines are manufacturing also makes operators productive simultaneously with the machines. By reducing machine time, the company can recover from the economic loss it suffers when each machine stops producing over 40 minutes.

Thus, the values that could be produced at this time become smaller than those with the average of 60 minutes. As a result, economic and financial losses from sales projections become smaller, making time better spent.

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# **Implementation of Information Technology in the Logistics Area in a Manaus Electronics Company**

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## **Abstract**

*This article aims to elaborate a continuous improvement in the logistics and production process of an electronics company, through the implementation of IT focused on customer service within the deadlines. The case study proposal was based on the problems faced by the company in question, such as: lack of stock accuracy that directly impacts material separation due to the delay in systemic balance adjustments, BOM impressions for material separation in excess, late orders, among others. The main objective was to highlight the importance of information technology in the logistics area for the production process. As specific objectives we sought to analyze the importance of information technology for the production process; verify the advantages of an information system in the logistics area; analyze the results of the implementation of a logistics information system for the production process. The methodology used was descriptive research, where visits were made in an electronics company located in the city of Manaus. As expected results, the importance of information technology within the production process reduces errors and increases the quality of production.*

**Keywords:** Logistics; Information Technology; productive process.

## **1. Introduction**

Companies are looking for new ways to increase production and reduce costs, because manual procedures require more effort and time, which is why the company gets high quality from its customers. Staying in

the market with a potentially efficient organizational image leads to increased demand and thereby revenue.

This work aims to develop a continuous improvement in the logistics and production process of an electronics company, through the implementation of IT, focusing on customer service within the stipulated deadlines, analyzing the benefits of technology and information within a process. indicating the advantage for the logistics process.

The difficulty that the company studied brings with it reflects several situations in which other organizations also share, such as performing processes by manual means, performing material collection through various impressions and high costs related to failures caused by incorrect counts. Related to this, technologies offer the practicality of data that generates important information to be passed on to managers.

Technical visits were used to verify how the process of counting parts is performed, which were used as data collection instruments, document analysis, interview and questionnaire, which were conducted with those responsible for the productive process of parts collection to future assembly of notebooks and other equipment belonging to the organization's orders.

Therefore, the question is: how can the implementation of technology and information in the logistics area improve the productive process of an organization?

## **2. Theoretical Referential**

### **2.1 Information Technology**

With increasing consumption, companies increasingly need technologies to help control information and data, so information technology can be considered a strong potential for the development of an organization, because it provides the control. higher data streams, which in turn bring about positive change that can be process automation, even as an advanced way to get business to leverage [1].

The emergence of this term came with the need to create strategies that can involve the company through the capture, organization, interpretation and strategic use of information so that technology can bring knowledge and practicality to various people, especially when involves processes that need a long time for an activity to be performed, in this aspect is defined as [2]: "Information technology is any device that has the capacity to process data and / or information, both systemically and sporadic, regardless of how it is applied. "

Information systems and information technology alone are not enough to manage or manage an organization, process or company, so the manager must have attributes that can make the best use of technology, making it favorable to the organization, making it a great strategic tool [3]

Therefore, there must be an agreement between technology and information and business strategy to make technology really useful and bring results into the organization; instead, it generates only expense. On the other hand, when they are interconnected, they can bring efficient results to a management decision process [1].

## **2.2 Information System**

Technology and information should be used as a powerful tool to leverage internal processes and increase business revenue. It can be used in many ways, from selling a product to manufacturing it, as a process control method. A company that knows how to make the best use of an information system may be able to make the best choices. With Technology and Information processes become faster and quality can also be a favorable factor, thus facilitating business management [3].

With the implementation of an information system, production processes can even reduce costs, increase productivity, expand business opportunities, thus allowing expansion to new markets, increasing quality and customer service and reducing waste [4].

Thus, it is analyzed that an information system is a set of related components that together make data enter and at the same time make data enter generating a set of information that may be needed for decision making. where processing converts raw data into important information for managers. And in the output corresponds to pass the information to the people who are responsible [2].

A system can be considered as any kind of platform that, when used, transforms data into information, and may use technological means, where data entry is performed manually by a responsible person, and during the inclusion of such data as it. They are undergoing changes and coming together, thus generating a set of information that is transformed through technology [6].

Thus, the organization that can manage these three items, where the qualification of people is what makes the difference in the results of the organization, can obtain an efficient return by obtaining the best resources, investing in employee training, thus bringing impacting results to the organization. the whole company. This is because a tool only becomes of great potential if it is in the hands of a person who has the experience and qualifications to handle it properly [7].

## **2.3 The role of information technology in logistics**

The way information technology has developed in recent years has brought about real changes in the way people operate their processes within the organization. Whether through software or hardware, IT has already become fundamental to logistics, facilitating the process, organizing information and generating decisions based on business reality [5].

Thus, all the interesting were able to realize that useful information such as: order status, product availability in stock, delivery schedule, payments, are items that are considered essential in a business process. Not to mention that this item is considered a determining factor for reducing inventory and human resources costs, as well as provides a control of everything that happens within the organization, and the information can be used strategically to further increase revenues [1].

Thereby, technology is increasingly applied to logistics processes as a way to make them faster, where you can adhere to the concepts of ECR – Efficient Consumer Response, which is the efficient response to the consumer, so that the importance is focused on the end consumer, responsible for this for the market dynamics, making that several companies seek to meet the increasing demands of the market and customers. ECR can make a difference for many organizations, especially today where the company that offers the most advantages and favors the consumption in some form is the one with the most demands [6].

## **2.4 Logistics Information Systems**

The logistics information system (SIL) offers several advantages in the internal operation that involves the logistics of the company, which in turn tends to unite all the utilities and needs of the company, together with the clients and managers [7], the methods from within. Sales, shipments, production schedules, inventory availability, order status, and the like with vendors can radically reduce information errors as users use the system to generate information that becomes available for future solutions.

Thus, the manager who is responsible for a given logistics activity can gain control of information necessary to stay with or improve it, according to the results that can be determined with the logistics information system used [5].

Within the Logistics Information System, each Order Management System (SGP) is described in detail, where it is possible to have customer contact in the product search and order placement stage. [8] Thus, this SGP is directly in communication with the inventory or warehouse control system, where it reports whether the product is available from stock. With this, the EMS provides information regarding material availability.

## **2.5 Services**

The concept of services is surrounded by the idea that it is something that the company can offer to its customers without being tangible, it is abstract, not noticeable. Service is considered as the way an organization would like to have its services perceived by its customers, employees, shareholders and financiers, in other words, the concept of service is the business proposition. [8]

Thus, the concept of service needs to be understandable for everyone so that it can express that it is something that materializes in different formats, but all is how the company intends to solve a particular problem, in a different way, where it can be viewed [ 9]

The companies that perform services occupy the top spot within their sectors before the economy in Brazil. The service is a constantly growing modality, where two items can be considered as more relevant in this area: the demands of consumers and buyers are increasing every day and increasingly new technologies make several services easily accessible. [10]

Thus, companies that provide service to the population are always seeking to satisfy their customers, so that they choose to improve their activities so that they can express the best, an organization's vision concerns me where it expects to be sometime in the future. [8]

Services are considered something of value that serves to collaborate with the continuation of something. Thus, "services are considered to be economic activities that create value and provide benefits to customers at specific times and places as a result of making a desired change in or on behalf of the service recipient" [11]. With this, companies are focused on the service factor, where they can offer their attributes to people or companies, and make customers acquire value or quality with what they offer. Thus, it can be stated that when a particular economy of expansion expands the service area, it generates employment and income for the local population [10].

## **3. Methodology**

This research has the main objective of conducting a study of an electronics company in Manaus, carried out through a technical visit to the company, where an interview was conducted with the head of the sector where the main problem arises. The interview to find out how the procedures are performed in the production process in a company of electronic technology. It is also performed for data collection the application of a questionnaire with 10 questions to ascertain the procedures performed within each activity related to logistics and the production process.

The type of research performed is descriptive, and tries to highlight what happens as a way to make everyone aware of the problem that is causing discomfort in the organization and thereby seek a solution by implementing a response.

Regarding the research methods used for the development of this work, an interview was applied to those responsible for the production process, in a semi-structured manner, surrounded by 5 questions related to the methods applied in the production process and how the activities are currently performed. The data are obtained and analyzed according to the answers offered where the characteristics that permeate the importance of the problem-oriented solution are observed. They are presented in graphs and tables so that the results can be compared.

#### **4. Applied Studies**

Today, the company has an exclusive person to print the list of items to separate from the orders that will produce on the day, but this person, as well as the planner does not have a 100% view of the materials in stock, because every year the Inventories only occur in the logistics sector, this does not guarantee the planner that all the simulated materials in the “Down” orders will be all right to fulfill the orders to be produced, because currently the largest case of surplus balance is in the production process, first of all. Inventory must take place in the company as a whole and orders to lower should only consider the relevant material warehouse, in this case logistics, since once the material has a balance in the production warehouse, one must imagine / understand that it needs balance / consumption adjustment only.

However, the company does not have this critical view of deposits and inventory, there are often delays in billing service because of this and others, the daily work ends up being stressful / exhausting most of the time, for those who end up having to solve the problem of lack of materials. With the data collector, the company can use the same annual inventory time to perform inventory across the enterprise, not to mention that it would be more accurate and assertive in balance.

The collector with its high technology would help the company to save time in its logistics and production process, because a logistics operator for example: The same having a collector in hand, can start separating items of the next order to produce, the reader behind In real time the bill of material view according to the SAP system used by the company, if it detects any divergence / neglect of any item, it will have the power to adjust the balance and inform the PCP, so that it has action of make reasonable decisions for billing negotiations. The reader would minimize the cost for prints and toners, the person who is currently exclusive for bill of materials printing, could just be for rotary inventory where the company benefits greatly from this action.

Even though the reader has a higher cost than printing and toning costs, besides helping the environment,

it helps the company, if it were already being applied, today the planner simulating and lowering the production orders that they are considering. only relevant material warehouses (logistics sector), the logistics operator would have no problem locating, sorting, sending the correct order balance to the production warehouse, just as production would not have to wait for balance adjustments that often do not exist In fact, with the implementation of this technology, revenues would be met ahead of time, at least 90% of the errors found today would no longer impact other future demands.

## 5. Results and Discussions

A company needs to gain insight into its flows and find the best strategies to improve its processes, speeding them up and making it easier to achieve quality. The company studied presented difficulties regarding the amount of time taken to collect relevant information about the material.

Before the process of collecting the items to be produced took about 3 hours, so it took time and this made the company not speed up its processes, making the process slow and costly. The RFID system used in conjunction with the data collector reduces the amount of steps and procedures that were previously performed manually. Using the SAP System, the use of the collector causes all information being digitally accounted for to be updated from the system balance, thus the information is written off in real time.

The SAP system is an integrated ERP system that transmits information to all sectors involved, so if an employee enters information about a particular input, that information is also updated in the materials control, the supplier's sector, and the others involved. This system is updated when the employee uses the data collector, placing it on top of the material code in stock, and instantly updating it in material stock. As shown in Figure 1.

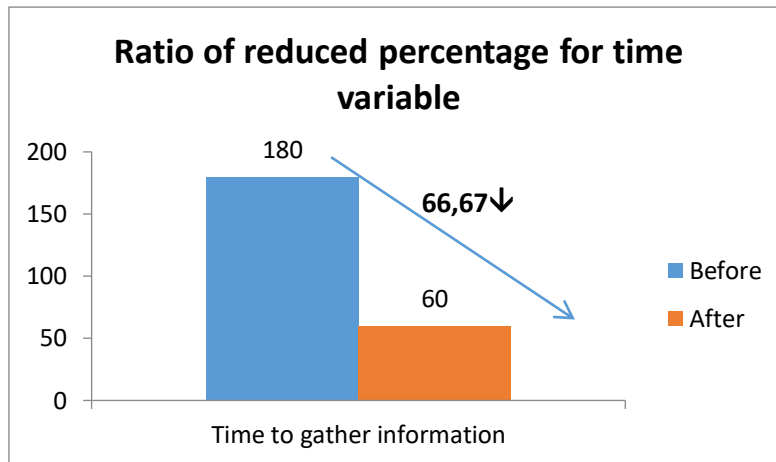


Figure 1 - “Sequencing” System Statement Used for Production Management

Source: Author, 2019.

The RFID system brings a technology capable of capturing bar code information inserted in the parts and

when used with the data collector passes the information directly to the SAP control system, updating it automatically. Thus, the reduction of time after the use of the indicated technologies brings a time differential for the organization, as shown in Graph 1.



Graph 1 - Ratio of reduced percentage regarding time variable

Source: author, 2019.

In the previous processes, for each piece passed on by the logistics industry, the person responsible for the parts quantity information would have to print several labels per day, which generates around a significant amount, also causing the responsible employees to spend more time. to check the machine serial numbers one by one. According to the on-site survey, performing observational and documentary analysis of printing and photocopying costs that the company performed monthly, generating a considerably high cost to the annual average, it was found that if the company maintains the same usage pattern in a Real projection of what was already done in the previous year and what is being determined from this year, until the end of the current year, the organization acquired an average variable cost of R \$ 2,742.73 monthly.

Thus, the forecast of costs with printing and photocopying that the company may have until the end of the current year using the same procedures currently practiced, where comparing the costs can be observed that in 2017 the value was obtained. monthly average of R \$ 1,979.13, and from 2018 onwards, an average monthly cost of R \$ 2,722.4 can be determined. However, with the help of the two production process implementation technologies, the costs fall because it does not have to be continuously printed in the same quantity as the one previously mentioned, requiring only the inclusion of codes belonging to the RFID chip inserted from the Kaban methodology.

However, with the help of the two production process implementation technologies, the costs fall because it does not have to be continuously printed in the same quantity as the one previously mentioned, requiring only the inclusion of codes belonging to the RFID chip inserted from the Kaban methodology.

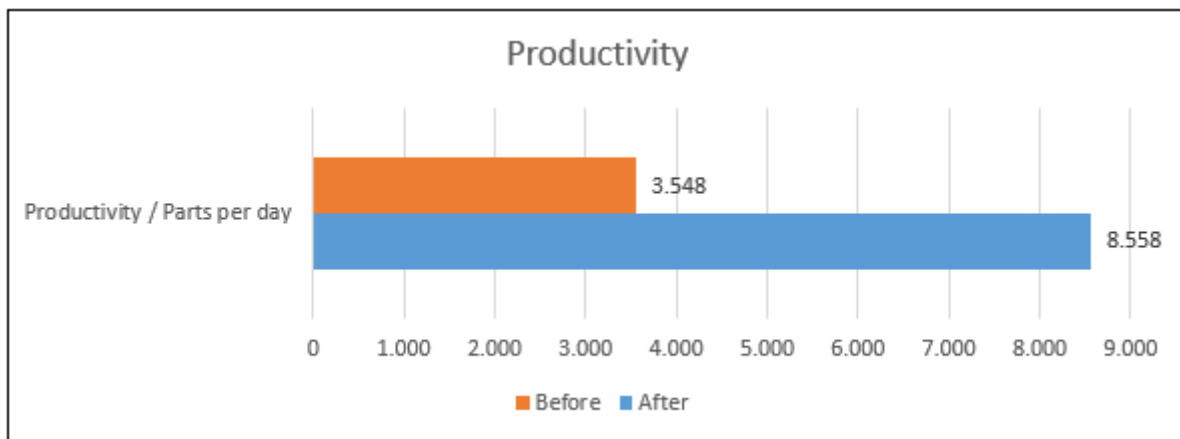
As a result, the company acquires the standards of Just in Time production, where production information and parts accounted for, transported and shipped in real time and accurate, where every minute can be part of a quality standard geared towards quality. efficiency of the organization. The use of the SAP System together with RFID technology in chips together with collectors causes the amount of errors in the counting of parts to be reduced when this quantity is passed on the label that has the chip and when



this information is updated through from the SAP system the information is not lost and reduces the amount of errors.

The company is thus able to offer its services and products in real time, accurately, meeting deadlines and maintaining their quality, turning towards efficiency in the logistics environment, having a competitive advantage and using this data as a business strategy vis-à-vis other company. companies in the same industry.

Thus, when verified the impact on time in reference to the company's productivity we can compare, before and after the application of the two technologies, according to Graph 2.



Graph 2 - Company Productivity Projection Statement

Source: author, 2019.

As shown in Graph 2, you can see the difference in the average productivity of the company, the amount of more parts that the technologies together contribute to the more efficient processes. What was previously smaller, as quoted 3,548 average part quantities per day, after implementation of process efficiency solutions, the amount of productivity can rise to an average quantity of 8,558 per day. This makes the company have more customers and consequently higher revenues.

Thus, technologies such as the SAP system, which is precisely an ERP system, where all information is integrated as advocated by Turban, Mclean and Wetherbe (2010, p. 92): “ERP integrates all departments and functional information flows into one on a single computer system with a single database that can meet all of your business needs. ” This way, this system passes the information correctly and up-to-date in real time throughout the company. Bringing management to the exact or most accurate information that facilitates increased productivity.

## 6. Final Considerations

Companies are always adapting and improving their processes with a focus on staying in the market and streamlining their internal procedures, such as reducing failures and scaling up their production or assembly. This makes it a company ahead of others and competitive, and may even gain recognition for their deadlines and the quality that their internal services may be performing.

Information technologies are innovations that seek to bring companies, both industrial and commercial or services, the practicality and reduction of time efficiently, enabling the organization to reduce costs, time

and increase customer satisfaction and consequently this has repercussions. on your monthly or yearly billing. Thus, by generating more profitable returns, the company can invest in other means to become better, which can be in more intellectual capital to increase the quality of production or processes.

Within the case study, the SAP system being used in conjunction with RFID technology potentially transforms information stored by the chip by updating the organization's inventory without requiring the employee to have time to manually count and then pass this information back to the inventory, which in itself consumes time, increased the flow of the counting of the pieces, being reduced in the studied case to only 1 hour, which previously occurred in 3 hours. Along with this reduction of prints also reduces variable costs with inks and paper. The result of this is increased productivity and consequently profitability of the organization, which by the way is potentially good, as it can use these resources to achieve better business opportunities.

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# **Analysis of The Basic Sanitation System of Black Land Earth in Manacapuru-Am**

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## **ABSTRACT**

*Due to the adjunct population growth of the Industrial Revolution since the 70's, it has been thought and planned about the adequate urban infrastructure, which is taking into consideration the welfare of the population. From this line of thought, sanitation has become one of the alternatives for municipal development, because besides encompassing sanitation services, it also has interrelationship with other areas such as health, housing, leisure and others. Thus, this article aimed, through the analysis of the basic sanitation system, to facilitate the identification of the current problems in the sector of the black neighborhood in Manacapuru - AM. To this end, discussions were held on the structure of the Municipal Basic Sanitation Plan of the municipality and field measurements were collected for the development of diagnostic maps of basic infrastructure characteristics, such as drainage, water and sewage network, waste collection and junk dumps. Thus, the analysis of the previous and current sanitation situation was carried out. Increases were found in the junk dumps, and in the drainage system's mouths and in the absence of a sewage system. From this the adopted method was efficient for analysis of the basic systems, being able to be used for evaluation of the other districts of the city.*

**Keywords:** Municipal Sanitation Plan, Municipal Master Plan, Geoprocessing, Basic Sanitation System, Terra Preta.

## **INTRODUCTION**

Basic sanitation are actions of paramount importance to the health and quality of life of the population, being the infrastructure services and operational facilities for drinking water supply,

sanitation, urban cleaning and solid waste management, drainage and stormwater management. urban (LUDWIG *et al.*, 1999; LEONETTI *et al.*, 2011).

Early records of the use and importance of basic sanitation emerged in ancient Egypt, yet during the seventeenth century some countries in Europe such as Germany, Belgium, France, and England lived in poor hygiene conditions causing cases of diseases such as cholera and fever. typhoid (CAVINATTO, 1992). In Brazil this problem was no different. Since the arrival of the Jesuits, water-related diseases were common, but it was only in the twentieth century, after outbreaks of water-related epidemic diseases were first taken (PEZELLA e SILVA, 2011).

As a result, several agents hampered the development of sanitation in Brazil during its history over the years, when only from the 70's, the National Sanitation Plan (Planasa) was consolidated (SOARES *et al.*, 2002; LEONETTI *et al.*, 2011). Thus, legislation emerged that could mitigate the problems over the years, through appropriate guidelines, measures and infrastructures for the system (NERI *et al.*, 2009; DA COSTA *et al.*, 2019).

In attention to the disordered urban growth associated with the Industrial Revolution, policies have been devised for basic sanitation, so that municipalities can diagnose their needs. And associated with these needs, Federal Law No. 11,445 / 07, called the National Basic Sanitation Law - LNSB, entitles municipalities to manage these guidelines, which are intended to identify short, medium- and long-term objectives and goals. to adjust and expand the basic sanitation system for the population, so in the municipality of Manacapuru / AM is no different (BRASIL, 2007).

In order to discuss approaches related to basic sanitation, Bovolato (2015) presents as one of the problems that can affect the environment the lack of investment in basic sanitation. While Ludwig *et al.* (1999) showed relationships between the basic sanitation situation and the prevalence of diseases caused by parasitic organisms in studies carried out in the municipality of Assis in the state of São Paulo. From this it can be assumed that the lack of investment in the system can directly affect the environment and the population.

The city of Manacapuru belongs to the metropolitan region of Manaus and is located on the left bank of Rio Solimões, 84 km from the Amazonian capital. Santos *et al.* (2018) showed that the population living in an unhealthy environment due to poor sanitation conditions is a sick society. Since the scarcity of the service has been generating diseases such as diarrhea, hepatitis, dengue, yellow fever, malaria and others, due to contaminated water, vector transmission and oral closure. In addition to harming the preservation of the environment, which is a parallel effect to the absence of the system, as it has been causing environmental degradation and has been contaminating several watercourses harming various species and the ecosystem itself.

With this in mind, the use of tools such as geoprocessing for analysis of the basic sanitation system is an alternative that can facilitate the identification of problems in the sector, due to their use for monitoring and control (BORJA, 2014; ALMEIDA *et al.*, 2009; PEREIRA and MORAIS, 2015). Thus, with the knowledge of these aspects and where they occur, it is possible to visualize them through maps that can identify and reveal probable solutions (SANTOS and WALDEMAR, 2007). Thus, a good management of the basic sanitation system allows the population to enjoy the environment with quality,

and at the same time, the municipalities will save on public health expenses directed to the treatment of diseases caused by lack of service (CARVALHO, 2010).

This paper analyzed the basic sanitation system of the Terra Preta neighborhood in the municipality of Manacapuru through geoprocessing, where environmental diagnostics, mapping of sanitation services to locate them in the neighborhood perimeter and comparing the basic system before and after the plan were obtained. director of the municipality, to observe its development over time. Since the service does not only involve the sanitation system, it has been bringing benefits to other areas as well, so it should be properly implemented. Therefore, the Sanitation Law imposes measures to facilitate this service in the municipality, one of the main ones being the Municipal Basic Sanitation Plan that serves as a management tool for the sector (CORRÊA, 2018).

The analysis of municipal sanitation systems leads to a control of the progress and expansion of municipal services. Thus, to support municipal management, analyzes of this type of service can assist in the progress of the development of sanitation plans, bringing improvements in public health and the environment. Thus, this work has its importance for growing city populations, where it will be possible to study the current municipal sanitation plan, the places that are being affected by its lack and propose improvements in its management.

## **MATERIAL AND METHODS**

This research was conducted in the Terra Preta neighborhood of Manacapuru / AM, being one of the most inhabited neighborhoods in the city, where CENSO (2010) pointed out an average of 5,389 inhabitants. Initially, analyzes were carried out on the structure of the municipal basic sanitation plan of the municipality of Manacapuru, which was approved in 2012. After analyzing the plan, the relevant sections of the following topics were highlighted and discussed: Diagnostics of sanitation services; Planning parameters; Demands; Prognosis; Programs, projects and actions; Investment Forecast.

To obtain the results, field measurements were carried out over a period of three months throughout the neighborhood. Thus, for the development of the analysis of the diagnostic maps, field information was surveyed using a GPS receiver (GPSMAP 78S GARMIN). The latitude and longitude coordinates of each point of the municipal sanitation infrastructure were collected, in order to produce the maps of the respective services.

After field measurements the data were processed in a georeferenced cartographic base with the aid of the tool, ARCGIS version 10.3. Initially the coordinates were stored in a spreadsheet in Excel 2013, which had two columns with the coordinates of latitude (X) and longitude (Y). Soon it was necessary to convert the GMS coordinates to decimal cranes, because Arcgis Software does not accept import in GMS format (degrees, minutes and seconds). The document was then saved in Excel XLS format.

Subsequently, the cartographic base of the study area was added and then the coordinate points stored in the spreadsheet. Thus, the points of the basic sanitation system services were distributed on the map. Comparison analysis was performed through maps of the current sanitation services generated

during the execution of the work. Afterwards, comparisons were made through a visual analysis of the activities existing today with the maps prepared in the Municipal Master Plan of 2006.

After the visual analysis, it was verified if the municipal sanitation services expanded or stagnated during the period. At the end of the previous stage, a new visual analysis was performed to observe in both maps the number of wolf mouths in each street of the neighborhood, and in parallel, it was identified which neighborhood streets have regular solid waste collection. among them, which ones have junk dumps and also, which streets in the neighborhood have water and sewage system.

## RESULTS AND DISCUSSIONS

### Municipal Plan of Basic Sanitation

Beginning with Law No. 445/07 with its guidelines and definitions of basic service planning, the Municipal Basic Sanitation Plan (PMSB) has become a tool for expanding access to the system.

Analyzing the situation and the quality of services through the diagnosis of the sanitation system provided by Manacapuru PMSB, it was observed that the water supply system uses surface and underground springs, and 70% of the municipal demand is It is supplied by underground wells and is explored by 29 tubular wells with depths between 110m and 220m, which includes the Terra Negra neighborhood containing two distribution reservoirs. Physicochemical analyzes are performed once a year. Regarding the sewage system Manacapuru is among the municipalities of Amazonas that do not have sewage treatment, so the population opts for septic tanks or even simple holes that serve as untreated sewers.

According to the plan, the drainage system is located in almost all its urban extension, but the rainwater has its final destination only through the channels being the mouths of the wolf to the bodies of water. With regard to solid waste management and management, the former responsibility was formerly the Secretariat of the Environment, today it is being administered by the Municipal Secretariat of Public Works and Services. Home collection services are done once a day, while public street and street sweeping is done three times a week, except for the Center, which is daily, and hospital collections were done once a week and buried in the dump. a company responsible for the final disposal of waste from the hospital, clinics, health post and pharmacies.

According to the planning parameters adopted for development, the planned PBMB implementation can be seen in Table 1. These parameters were constructed from hypothetical data and are therefore not accurate and reliable. At the same time, the city does not have micrometers for the analysis of the water supply system, as well as the absence of scales for trucks, which does not allow the records of daily travel numbers of these vehicles through the city. Thus, it was possible to obtain them through IBGE, DATASUS, SNIS, CETESB, ABRELPE and IPAAM.

Table 1: Year of activities for the implementation of the Municipal Basic Sanitation Plan in the city of Manacapuru-AM.

ACTIVITY	YEAR
Plan start	2013

End of plan	2032
Short term works	2013 a 2017
Medium term works	2018 a 2022
Long term works	2023 a 2027

Source: Manacapuru Municipal Sanitation Plan.

The planning of the urban drainage system and stormwater management were not performed in the original plan, which contradicts Tucci and Silveira (2001), who show that the adequacy of the development of the cities with the environmental situations are necessary attitudes to plan and control these impacts that can cause more frequent flooding, flooding and environmental devastation.

According to the demands, two population growth scenarios were considered until the end of the plan in 2032, with a 1-optimistic scenario with a geometric growth rate of 2.70% per year and a 2-less optimistic scenario with declining growth rates ranging from 2.02% per year and 1.46% per year, however both pointing to a higher average growth than the recent Demographic Census, the local potential and mainly by the greatness of the State of Amazonas. In addition to these factors, the municipality is in a state of growth in relation to its easy accessibility, after the construction of the journalist bridge Felipe Daou, Highway AM-070. Subsequently, it was observed that the demands surveys ruled out the urban drainage system and rainwater management.

For a probable future development or the result of a process based on observations of the present, it was observed in the prognosis that one of the greatest difficulties encountered in preparing this PMSB was obtaining a cartographic base and cadastral elements. Therefore, it is suggested to perform topography services, planialtimetric surveys and registrations of existing units. Due to the water supply system to meet the short, medium and long-term needs of the city, it is more viable to explore the surface spring, in this case the Solimões River, since it has a year-round capacity to supply the municipality, although its water has a high turbidity index. Knowing that in rivers for water supply turbidity will affect water disinfection as it may contain organisms in the suspended material that will make disinfectant action difficult. Another deduction would be the formation of excess sludge in the treatment plants. Thus it will be necessary to define the characteristic, origin and grain size of the turbidity, making it easier to choose the most effective treatment method.

During the elaboration of the basic design of the supply system, it is recommended to develop studies aiming at the use of the existing wells, aiming at the control, since the uncontrolled use of the underground aquifer can cause lowering of the water table affecting several segments. And noting that there is currently no sanitary sewage system in operation and planning to meet the provisions of current legislation, it is recommended to prepare a basic project and an executive to implement this system in the shortest possible time, providing a network collector, change collectors, interceptors, pumping stations, sewage treatment plant and outfalls.

According to urban cleaning and solid waste management, due to the lack of scales in the municipality, there are no reliable estimates regarding the quality of solid waste collected daily, an essential parameter for the calculation of the surface area required to install the landfill with minimum service life of 20 years. For Manacapuru it was adopted as an area to be found. It is recommended that

the City Hall carry out appropriate suitability studies of the chosen area, according to the current Brazilian standard, together with the competent environmental agencies. Consequently the urban drainage system and stormwater management according to the information obtained from the City Hall, Manacapuru had approximately 91 km of street, for the Host District that should have a short and medium term drainage system. For this purpose, the basic project should be prepared so that the works to be auctioned for its expansion.

As an alternative to improvements in the basic sanitation system, programs, projects and actions are suggested, aiming at water quality control, water safety plan-PSA, control and reduction of water loss, environmental education and social communication.

According to the investment forecast for the development of the PMSB, table 2 shows the survey of all sanitation services. The short, medium and long term needs of the districts and communities are included in the Municipal Basic Sanitation Plan, which foresees investments of R \$ 85,000.00 per district or community aiming at the implementation of simplified water supply systems. which also foresees investments of around R \$ 150,000.00 per district or community aiming at the implementation of simplified sewage systems.

Table 2: Investment Forecast (2013–2032)

Description	Investment (R\$)		
	2013 a 2017	2018 a 2022	2023 a 2032
<b>Water supply system</b>			
Localized works	27.379.170,00	7.371.315,00	7.371.315,00
Linear works	4.547.749,14	3.410.811,85	3.410.811,85
<b>Sanitary sewage system</b>			
Localized works	11.197.109,62	3.014.606,44	3.014.606,44
Linear works	19.255.680,00	14.441.760,00	14.441.760,00
<b>Urban cleaning and solid waste management system</b>			
Implementation of Integrated Solid Waste Center	4.301.891,40		
Dump Recovery	345.000,00		
<b>Urban drainage system and stormwater management</b>			
Linear works	8.268.634,80	16.537.269,60	16.537.269,60
Riverside Population Removal and Resettlement	9.091.200,00	18.182.400,00	18.182.400,00

Source: Manacapuru Municipal Sanitation Plan.

### Diagnostic Maps

Understanding that public cleaning and solid waste management services in the state of Amazonas are predominantly the responsibility of municipal governments for their administration and operation. Figure 1 shows in the current diagnosis a higher concentration of junk dumps compared to the survey conducted by the Municipal Master Plan (PDM), with a total of 26 identified junk points, 15 more



than indicated in the PDM. Manacapuru is one of the municipalities of the Manaus Metropolitan Region that has been awarded the Municipal Plan for Integrated Solid Waste Management since 2012, but the municipality still has difficulties in its final destination, contributing to the increase of the locations of incorrect and disorderly solid waste disposal.

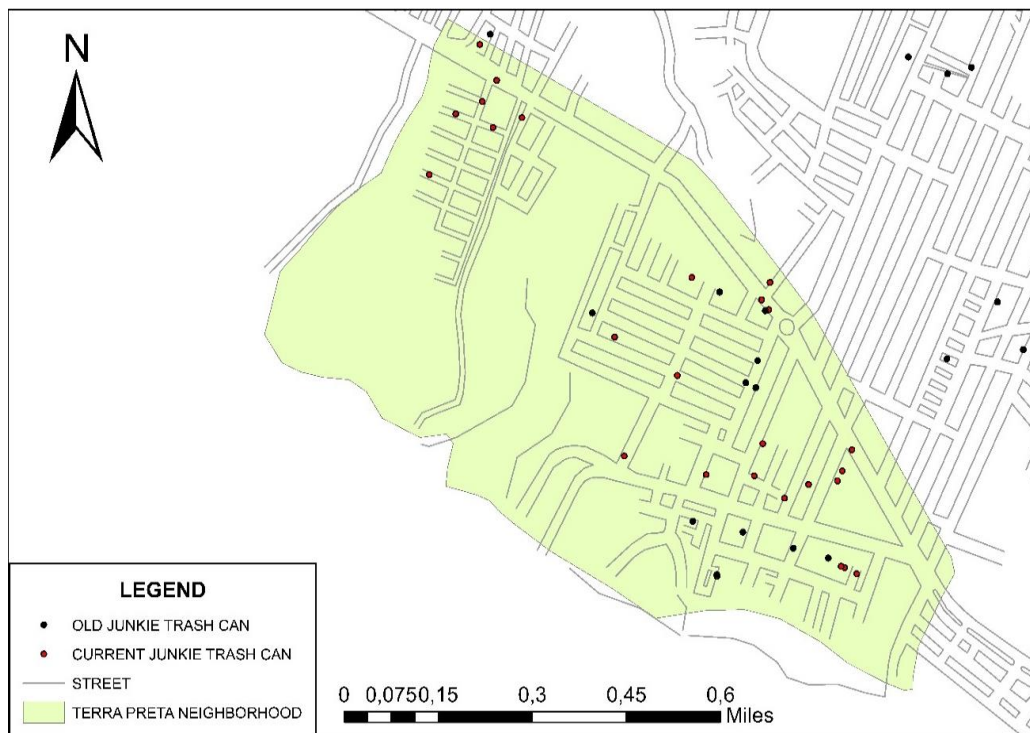


Figure 1: Map of the old and current junk dumps of the terra negra neighborhood in Manacapuru-AM.

Despite the expansion and daily routes of solid waste home collection trucks (Figure 2), there is a visible accumulation of waste throughout the neighborhood (Figure 1). According to Ferreira and Anjos (2001), even though the importance of the efficiency of the urban public cleaning activity for the environment and the health of the population is undeniable, there is little positive action against this situation in which the water management system is located. municipal solid waste, including in Brazil. However, some people may be prone to being affected by environmental issues, leading to decreased quality of life and increased health problems.

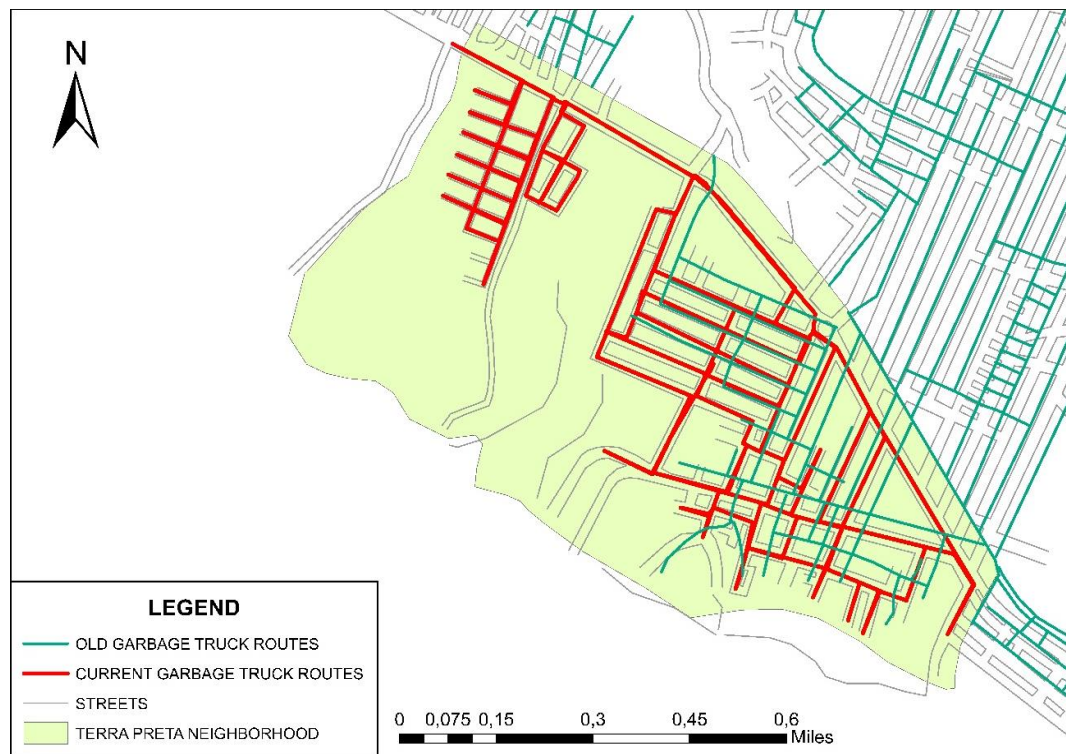


Figure 2: Map of the old and current routes of the home collection trucks of the terra negra neighborhood in Manacapuru-AM.

Subsequently, Figure 3 shows the enlargement of the drainage system lobes, which is currently 46 points, 7 more compared to that described in the PDM. However, there is an uneven distribution in this increase, since they are clustered in the main streets. According to Vinagre et al. (2017) urban drainage aims to control the risks of flooding, flooding and disease transmission through water. Thus the stormwater drainage system needs to be evaluated frequently, in order to obtain data highlighting emergency points, which may overflow, resulting in the creation of preventive measures for flooding.

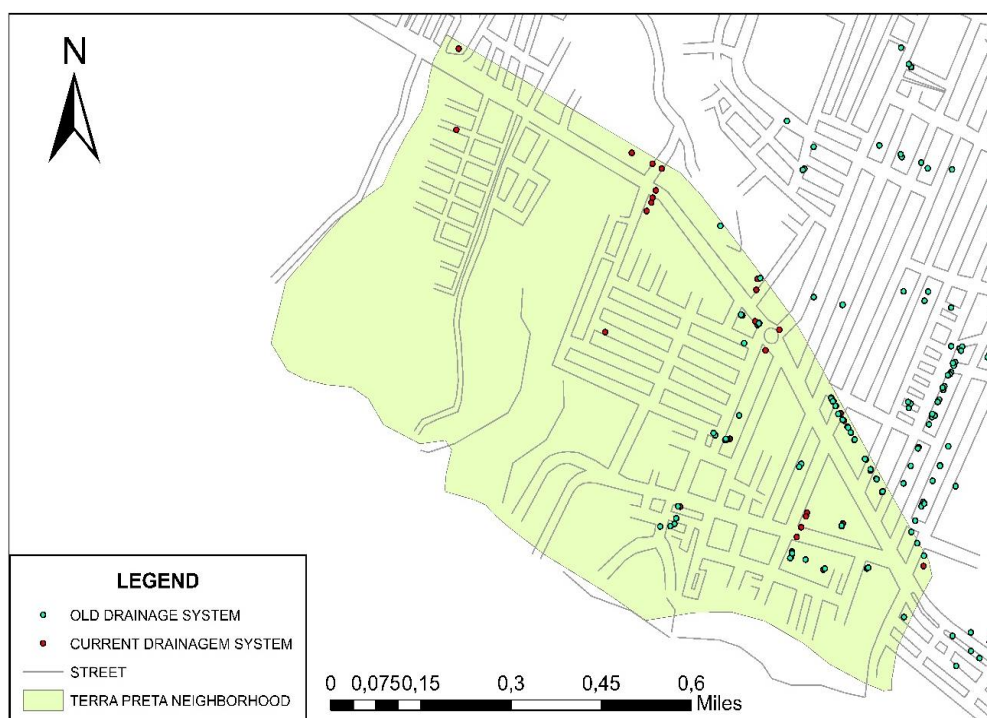


Figure 3: Map of the old and current wolf's mouths of the terra negra neighborhood in Manacapuru-AM.

Water is certainly the most important natural resource for man, among the many natural elements accessible to him, as established in Article 3 of the Universal Declaration of Human Rights. Thus, knowing that the black earth neighborhood is supplied by the underground source, Figure 4 shows the same amount of reservoirs in the area, but we can see a difference in one of the points currently identified in relation to the one diagnosed in the PDM, due to is disabled and currently in another landmark.

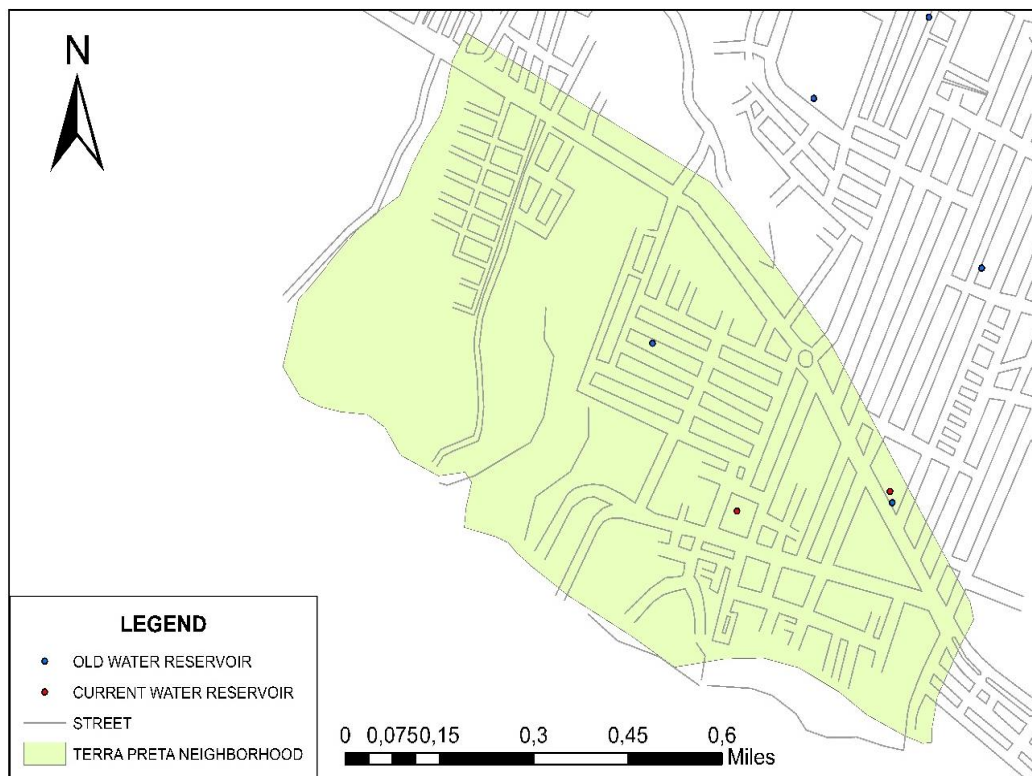


Figure 4: Map of the old and current water reservoirs of the Terra Preto neighborhood in Manacapuru-AM.

As pointed out the absence of a sewage system in the city, given the fact that the solution alternatives, for the definition of the type of treatment are technically feasible, in the elaboration of the basic project should be developed environmental and economic feasibility studies. definition of alternative solution for sanitary sewage treatment system.

## FINAL CONSIDERATIONS

From the understanding of the negative impacts generated to the health of the population and the environment due to the lack of basic sanitation, one must understand the real socioeconomic condition and the local infrastructure, because without good management the public authority has difficulty in corrective actions.

Thus, according to the assessments of the conditions of the basic sanitation system, carried out in the terra negra neighborhood in the city of Manacapuru - AM, and the current and previous verification of this situation, the use of this method was efficient and can be recommended for analysis of other

neighborhoods. of the municipality. Since it allowed the visibility of 15 new junk dumps points and 7 new cake mouths, as well as the deactivation and exchange of one of the neighborhood reservoirs. As well as the lack of sanitary sewage system in the municipality to date.

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## **Comparative Analysis Between Native and Hybrid Mobile Applications**

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### **Abstract**

*With the growth of technology in the mobile area, the app market has been bringing solutions to many problems and making life easier for many people, whether in the business, technology, administrative and many others. It is necessary to understand that to build an app, there are many technologies for different purposes, and developers need to know which one is best applied in every situation. Therefore, the objective of this research is to bring an analysis about the native and hybrid development, showing its main features and information regarding the usability and functionality of two existing applications, which were built within the standards of each tool, based on two features of ISO / IEC 25010: 2011 regarding Software Product Quality. An exploratory research was conducted to bring comparative data regarding applications, and based on the results obtained, it was observed that it is possible to develop similar applications in interface, quality and functionality, even if they are built with different technologies. As a result, native technology is often used to build more robust functionality-based applications that follow the interface standard of each platform, and hybrids are a lower-cost alternative, as well as fact that its source code is fully reusable for use on other platforms.*

**Keywords:** Application; Mobile; Technology;



## 1. Introduction

The average Brazilian spends 200 minutes a day on mobile apps, according to a study published in Exame magazine [1], published by Abril. With the growing number of smartphones, app stores like Google Play, App Store and Microsoft Store have become showcases for users and a range of opportunities for developers to showcase their ideas through tools.

According to the Coworkers Technology Portal [2], apps are indispensable to people's lives, and make them increasingly simple in performing everyday tasks. 70% of users, distributed across smartphones and tablets, use apps for banking, and 96% use to upload media content. Another 73% like to buy products or services using a mobile application, ie a smartphone brings the solution to many tasks in the palm of your hand.

For a good application to work properly, nothing better than performing well, and 60% of users define it as a very important point when evaluating, according to the blog One Day Testing [3]. In addition to overall performance, another point to consider is load time in seconds, where 31% of users expect an application to load around 2 seconds on average. People want to perform their tasks quickly and satisfactorily, in every way.

An application can be developed using the various technologies on the market, and even mixing them together. Based on a blog post by the Total Cross framework [4], a solution that uses the Java programming language for multiplatform mobile applications, the conventional method for this development is usually done using the native language, for example, Java for Android, Objective-C and Swift for IOS platform. Native languages and technologies often need a specialist, and hybrid technologies often need

## 2. Methodology

The methodology applied in this study was based on bibliographic research [5], based on existing material, such as information sites of frameworks, books and technology portals focused on software development.

According to the information gathered, a descriptive research was conducted [5] to apply the ISO concept of Software Product Quality, native and hybrid technology.

For comparative analysis, an exploratory survey was conducted [5] between the Skype and Discord applications, which will be cited below, based on the Usability / Functionality characteristics of ISO / IEC 25010: 2011 - Software Product Quality. These two characteristics were chosen simply because they are directly linked to the eyes of end users, ie it is first taken into account how to use the functions of the applications and how aesthetic it is, whether it looks good or not.

## 3. Development

### 3.1 Theoretical References

#### 3.1.1 Iso / Iec 25010: 2011 - Software Product Quality

According to ISO 25010 [9], for a software to be considered of quality it must obey 8 characteristics

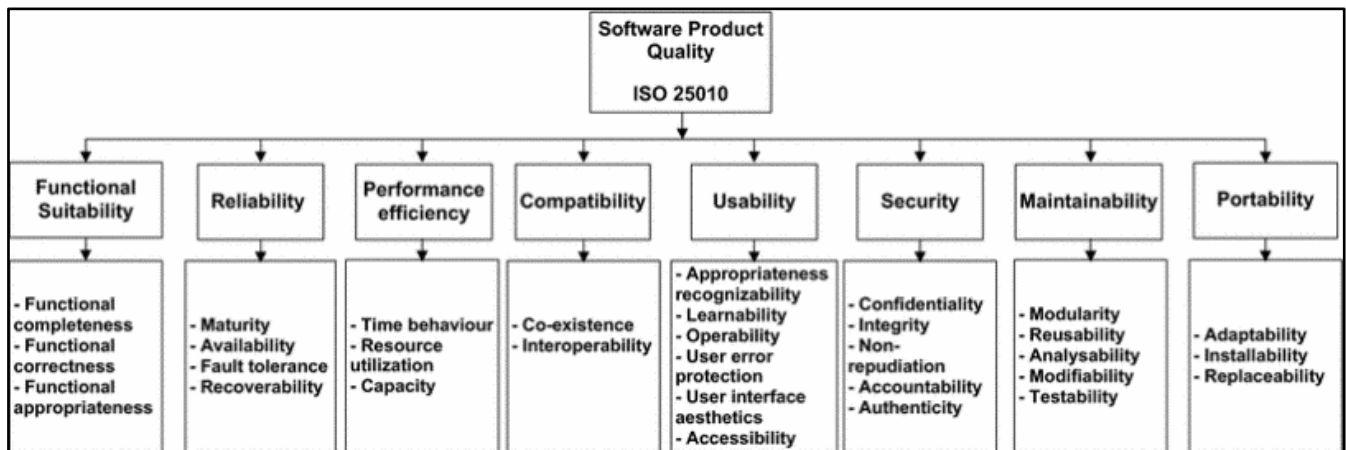


Figure 1: Software product quality characteristics. Source: [9].

According to ISO, the Functionality feature represents the degree to which a product or system provides functions that meet goals and needs when used under specific conditions. It is composed of the following sub-characteristics:

- functional completeness;
- Functional correction;
- Functional suitability.

Usability refers to the degree to which a product or system can be used by specific users to achieve specific goals regarding effectiveness, efficiency and satisfaction in a specific context of use. Its sub-characteristics are:

- Recognition of adequacy;
- learning ability;
- Operability;
- Protection against user errors;
- Aesthetics of the user interface;
- Accessibility.

### 3.1.2 Native Technologies

The use of native technologies is known for their great performance, a well-sought-after feature for building mobile business applications [6]. A native application has great integration with device features such as the use of cameras, GPS and other features without relying on external technologies such as Application Programming Interface (APIs).



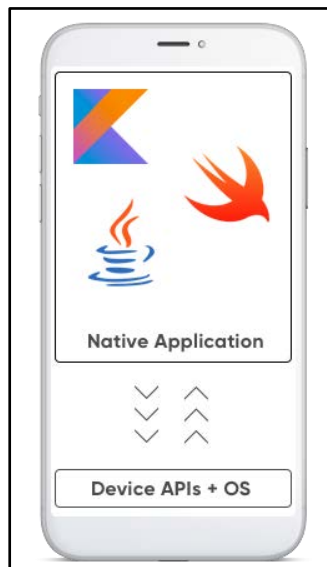


Figure 2: Example of native Android ecosystem.

Source: [7].

The tools used for the Android platform are:

- The Java language, which is well established in the market and still the preference of the vast majority of developers, is being replaced by Kotlin, which has become the official language of programming directly to Android.
- Regarding IDEs (Integrated Development Environment) we have large-scale use of Eclipse, a well-known tool, and Android Studio, created by giant Google and considered the official IDE for development.

For IOS development we have:

- Swift and Objective-C languages, which are considered platform favorites;
- The most commonly used IDEs are IntelliJ AppCode and Apple XCode.

### 3.1.3 Hybrid Technologies

Apps built with hybrid technologies can also be downloaded from the conventional stores on each platform, such as AppStore for IOS and Google Play for Android, and the use of device features like camera, GPS and more is also accessible, but not as easily. of the natives [8].

Basically, it is necessary to have extensive knowledge in web technology (HTML, CSS, JavaScript), and its execution is done in a browser in full-screen mode, called webview, and the user can not identify at the time of opening / execution.

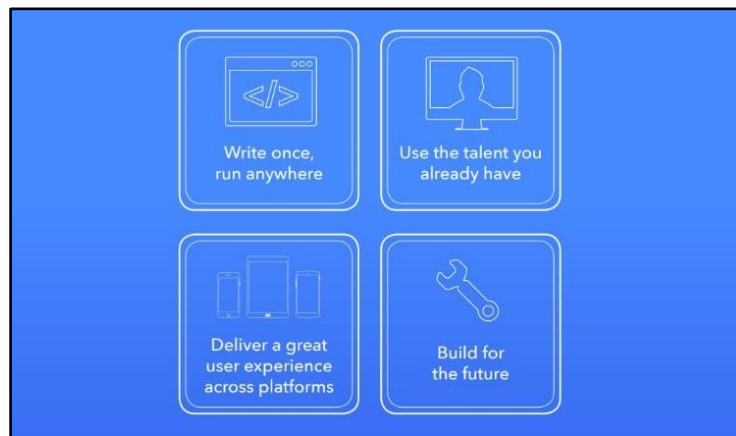


Figure 3: Principles of hybrid technology.

Source: [8].

For hybrids there are many tools, the most used are [7]:

- Cordova, an open-source framework that connects web technologies to devices;
- PhoneGap, which basically uses the concept of Webviews to build applications;
- Ionic, which is considered a SDK (Software Development Kit), and brings the novelty of customizing the application according to the chosen platform and a set of other tools, including for testing;
- React Native, which already brings a different concept from the others. This makes a mix of native code and hybrid tools. In the end, the application built by him does not become completely hybrid precisely because of this.

## 4. Results

For the comparative analysis, only two of the eight characteristics of ISO / IEC 25010 were taken into consideration, namely Usability and Functionality. We have selected the device Samsung Galaxy S8 containing the Android operating system in version 9.0, also known as Android Pie. The device has 4GB of RAM:



Figure 4: Samsung Galaxy S8.

Source: Authors (2019).

The selected applications were Skype, built with native technology and Discord, made using hybrid mobile technology React Native.

First of all, the RAM consumption between applications, opened only on the home screen without any active functionality, was measured, as shown in Figure 5:

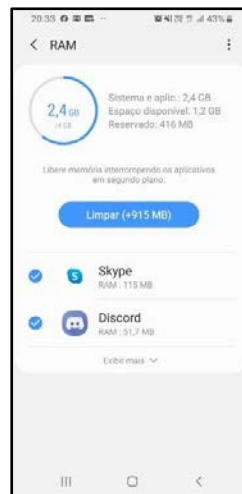


Figure 5: RAM consumption between applications.

Source: Authors (2019).

The application login screens are different from the beginning, where Skype focuses on the Light theme and Discord uses the Dark theme by default, and on the other screens follow the same process, as shown in Figures 6 and 7:

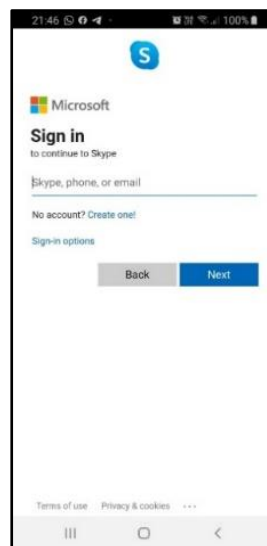


Figure 6: Skype login screen.

Source: Authors (2019).

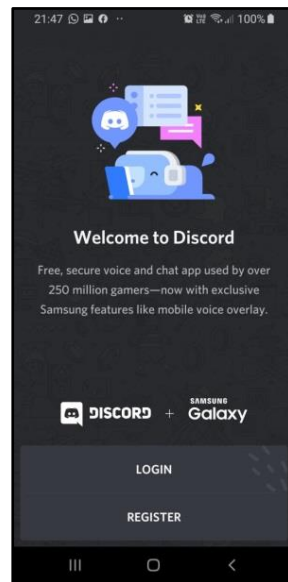


Figure 7: Discord Login Screen.

Source: Authors (2019).

According to figures 8 and 9, after the login screens, we have the following initial screens:

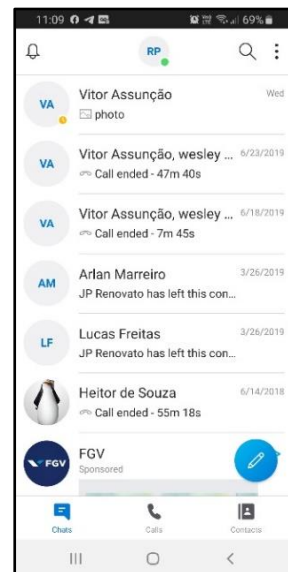


Figure 8: Skype home screen.

Source: Authors (2019).

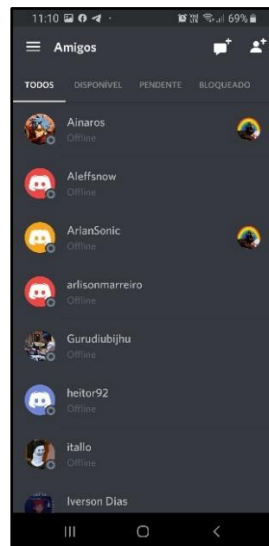


Figure 9: Discord home screen.

Source: Authors (2019).

According to the Attractiveness sub-feature of the Usability 250 ISO principle [9], it says that software must be able to be attractive to users, and must also follow the Apprehensibility process, which is the ability of the user to learn to use the software. application as easily as possible. With this, Skype offers the user right away its main features and functionality through the lower menu (Chat, Calls, Contacts). Discord follows a major interface principle of hybrid technology, where applications are very similar across platforms, making it different from Skype, which has one standard for mobile and one for desktop. The highlight and visual identity is that of the left side menu, which are the server creation features, including it is very similar to the Desktop application:

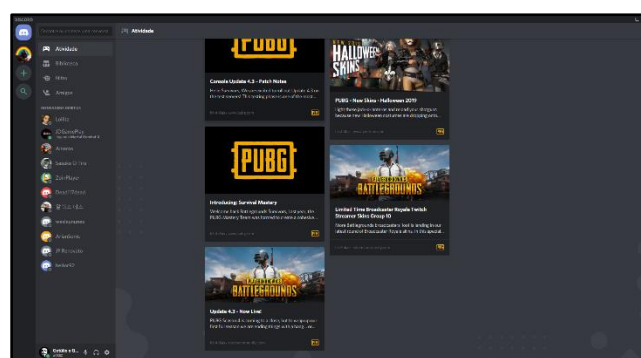


Figure 10: Discord Desktop Interface.

Source: Authors (2019).

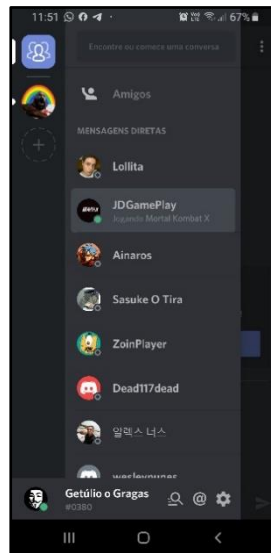


Figure 11: Side menu in the mobile app.

Source: Authors (2019).

For key voice and video calling features, in Skype just click on the desired contact and choose the desired call type in the upper right corner of the conversation, as shown in Figure 12:

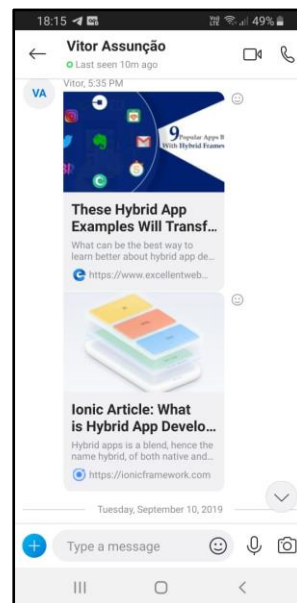


Figure 12: Chat with user on Skype.

Source: Authors (2019).

To have access to voice and video calling features in a private chat in Discord, you need to click on the three dot menu, as shown in Figure 13:



Figure 13: Chat with user in Discord.

Source: Authors (2019).

Discord communication servers are the main functionality and differential of the application. Skype only allows you to call a contact, and later you can invite more people to join:

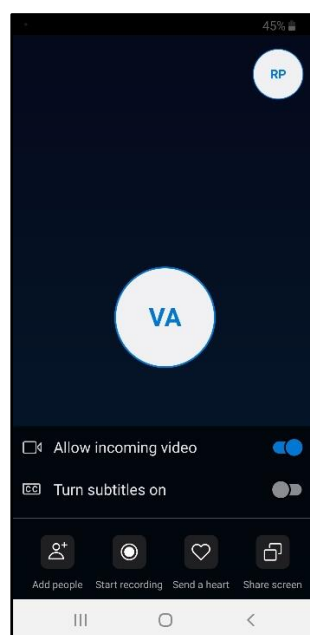


Figure 14: Invite people to the server.

Source: Authors (2019).

To create a new server, you must choose a name, an image, and choose the region:

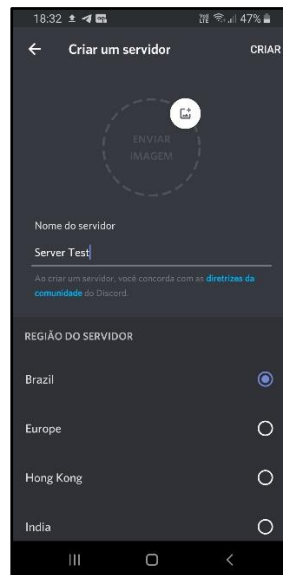


Figure 15: Creating a new server.

Source: Authors (2019).

After creation, the application offers the option to invite people to join the new server, or also the user can share the access link:



Figure 16: Invite people to the server.

Source: Authors (2019).

With this, the server is already created. You can use both voice and text channels:



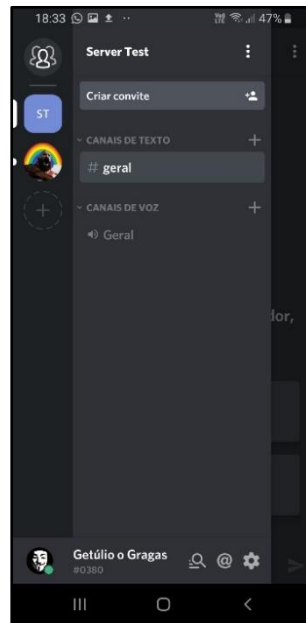


Figure 17: Server created with its respective channels.

Source: Authors (2019).

## 5. Discussions

The results found in the analysis refer to good examples of use of the technologies mentioned. The application development market is increasingly competitive due to the emergence of various tools that are competing against each other.

Both natives and hybrids came with the proposal to deliver the best mobile solutions to the market, where they have to some extent their strengths and weaknesses, such as native applications have a great integration with the features offered by the device (Camera, GPS), and hybrids offer a lower cost of developing and leveraging existing web technologies known among developers. As a result, both technologies, even when used together, can deliver great results.

## 6. Final Considerations

To build mobile applications, the market offers a large number of languages, technologies and tools, each of which has its own specific application. The research showed the structure of native and hybrid technology, comparing through interface analysis and functionality.

Native apps are great for more customer-specific solutions, have great integration with device features, and work well offline. Already hybrids are perfect in relation to development costs, good use of web technologies and are multiplatform, ie the source code is well reused.

This makes it possible to get native and hybrid applications with great functionality and good usability. The use of both development technologies is valid for the market, including even joint use, but it is necessary to identify not only the customer's needs, but also the resources available for project development.

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# **Analysis of The Current Situation of Irregular Dwellings in The Black Land Neighborhood of Manacapuru-Am: Causes and Consequences**

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## **ABSTRACT**

*The present work aimed to perform an analysis of the current situation of irregular dwellings in the black earth neighborhood of Manacapuru-AM using geotechnologies. The methodology consists in identifying the irregular occupations of the neighborhood, and demonstrating the problems encountered as well as the possible solutions. The information obtained was used to generate the diagnostic maps to analyze the characteristics of irregular dwellings and if they have water and sewage network, waste collection, junk dump and drainage network, because it is a simple technique, it is possible to be used in other neighborhoods of Manacapuru, being extremely important in helping public policy planning and environmental monitoring.*

**Keywords:** geoprocessing, master plan, sanitation, irregular use, black earth.

## **1. INTRODUCTION**

With the population growth of cities, social and environmental problems such as irregular occupations and risk areas arise (MENDONÇA, 2004; ALMEIDA and TRINDADE, 2017; PEREIRA, 2019). Thus, with less physical space and / or financial conditions, the less privileged part of the population often choose to occupy areas of risk and / or preservation, and in some cases are responsible for soil degradation, riparian forests, water bodies, springs. and slopes (SAMPAIO et al., 2003). The identification of environmental degradation by anthropic action in the Pernambuco forest zone was studied by Lorena et al. (2018). The authors used geoprocessing techniques from 2006 to 2011 to show

that anthropic action and deforestation are the main responsible for the degraded areas along the banks of the Tapacurá River.

In addition, the socioenvironmental impact of these irregular occupations and constructions may increase the cost of water treatment and threaten the quality of distributed water due to urban pollution (GUERRA, 2017). The proposal of a methodology to evaluate the impact of land use and occupation on water quality in small and micro watersheds in rural areas was the main objective of Silva (2018). While Pereira (2010), Perin (2013) and Martins (2014) showed that water resources can be impacted by land use and occupation.

At the same time, population growth has become one of the main factors that has been constantly affecting the environment and the reality of urban areas. Nowadays this growth has become a challenge, as we must specify what is regular and irregular within the urban context, so that the areas where they particularly want to occupy are in accordance with current legislation. However, to say that it is appropriate or not about the extent to which it is intended to occupy is in such a way as to meet the expectations of accommodating the city's population with at least the basic sanitation provided for by law (MARTINS, 2006; FREITAS *et al.*, 2017).

However, associated with irregular occupations are landslides, favored by the removal of the vegetation cover (FREIRE *et al.*, 2018; DE ALENCAR SILVA, 2018) and impermeable soils. Residents of these areas poorly use basic sanitation, such as reservoir water supplies and drinking vessels, causing damage to public health and the population's own development, as basic sanitation has become essential for society and for the protection of the environment. Thus, it is essential to study these areas to obtain the planning and to know which areas are irregularly occupied (TASCA *et al.*, 2017).

Brazil is one of the countries with one of the highest rates of social inequality in the world, where part of the population lives in places considered inappropriate by illegality or due to the risk of disasters. The Terra Preta neighborhood, located in Manacapuru Municipality, has permanent preservation areas such as: steep slopes, hilltops, waterfronts and water bodies, wetlands, etc., however, the residents occupy these unsuitable areas for housing, endangering your safety (COSTA, 2018).

However, households do not have enough income to acquire the land, as land has become a source of monetary wealth. Unfortunately, construction in irregular areas has brought serious environmental and urban problems (SILVA and MORAES, 2018). Technically, the soil is a legal institute that is responsible for allocating the areas where the buildings can be built according to the master plan. Thus, without the planning established through master plan the houses are unable to be considered worthy of occupation, ie, occupations without any control of the public power (REIS, 2019).

Thus, through geoprocessing, the situation of irregular dwellings in the Terra Preta neighborhood in the municipality of Manacapuru was analyzed, thus showing possible solutions to the problems encountered, with the objective of guiding the public managers of the municipality. Finally, residents were made aware of irregular occupations and the risks they expose.

## 2. MATERIAL AND METHODS

The study was limited to the Terra Preta neighborhood in the municipality of Manacapuru which is located on the left bank of the Solimões River in the state of Amazonas (as shown in figure 1). First, an analysis of the legislation was carried out to specify the laws that regulate land use and occupation in the city. Given the diversity of irregular occupations in the Terra Preta neighborhood, it was necessary to elaborate a typology of such areas, to facilitate the identification and subsequent characterization in loco. The master plan of Manacapuru / AM was used as a basis for the identification of land use and occupation based on current laws. For these are a basic instrument for planning and guiding the development policy and planning of urban expansion and social functions of the municipality.

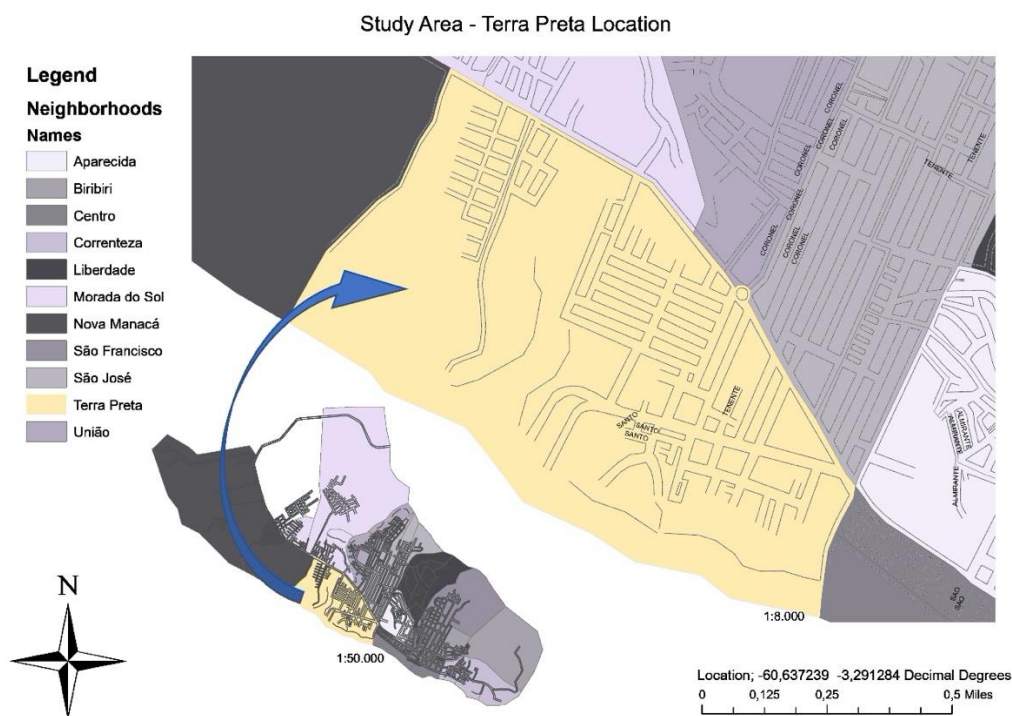


Figure 1: location of the area of the black earth neighborhood of the municipality of Manacapuru.

Subsequently, field measurements were performed over a three-month period (from June to August 2019). The field information obtained by the GPS receiver (GPSMAP 78S GARMIN), were prepared diagnostic maps that served as a tool for the identification and analysis of irregular occupations present in the neighborhood. After checking the diagnostic maps, the characteristics of each irregular dwelling were analyzed, such as presence of water and sewage network, waste collection, junk dumps and drainage network.

The data obtained in loco were tabulated so that the columns represented latitude in x and longitude in y, converted to decimal degrees. Subsequently, the information was saved in xls format (Excel) making it easy to export to the Arcgis version-10.3 environment. Finally, a visual comparison analysis was performed between the updated maps of irregular occupations generated on the spot, and the data obtained through the survey of the municipal (Civil Defense Secretariat) and federal (Brazil Geological Service-CPRM) public institution.

Thus, from the analyzes it was possible to understand the process of expansion or paralysis of irregular occupations, and the possible estimates generated by the maps of the municipal master plan. Following the previous step, the streets that have basic housing infrastructure were identified, such as: water and sewage network, drainage network, waste collection and junk dumps. Finally, based on the information generated, improvement proposals were generated for the neighborhood.

### 3. RESULTS AND DISCUSSIONS

#### MASTER PLAN

Manacapuru is one of the member municipalities of the Manaus Metropolitan Region - RMM, a Brazilian metropolitan region created on May 30, 2007 by Complementary Law No. 52/2007 and amended on January 27, 2008 by Complementary Law No. 59 encompassing Manacapuru Municipality. , according to the IBGE population estimate (2018), the population at the moment of the census is 96,236 inhabitants, distributed over a territorial extension of 7,336,579 km<sup>2</sup>.

According to the federal constitution, article 182 and 183, the master plan is an indispensable municipal law for municipalities with cities with population of more than 20,000 inhabitants and which should be a basic instrument of the municipal policy of urban development and expansion, which has as its objective aim to order the full development of the social functions of the city and to ensure the well-being of its inhabitants. Article 182 of the federal constitution states that the policy of urban development and expansion, of which the master plan is the basic instrument, must express the fundamental requirements of city ordination, since the constitutional text includes housing, sanitation urban transport, and the planning and control of urban land use, of land parceling and occupation.

Thus, the master plan of the municipality of Manacapuru was prepared by law No. 52 and approved on October 10, 2006, so that the municipality from this law meet the determinations imposed by the statute of the city law No. 10,257 of 10 July 2001 and the Brazilian Constitution (1988). The master plan of Manacapuru is based on the laws of land use and occupation, it is observed in table 1 that it states that the land parceling is not allowed according to art.54.

Items	Category
I	On land located in preservation areas, as provided by this law and its regulations;
II	In flooded or flood-prone land, before steps are taken to ensure runoff;
III	On land that has been grounded with material harmful to public health without being previously;
IV	On land in protected areas, in accordance with this law and its regulations, without complying with the guidelines set forth therein;
V	Prevent free access to rivers;
VI	On land with a slope equal to or greater than 30% (thirty percent), unless the specific requirements of the competent authorities are met;
VII	On land where geological conditions do not advise building;
VIII	In ecological preservation areas or those where pollution impedes bearable sanitary conditions until their correction;

Table 1: Areas not permitted for land use.



Source: Master Plan (2006).

Therefore, from the information described in the master plan of Manacapuru / AM it was possible to detect in loco the basic characteristics for the identification of land use and occupation from the current laws and the typology used based on art. 54 described in Table 1, which facilitated the identification of a variety of irregular occupations in the Terra Preta neighborhood, such as: occupation in flooded or flooded land, land in protected areas, in land with slopes equal to or greater than 30%, on land where geological conditions do not advise the building, shown in Figures 2,3,4 and 5.



Figure 2: Flooded houses during floods.



Figure 3: The houses after the flood.



Figure 4: Terrain with slope greater than 30%.



Figure 5: House destroyed by ground mass movement.

## DIAGNOSTIC MAPS

The diagnostic maps were elaborated as a tool for the identification and analysis of the irregular occupations present in the Terra Preta neighborhood. In which the verification of these maps was possible analyzes the characteristics of each irregular dwelling in the neighborhood, such as presence of water and sewage network, waste collection, junk dumps and drainage network within this urban space. The data collected on site were necessary to perform a visual comparison analysis between the maps prepared in the 2006 municipal master plan along with the existing land use and occupation guidelines for land subdivision, and the data obtained through the institution survey. (Civil Defense Secretariat) and federal (Brazil Geological Survey-CPRM) public area delimiting areas considered inappropriate for housing.

Figures 6 and 7 show the areas of the Terra Preta neighborhood considered by the master plan, the geological service of Brazil-CRPM, and the municipal civil defense secretariat as irregular occupations. The villas are made up of all kinds of materials in which they are set on steep hillsides that lead to streams and rivers, with risk of slipping, since there are ravines and cracks in the hillside and many walls and walls have cracks. At the base of this slope are houses that are at risk of material.

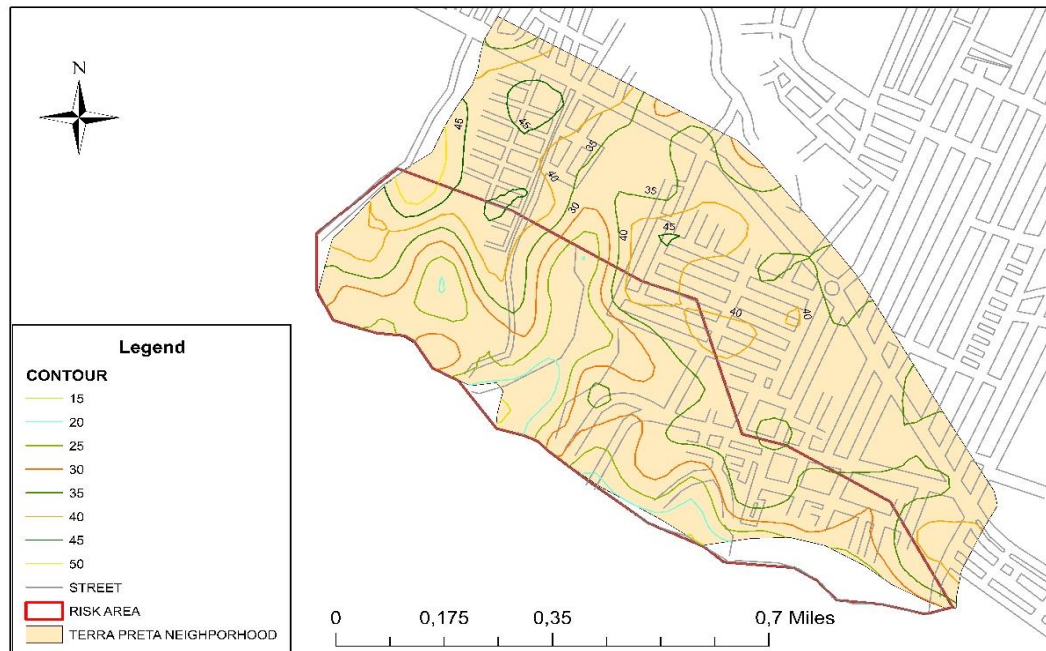


Figure 6: Map of the old and current risk areas of the Terra Preta neighborhood in Manacapuru-AM.

In the lower zone, houses are built on stilts, as they constantly suffer from flooding events as shown in Figure 7.

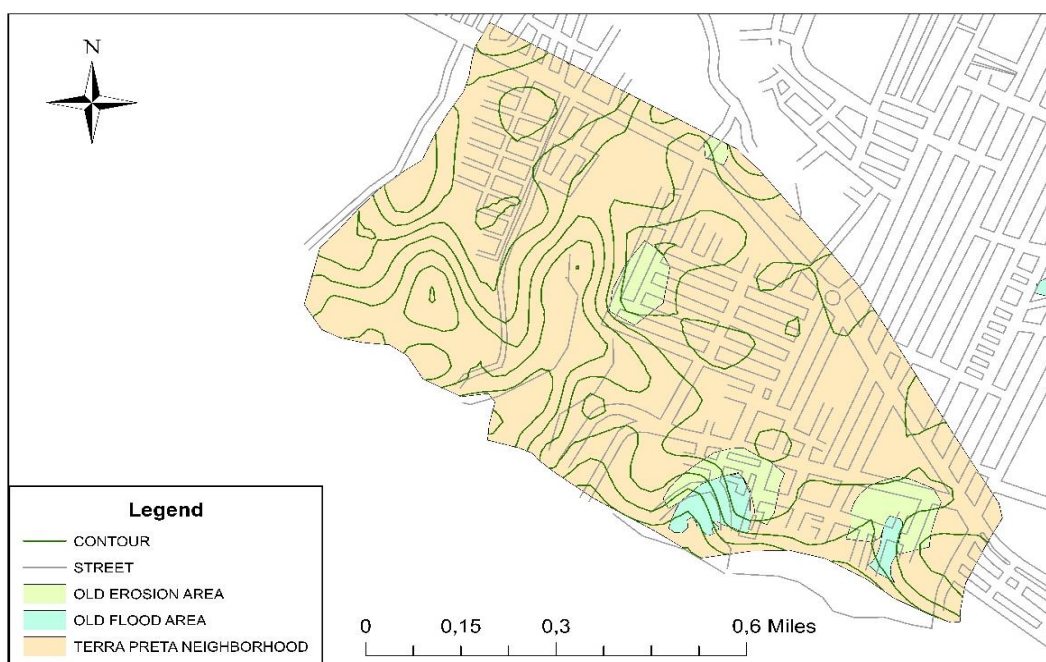


Figure 7: Map of old and current flooding and erosion areas of the Terra Preta neighborhood in Manacapuru-AM.



For housing installation vertical slopes are common for slope, there are sloping trees, banana trees on the slope, solid waste, wastewater thrown by PVC pipes and septic tanks at the top of the slope saturating and eroding the soil, absence of sewage or rainwater drainage system, as well as a slip scar show instability of the area. The Terra Preta neighborhood is located on the edge of Manacapuru, where the Solimões river turns and undermines the ravines, causing the phenomenon of fallen lands, especially during the ebb. Thus, the river is an extra risk factor for these riparian residents as there is a record of landslide with fatalities.

In October 2010, according to CPRM, three children died due to a large rotational landslide that hit some houseboats, several regional boats and canoes. In March 2017, civil defense relocated the population affected by a landslide in the black earth district on the riverside street leading to the deaths of some residents (Figure 6). Due to this disaster, the municipality declared an emergency situation in March. This natural event was recognized by the Federal Government, and families who had their homes destroyed received relief until their needs returned to normal, totaling 41 families who had their homes invaded by land and currently the affected are on paid social rent. by the City Hall of Manacapuru.

Area near the steep slope, are over 30 m high, and high slope in several stretches, where houses are a few meters high on the slope.

According to CPRM currently in the area known as Beco do Boto, there are houses on the edge of a steep terrain slope, with a height of approximately 20 m, with a slope ranging from 60-80 °, with houses at the top of the slope. In the lower part, it is constantly flooded (Figure 7) and presents greater landslide potential because it consists of consolidated silt-silt sediments, sawdust and solid waste discharged into these sediments.

From 2013 to 2018 there was an increase in the size of risk areas accounted for by CPRM. An allotment was newly built on the other bank, which in this case is less steep of the stream, and even with low slope may have poorly competent soils (Figure 6). In 2013 about 161 properties and approximately 644 people were at risk, and in 2018 around 261 properties and approximately 1,305 people are at risk. In 2019 civil defense accounted for 95 families that suffered flooding about 380 people in the black earth neighborhood and 2 families on the riverside street by soil mass movement (Figura7).

In this way, Terra Nova district, like any other district in Brazil, suffers from various problems related to irregular occupations, and one of them is the lack of basic sanitation, in which the disorder with the disposal of garbage in public places and private wastelands are easy targets. for the irregular disposal of waste of all categories, as well as disturbing by its stench and attracting insects and rats, as well as causing difficulties in the rainy season, when the waste is carried by water into manholes, causing flooding. . Figure 8 shows the map of the current and old junk dumps in the Terra Preta neighborhood, which was compiled with data from the 2006 municipal master plan and current data collected on the spot to check for an increase in junk dumps over the years. Given this it was found that 2006 had 11 points of junk dumps and currently 26 points, so there was a significant increase in junk dumps in the neighborhood and a third of this increase is due to irregular occupations, since in some streets the garbage truck does not pass to collect this waste as shown in Figure 9.

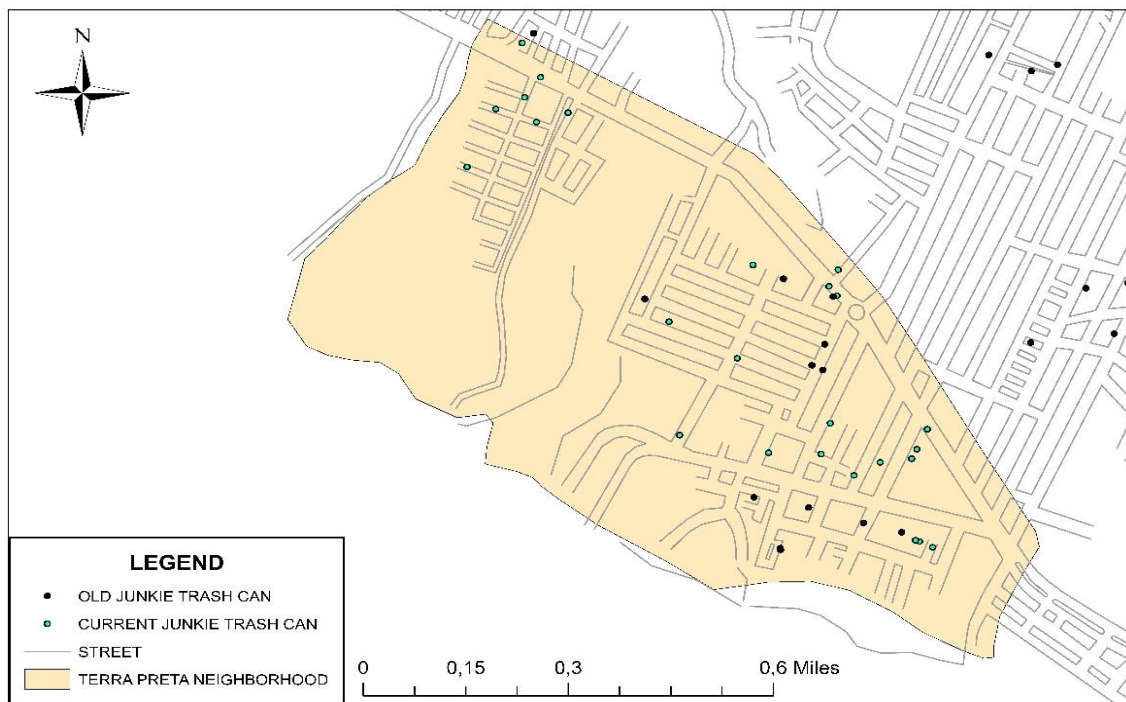


Figure 8: Map of old and current junk dumps of the Terra Preta neighborhood in Manacapuru-AM.

The neighborhood home garbage truck routes (Figure 9) currently still suffer from street infrastructure, often companies are unable to meet all demand as a result of not being able to reach the streets of irregular occupations and have as their One of the main consequences is the increased generation of municipal solid waste and many of this waste is dumped in areas protected by law. That, however, these effects cause harm to human health and the environment, and the most frequent are divided into physical, chemical and biological agents that are present in solid waste. It is observed that in 2006 garbage trucks did not cover most of the routes, but there is currently an increase in the areas covered by the services. Therefore, as it is an area that is difficult to reach, the companies responsible for garbage collection generated in these places do not act effectively.

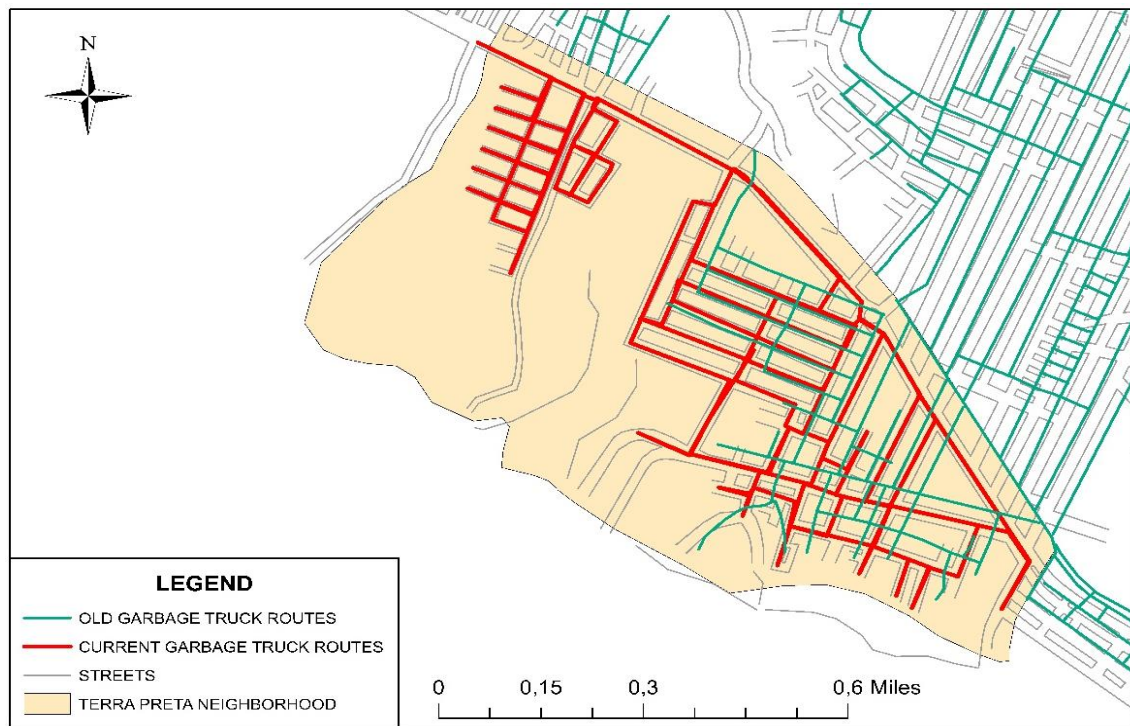


Figure 9: Map of the old and current routes of the home collection trucks of the Terra Preta neighborhood in Manacapuru-AM.

Since the routes cannot reach these places, the neighborhood is disturbed during the rainy season, when the waste left by them is carried by the waters into manholes, causing floods that often cause disease, damage and disrupt traffic, among other consequences. To avoid these catastrophic events, the master plan requires manholes to be laid out, as well, making it clear that there are areas in the cities and surrounding areas that should not be occupied: riverbanks, dune and native forest areas, the slopes above a certain range. quota and among others. They are included in the forest code and the law of permanent preservation areas. In addition to the problems of waterproofing the land and the destination of the garbage in these areas, the construction of dwellings in the canals bed stands out, reducing its cross-section and, consequently, the runoff, causing urban flooding. Much of the black earth district obtains manholes, as shown in Figure 10, totaling 39 manholes in 2006 by the master plan and 46 currently collected on-site. It can be observed that there is still a decrease, as well as the houses that are located in areas. inadequate have no drainage network.

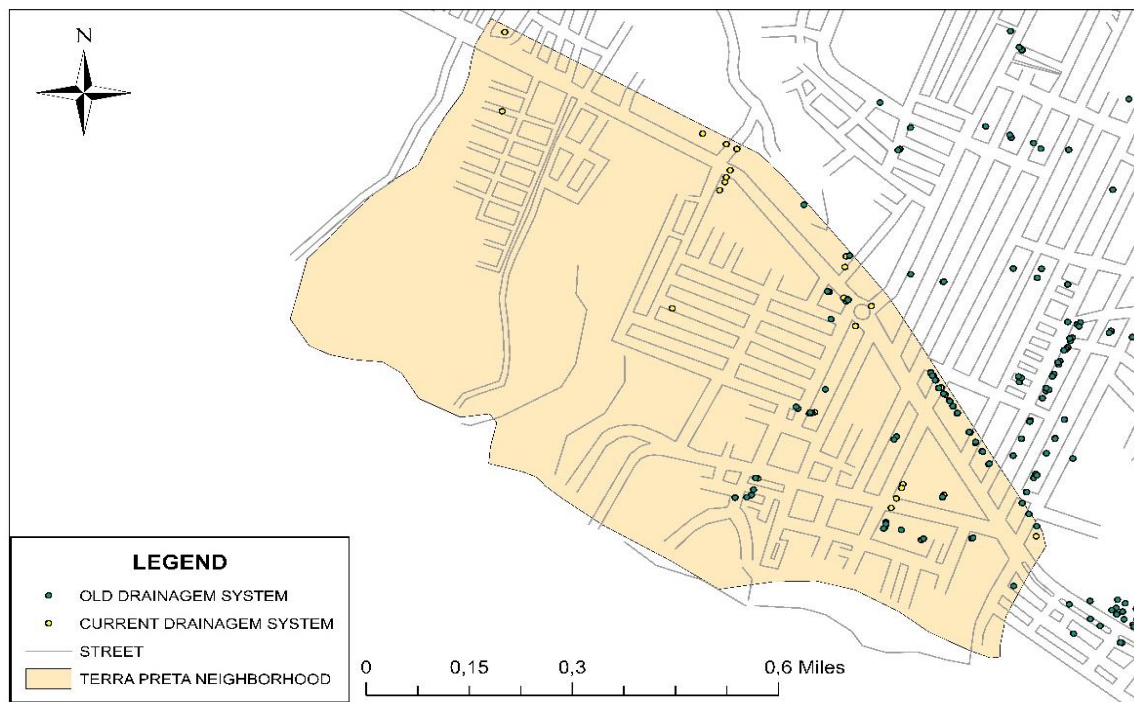


Figure 10: Map of the old and current wolf's mouths of the Terra Preta neighborhood in Manacapuru-AM.

The neighborhood's water supply system initially involves the capture of raw water from the environment, then there is adequate treatment to make it drinkable and, finally, there is distribution to consumers, in sufficient quantity to meet their domestic consumption needs. , utilities and other uses. The neighborhood as a whole receives this service, that is, even in areas that are improperly occupied receive water from the water reservoir. Figure 11 shows two reservoirs in the master plan map, but which currently do not reside in these stipulated locations, but two reservoirs were built to supply the population elsewhere.

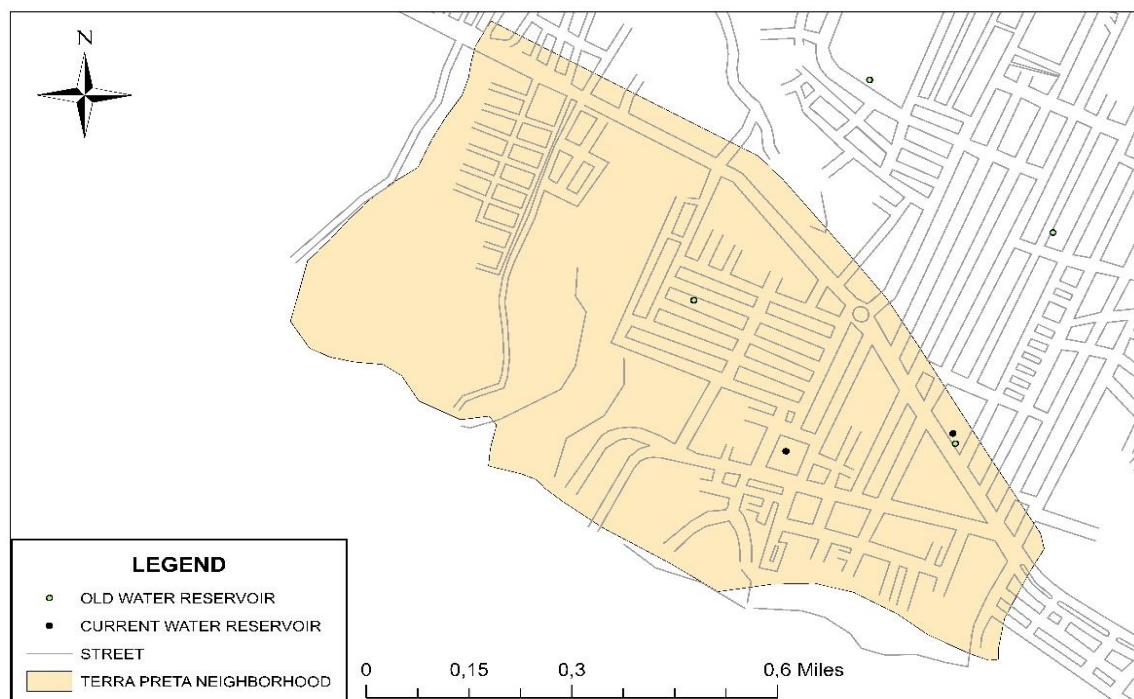


Figure 11: Map of the old and current water reservoirs of the Terra Preta neighborhood in Manacapuru-AM.

Based on the information generated, improvement proposals were prepared for the neighborhood. According to the CPRM, the black earth district will have to build an efficient drainage system to discipline rainwater and wastewater and containment works. As well as temporary removal of houses and floating near the hillside, during rainy periods and during severe ebb.

The population demands from the City Hall the supervision and prohibition of the construction of slopes, banks and interior of the watercourses according to rules established by law, as well as installing warning system for hazardous areas, through public means of communication (sirens, sirens), mobile phones), allowing effective removal of residents in the event of severe or continuous rainfall warnings, and conducting education programs for school-age children and adults in their community centers, teaching them to avoid occupying areas unsuitable for housing construction due to geological risk and also make them aware of the issue of garbage.

Another suggestion would be the implementation of the municipal risk reduction plan - PMRR, which has as its main objective the mapping of areas to further describe the direction of their urban planning, characterized by level of criticality, encompassing the slopes and / or susceptible settlements. floods located on either side of the dunes and surrounding areas or in other areas that are inappropriate for actual and complete social settlement of these settlements in the formal city.

And finally, the Civil Defense must act more preventively and, in times of drought, take advantage of the low number of occurrences to cover and survey all known risk areas and already take appropriate preventive measures. Following these tips will prevent future accidents in the neighborhood.

#### **4. FINAL CONSIDERATIONS**

The use of maps generated in Arcgis 10.3, allowed a supervised classification of land use and occupation based on the current laws of the municipality of Manacapuru properly. The Arcgis 10.3 application, through its different modules, made possible the accomplishment of the tasks, providing the data analysis and reliability in the obtained results.

Within the proposed objectives, the results from the data generation in the Terra Preta neighborhood proved to be efficient in classifying images of irregular occupations. Regarding the environmental impacts, the deforestation of the banks of rivers and streams was observed, as well as the risk of flooding to occupying families in risk areas. There is also a concern above with the narrowing of the stream, caused by the domestic sewage discharged there directly, or even due to the excess of garbage deposited on the site.

The methodology applied in the present work, because it is a simple technique, is possible to be used in other neighborhoods of Manacapuru, being extremely important in the aid of public policy planning and environmental monitoring.



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# **Descriptive Analysis of Advantages and Disadvantages of Expanded Polystyrene Monolytic Panels - EPS**

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## **Abstract**

*The light concrete of expanded Polystyrene is an innovation in the construction market, as it stands out for its execution, cost and efficiency. This new technique seeks to provide the constructions: lightness, cost reduction, reduction of time in works and good thermal and acoustic performance, producing comfort to the environment. This work aimed to study the use of light EPS concrete (Styrofoam) in internal and external walls, presenting the comparisons between this system and conventional masonry with ceramic blocks through the monitoring of a work in the city of Manaus - Amazonas.*



**Keywords:** EPS; Lightweight concrete; Constructive method;

## **1. Introduction**

The construction system of panels in EPS was developed by Monolite, so called the Monolite system, contemplating important advances for civil construction, more specifically for masonry lift. The construction process can be used both as structural closure as well as sealing structure. In the analyzed works, not only were the use of panels, but also in a mixed system with reinforced concrete structures or metal structures.

Monolithic panel (also called Monolite or monolithic only) consists of a large expanded polystyrene plate (EPS), high-strength lightweight steel meshes interconnected by electrowelded steel bars and additional layers of mortar or concrete, put into work by traditional processes or designed using projection equipment.

The origin of expanded polystyrene (EPS) panels comes from an Italian project, developed in a region subject to earthquakes, in order to create a monolithic structure that did not collapse and aggregate thermal insulation elements in the early 1980s (SOUZA, 2009).

According to Luebe (2004), expanded polystyrene has been used in Brazilian civil construction in a growing way, using expansion joints, lost coffin, insulation and road foundation, gaining space in the construction of slabs. It has been used in several countries around the world for more than 40 years, safely and efficiently, among all the technologies used in civil construction. Contrary to the thought, of being a premature system, the construction system with walls raised from panels produced in EPS and steel mesh, arrived in Brazil around the year 1990.

Polystyrene, or Styrofoam, as it is known in Brazil, is a synthetic aromatic polymer made with the styrene monomer, a liquid derived from the petrochemical industry, can be rigid or foamed, usually used in its white, hard and brittle shape. Taking into account its weight, it is a cheap resin, being widely used as an efficient barrier against oxygen and water vapor, having a relatively low melting point (AVESANI NETO, 2008).

These are structured with low carbon steel screens, with galvanized wires of 2.1 mm in diameter and mesh 50 x 50 mm or 150 x 50 mm, positioned, on its two sides. The plates are interconnected with each other, by galvanized carbon medium steel connectors, with 2.76 mm in diameter, electrosoldiers to the screens, forming a truss. Subsequently, in the construction process, receiving, on each of its faces, a layer of fck microconcrete = 25 MPa with a minimum thickness of 3.5 cm (TECHNE, 2012).

The dimensions of the panels are changeable, according to the desired modulation of the architectural design. Compared to conventional systems, there is a considerable reduction in waste and requiring reduced labor for the assembly of panels. There is a decrease in the manufacturing process and in its assembly, as it can reduce the costs of the foundation when using these panels, since they are lighter materials than another type of seal (SOUZA, 2009).

In order to understand aspects of safety, habitability and sustainability, it is an important thing to talk about materials that make up the system, which are summarized in expanded polystyrene (EPS),

galvanized steel and concrete.

From this and knowing that housing is the most desired construction one should understand and evaluate the constructive process in EPS panels in order to understand the complete system and its benefits.

Thus, we sought to evaluate and characterize the construction process in EPS panels, its system and benefits.

## 2. Methodology

A case study was carried out, characterized by a deep analysis of objects, which allow broad knowledge and other types of designs considered (GIL, 2007).

This research is of qualitative characteristic, a systematic procedure with the objective of providing answers to the proposed problems. Research develops from the formulation of the problem to the presentation and discussion of the results (GIL, 2007).

The study deals with the analysis of the advantages and disadvantages of the use of expanded polystyrene monolithic panels (EPS) in the construction process of popular houses, aiming to demonstrate the cost in relation to the use of this process.

## 3. Results and Discussion

The construction system is characterized by an alternative for replacing materials such as conventional masonry. Thus, we sought to understand the advantages of EPS in relation to the conventional.

Table 1 - COMPARISON BETWEEN CONVENTIONAL MASONRY METHOD AND EPS PANEL

CHARACTERISTICS	CONVENTIONAL MASONRY	EPS PANELS
MECHANICAL RESISTANCE	Excellent mechanical strength, however, lower than the system in EPS panels. It drives more heat, but spends more energy	Low thermal conductivity, reduction of energy and air conditioning expenses
FIRE RESISTANCE	Excellent. For a wall with a 9 cm block and mortar of 6 cm thick, one has a time of 150 min	Low. For a wall with 9 cm thick panel and 6 cm thick mortar one has a time 40 min. Flame retardation
THERMAL INSULATION K (W/m.k) thermal transmission coefficient (CCT)	It is constituted by good insulation, but the ceramic block has a lower resistive capacity than the EPS. Its coefficient ranges from 0.9 to 1.2	Main features, high ability to resist heat passage, its cell structure closed. Its coefficient ranges from 0.035 to 0.042
SOUNDPROOFING. Rw (db) sound resistance	For a wall of 15 cm (9 tij. + 6 arg.) you get a Rw=38 db	For a wall of 14 cm (8 EPS + 6 arg.) you get a Rw=38 db
STORAGE	Its storage takes up a lot of space, reducing the mobility rate in the work	It can be stacked horizontally superimposed with a maximum of 20 panels. Reduces space occupancy

WEIGHT	Larger, so that in the same dimensions that the panel with a thickness of 15 cm can reach 250kg/m <sup>2</sup>	Reduces the structural weight of the work, as the EPS is 98% composed of air. The finished panel with 15 cm thickness has its weight around 120kg/m <sup>2</sup>
MANPOWER	Does not need a specialized workforce	For its simplicity of execution does not require specialized labor, but a qualification through training
SPEED OF APPLICATION (PRODUCTIVITY)	Because of its fully artisanal system, it is characterized by a much slower and less productive method	Due to the easy handling and simplified application characterized by modularity, it presents high executive productivity
PRICE	Low initial unit cost, due to the abundance of its materials and simple manufacture	Higher initial unit cost, however, if taking into account the entire context involved the price may become lower
DURABILITY	Larger than any other material, being can exceed 100 years	The age limits of the EPS are not known, but understands that the material has great durability, as it keeps its properties unbeaten over the years.
EXECUTION OF COMPLEMENTARY INSTALLATIONS	Less efficient due to the need for rework to perform	Facilitated due to no need for cutouts of the walls
WASTED MATERIAL	Because it is a totally handmade concept, where the executive process is totally geared towards an almost always disqualified workforce, to a huge waste rate in this system	Due to their modular character, where the parts already come ready according to dimensional needs, it is possible that there is a reduction of almost 100% in waste
PLASTER ADHESION	Its adhesion capacity is much higher, due to a greater porosity that the material presents	There is difficulty in joining this material, due to its very high impermeability
MARKET	There is a better acceptance by its users	Limited due to factors such as ignorance of the material regarding its advantages
PAVEMENT LIMITATION	There are no limitations and can be checked in the most diverse quantities	There is a limitation of up to 4 floors. Since to obtain larger numbers, it is necessary to resort to auxiliary structures such as beams and pillars
SUSTAINABILITY	Large amounts of debris are used for further dumping, using a lot of water and energy from its manufacture to execution.	Expanded polystyrene 100% recyclable and reusable. With its use decreases the consumption of water and energy from its manufacture to its execution and decreases the generation of waste to nature.

Source: Own Authorship.

The EPS construction system presents numerous phases, where initially the foundations are prepared, made, according to the structural calculation, depending on the type of land, which can be adopted different types of foundation: type radier slab (with 18 cm of height); wall footing (40 cm wide and 15 cm deep in simple designs); or a special foundation, if, the terrain or architectural polling conditions are not favourable to the (TECHNE, 2012).

For hydrosanitary, electrical, communication, safety and others that may interfere with the radier, they are

positioned before the foundation begins. The pipe is grounded and leveled where on the ground there is the launch of the counter floor concrete. Once this initial part is done, one must proceed to the base of the floor, so that they are developed, with more cleaning and efficiency (Figure 1).



Figure 01: Radier type foundation

Source: Monolite, 2017.

After the foundation is concreted, the process begins in which the assembly of the base, alignment and plumb of the panels, for the lifting of walls, the assembler must fix the panels at the previously placed starts with the aid of a stapler, with AC steel clamps 60 (the same as attaching the mesh to the panels) or simply with annealed wire and tools. The panels have overlapping steel mesh flaps, so that they are sothey are sodoted to the next panel.

The assembly of the panels takes place in a simple and manual way, being connected to each other and to the starts with the use of annealed wire and pliers or through the use of a pneumatic pistol (stapler) (BERTOLDI, 2007) (Figure 2).



Figure 02: Stapler for Mooring of Panels in The Starts

Source: Thermotech, 2014.

The assembly of self-supporting panels is not complex, but requires care and standards to avoid misunderstandings in construction. They must be aligned with the iron guides of the contra piso and

mounted on the plumb, where the fixation is made by clamps and annealed wires. The panels will be numbered by the manufacturer of the construction system and the mesh tabs of each panel must overlap the tabs of the next panel for composition of the monolithic assembly (Figure 3).



Figure 03: Panel fixed on the start-ups of the radier type foundation

Source: ISOMAF (2019).

After the panels are installed, you can embed the electrical, hydraulic and sanitary pipes. The execution of the facilities takes place in a practical and fast way, without the production of debris and need for rework, keeping the built environment clean.

This is one of the advantages of this system compared to conventional masonry, in which according to Lueble (2004), in the placement stage of pipelines and pipes, a conventional construction, presents a high waste of materials, because masonry is broken and generated debris, which must be collected from a recycling plant (Figure 4).

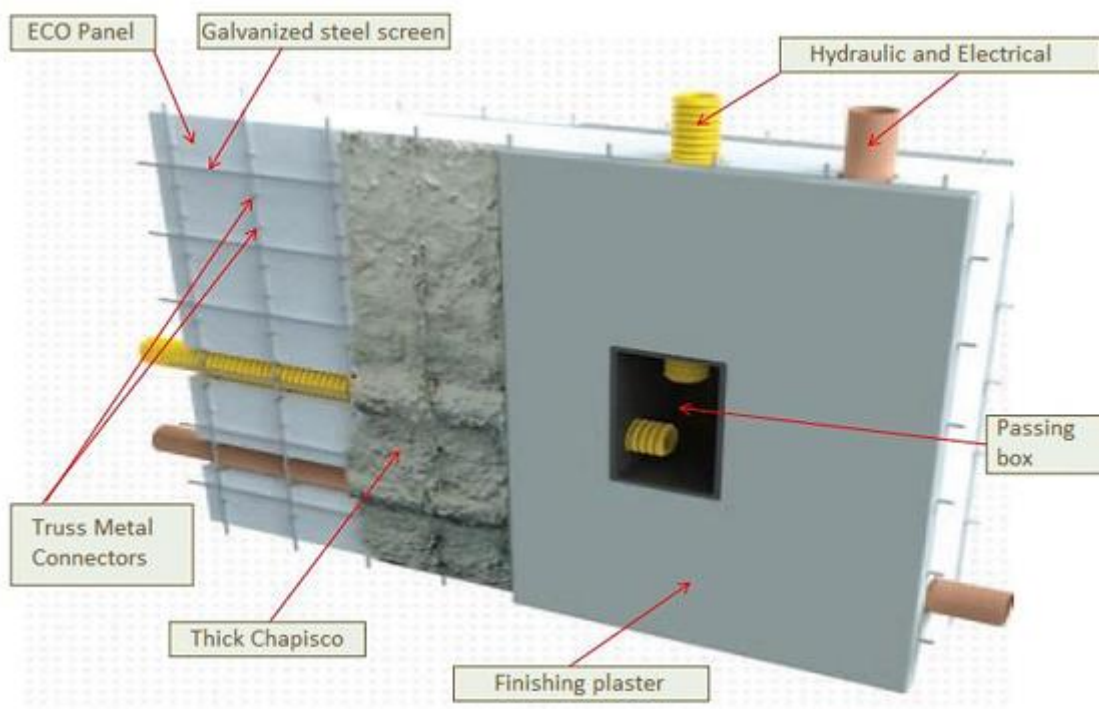




Figure 04: Electrical and hydraulic installations

Source: MONOFORTE, 2016.

In the case of rigid or semi-rigid tubes, when necessary, the metal screen is cut with pliers and at the end, the screen is closed again to hold the pipe. The system admits sophisticated mesh grounding, creating a Faraday cage and for multi-floor designs, recommending the use of shafts, as it facilitates access to and maintenance of electrical and hydraulic systems.

After the assembly of the panels, with alignment and plumb checked and all hydraulic and electrical installation has been carried out, the coating with mortar must be performed, which can be applied by manual process or by means of a pneumatic projection, with predetermined thicknesses according to the project. The use of pneumatic equipment provides greater productivity, coating compaction quality and causes low vibration to panels when compared to the manual process.

The coating is applied in two layers, the first has the function of filling the surface of the EPS until facing the mesh of the steel screens. The coating should always be done on both sides of the panel, so that it is not only one of the coated faces for healing, preventing the system from presenting differential retraction (MACHADO; PINTO, 2001) (figure 5).



Figure 05: Application of microcement with equipment

Source: Técnica, 2012

Only after application and curing the mortar, which the panel has resistance and becomes self-supporting, and can be used as a sealing element or also as a structural element of high load capacity. From the union of steel meshes and mortar micropillars are formed along the wall, which results in a monolithic building that resists earthquakes (seismic events) and vertical loadings.

In the application of the finishes there is nothing different from the others, it will be carried out in the same way as a conventional system, such as the application of tiles, plaster or mass running (SILVA, 2009) (figure 06).



Figure 06: Final Finish

Source: Técnica, 2012

Among the various advantages and benefits that the use of this construction system with monolithic panels in EPS can provide, we can mention the following:

- Low thermal conductivity: in which its organization is formed of numerous closed cells, with very small diameter, full of air, with the blocking of heat passage. A foundation that indicates the excellent thermal insulation capacity of the EPS is its constitution (98% air and 2% polystyrene), leaving, due to the amount of air, inside the cells without locomotion. Thermal insulation capacity is demonstrated by the Thermal Conductivity Coefficient (TCC), which, the lower the coefficient of thermal insulation capacity (REIS, 2015);
- Baixo peso: as execuções realizadas na obra são significativamente reduzidas, devido ao seu baixo peso, facilitando os serviços e podendo reduzir prazos (REIS, 2015);
- Low thermal conductivity: explained by closed cells and large amounts of air, which end up hindering the passage of heat. Thus, demonstrating itself as a good insulator (COSTA, 2007);
- Mechanical Resistance: even though it has a low weight, it has a high mechanical strength, which can be applied when this attribute is necessary (REIS, 2015);
- Construction up to 40% faster when compared to conventional masonry;
- The EPS used in the works does not generate combustion: characterizing safety for any work;

It is essential to have a high quality material, which is certified and produced by specialized companies. The EPS used in the walls is differentiated and come in panels ready to be fixed on the base, so one should always buy from a renowned manufacturer so as not to have problems in his work with some disadvantages, such as consumer ignorance; low adhesion to the chapisco; high initial cost.

#### 4. Final Considerations

Depending on market changes and current trends where the focus on sustainable construction swells is growing significantly, the use of methods that reduce waste creation and energy expenditures, becoming increasingly frequent in construction occupying more and more space, showing that the monolithic system of EPS is an advantageous option for those looking for innovative constructions.

It was observed that the method of monolithic polystyrene panels (EPS), is a new and innovative system in Brazil, replaces conventional walls, because it is a prefabricated, modular, lightweight system

composed of expanded polystyrene EPS, enabling a new and advanced construction system, by synthesizing the advantages of the traditional system and prefabricated, dispensing beams and pillars, and towed in structural mortar.

Light concrete is recognized for its reduced specific weight and high thermal and acoustic insulation capacity. As it is a product of fast production and application, high fluidity (molded without needing density), presents itself as an excellent option for execution of structural walls or sealing.

The use of EPS plates for the elevation of internal walls is an economically and technically accessible solution, given the speed and containment of expenses provided to the construction of the work under study. Thus, the greater the size of the work, the more advantageous the system becomes.

It is concluded, then, that this system is economically viable to build popular housing, because its thermal, acoustic and sustainable advantages characteristic of the method. EPS panels have become a sustainable solution reducing the use of renewable materials, this method does not generate leftovers, as all parts are designed and manufactured on measures, through architectural designs the panels are delivered to be delivered to be fixed in the work, thus minimizes the loss of materials at the time of execution.

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# **Preventive and Corrective Predial Inspection and Maintenance: A Case Study in a Residential Building in Amazonas**

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## **Abstract**

*This article aims to describe the main manifestations found in the external area of the residential building. The case study was performed through visual inspections of the structures, identifying the causes and proposing a correction method for these anomalies. Based on the literature review in books, articles, norms and laws, we sought to understand the definitions related to the inspection and preventive maintenance and corrective to the performance of the building, presenting the main points of interest using as reference the ABNT NBR 5674: 2012 - "Maintenance of buildings" and ABNT NBR 15575: 2013 "Performance of Housing Buildings". After all the on-site survey was carried out, the intervention strategies were presented, ensuring that the facilities receive the necessary maintenance according to the needs of each environment. Therefore, it is concluded that the lack of maintenance in the residential building has caused discomfort in the residents and the expected performance for the building. Therefore, it is very important to have proper planning and conducting the building inspection throughout the building's life, and should have specialized and qualified professionals to perform preventive and corrective maintenance, so it will be possible to rescue its performance, ensuring durability, comfort and real estate appreciation.*

**Keywords:** Building Inspection, Preventive and Corrective Maintenance;

## 1. Introduction

Due to several accidents caused by constructive failures, lack of inspections and maintenance, has been causing deaths and collapses due to carelessness of buildings. Taking as an example the seven-story building that collapsed in Fortaleza on October 15, 2019, leading to the death of some residents. If the building had the Owner's Manual with the necessary recommendations for preventive maintenance and a building inspection plan they could have a good performance in the development and the comfort of its users, which in contrast was maintained due to poor union management. The importance of hiring a responsible technician is of great importance to avoid inconvenience and poor execution of the services provided by the hired company. More liquidators seek less qualified companies and professionals to have lower cost to execute the contracted retirement plan. The building inspection should be understood as a study of the building, where it will present details of how the quality of the building is and if it presents nonconformities that impair its durability and devaluation of the building.

The case study was conducted in a residential building in Manaus-AM and, through visual inspections of the structures, it was possible to identify the causes of the manifestations found and propose an essential recovery method to rescue its performance, aiming to adapt the building to the quality. intended and to guarantee durability.

## 2. Theoretical Foundation

### 2.1 Building Inspection

According to IBAPE (2012) "Building Inspection is the tool that classifies nonconformities found in the building as to their origin, degree of risk and indicates technical guidelines necessary to improve maintenance".

According to GOMIDE (2009), it defines the Building Inspection as being a technical survey of the building to ascertain its technical conditions and to determine the preventive and corrective measures necessary for the good conservation and maintenance of the building.

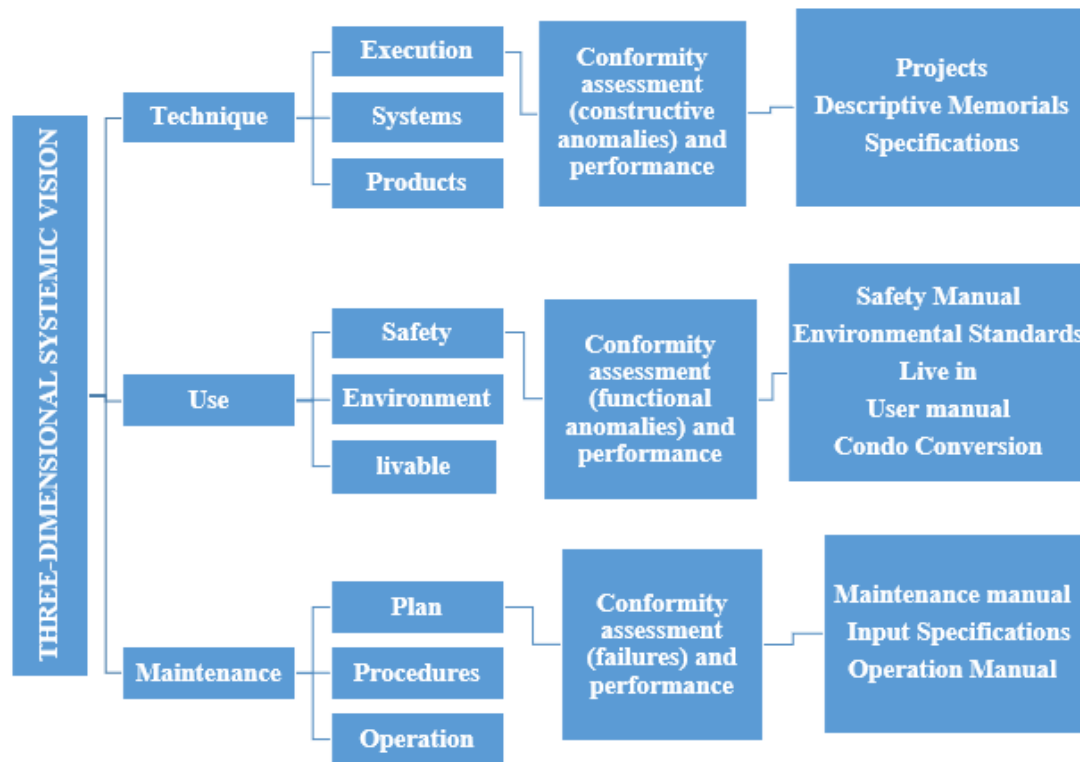
According to the Building Inspection Standard of IBAPE / SP (2015):

The objective of identifying the general state of the building and its building systems, observing the aspects of performance, functionality, useful life, safety, state of conservation, maintenance, use and operation, considering the expectations of users.

The concept of Building Inspection, "was defined as the evaluation of the technical conditions, use and maintenance of the building in order to guide the maintenance and achieve Total Building Quality" (GOMIDE; PUJADAS; FAGUNDES NETO, 2006).

The building evaluation can only be performed by professional engineers and architects, who are registered in the Regional Council of Engineering and Agronomy - CREA and the Council of Architecture and Urbanism - CAU. In the technical visit it will be possible to register the constructive problems and the pathological manifestations, in order to present the means of prevention and correction of the property providing comfort for users. Flowchart 1 shows the three-dimensional systemic view and

the conformities are indicated according to the severity, urgency and disposition of each one. Thus, a plan will be proposed for the maintenance of the building according to the need pointed out during the technical visit.



Source: (GOMIDE; PUJADAS; FAGUNDES NETO, 2006).

## 2.2 Building Inspection Rating

Item 6.1 of the IBAPE / SP Building Inspection Standard (2012 p. 6), conceptualizes the three levels of rigor as follows:

6.1.1 Level 1 - Building Inspection performed in buildings with low technical complexity, maintenance and operation of their elements and building systems. Usually used in buildings with very simple or nonexistent maintenance plans.

6.1.2 Level 2 - Building Inspection performed in buildings with medium technical complexity, maintenance and operation of their elements and building systems, of medium construction standards and with conventional systems. Usually used in buildings with several floors, with or without maintenance plan, but with outsourced companies hired to perform specific activities such as: maintenance of pumps, gates, water reservoirs, among others.

6.1.3 Level 3 - Building Inspection performed in buildings with high technical complexity, maintenance and operation of their elements and building systems, [...]. At this level of building inspection, a Maintenance based on ABNT NBR 5674 is performed in the building. The Building Inspection at this level is prepared by qualified professionals from more than one specialty.

According to IBAPE / SP (2015, p. 13), "building inspection work considers the building as the human body and, as in a medical checkup, evaluates each part or constructive element".

According to the Building Inspection Standard of IBAPE / SP (2012), “all the documentation required for the building inspection sequence, makes a division containing three types of documents: technical, administrative and maintenance and operation documentation”.

The main steps for conducting building inspection will be briefly presented in table 1.

Table 1 - Main steps for conducting a building inspection.

<b>MAIN STEPS FOR PERFORMING A BUILDING INSPECTION</b>	
STEP 1: Survey of data and documents of the building. Administrative, maintenance and operation technicians (plan, reports, history, etc.)	
STEP 2: Interview with the manager or union to find out information about the use of the building, history of renovation and maintenance, among other interventions.	
STEP 3: Conducting building surveys, carried out with a multidisciplinary team or not, depending on the type of building and the complexity of existing building systems.	
STEP 4: Classification of deficiencies found in surveys, by construction systems, according to their origin.	
STEP 5: Classification of problems (anomalies and failures), according to priority level, as established by standard	
6th STEP: Preparation of the list of technical priorities, according to the priority classification of each problem found. This list is ordered from most critical to least critical.	
STEP 7: Preparation of recommendations or technical guidelines for solutions to the problems found. These guidelines may relate to the adequacy of the maintenance plan or repairs and remediation for troubleshooting.	
STEP 8: Maintenance quality assessment, as established by standard	
STEP 9: Evaluation of the use of the building. It can be classified as regular or irregular. Observe the original conditions of the building and its building systems, beyond the limits of use or shape.	

Source: IBAPE / SP 2015.

For the validation of the building inspection must present all the necessary documents that is made by the responsible of the building selecting which are applicable for each inspection, according to:

- administrative documentation;
- Technical documentation;
- Maintenance and operation documentation;

The building inspection is performed by the responsible technician who will prepare the report and present the nonconformities of the characteristics observed during the technical visit, classifying the degree of risk and relating to the appropriate maintenance method.

### **2.3 Building Maintenance**

“The term maintenance had its historical origin with the military, with the meaning of keeping in combat units, the troops and the military equipment in combat conditions. (FERREIRA, 2010) ”.

Building maintenance contributes to the preservation of natural resources sources and interventions necessary for safety, functionality and comfort, aiming to guarantee the useful life of a building, avoiding the need for a new building.

According to NBR 5674 (2012), defines building maintenance, "in a set of activities to be performed to conserve or restore the functional capacity of the building and its constituent parts to meet the needs and safety of its users."

For GOMIDE, NETO AND PUJADAS (2006), defines:

Maintenance is a common activity in the industrial area, but the same is not true of buildings. Despite the recent evolution of studies of these activities in Brazil, the reality reveals improvisations and lack of professionalism in most Brazilian buildings.

Maintenance is prominent in the overall cost of buildings, presenting some variables during the process and cannot be done suddenly and without planning. It should be understood as a technical service, whose responsibility requires adequate training of all involved during the maintenance process.

#### **2.4 Classification of Building Maintenance**

There are, however, several types and levels of maintenance. Gomide et al. (2006) apud Castro (2007), basically identify the following modalities:

Predictive: is the inspection activity aimed at the study of systems and equipment, in order to predict possible anomalies or failures in them, based on their performance and behavior, and from this, implement and direct preventive maintenance procedures. ;

Preventive: This is the activity that kicks in before repair is needed. Requires a schedule, with pre-established dates, following technical criteria determined by the supplier or manufacturer of the product. It is essential to record all activities performed;

Corrective: is the activity aimed at repairing or restoring failures or anomalies, whether planned or not. It necessarily implies the total or partial shutdown of a system. It is the type of maintenance that presents the costs plus the activity that aims to identify the causes of failures and anomalies, helping high execution;

Detective: It is in maintenance plans, with the goal of attacking the source of the problem, not just the symptom of it.

The absence of maintenance increases the risk of accidents, both from total collapses that may affect its users, and from the detachment of parts, especially façade elements (OLIVEIRA 2013).

The authors Gomide, Neto and Pujadas (2006), describe that there are several forms of classification of Maintenance types, but, first, it is necessary an analysis linked to the classification with the feasibility of performing the services ”.

- Existing Failures and Anomalies - are linked to problems arising from maintenance service and operation of buildings;
- Maintenance Plan Activities - presents information and guides maintenance activities.
- Type of Intervention - will present the type of maintenance to be addressed.

This type of classification helps the professionals to identify the cause of the failure and the appearance of the anomalies, helping the proper maintenance for the building, increasing its useful life.

## 2.5 Building Performance

According to FRANGOPOL et al. (2012), “In order to maintain or improve the reliability and functionality of structures, integrated management planning should be adopted, appropriate to the entire building life cycle”.

According to GNIPPER and MIKALDO Jr (2007, p. 02), [...] “the performance requirements are related to the actual use of the building, the resistance it should offer to the wear it causes and the consequences it will produce. about the environment”.

The NBR 15575: 2013 is divided into six parts each behind the definitions and concepts for better understanding, establishing the performance requirements that must be met in buildings, checking if the building is meeting the minimum required by the standard.

- Part 1: General Requirements;
- Part 2: Requirements for structural systems;
- Part 3: Requirements for flooring systems;
- Part 4: Requirements for the internal and external vertical sealing system;
- Part 5: Requirements for the roofing system;
- Part 6: Requirements for the water health system.

The preventive building maintenance plan directly interferes with the estimation of the building's useful life and its correct design combined with a considerable increase in the final useful life value, as shown in Figure 1.

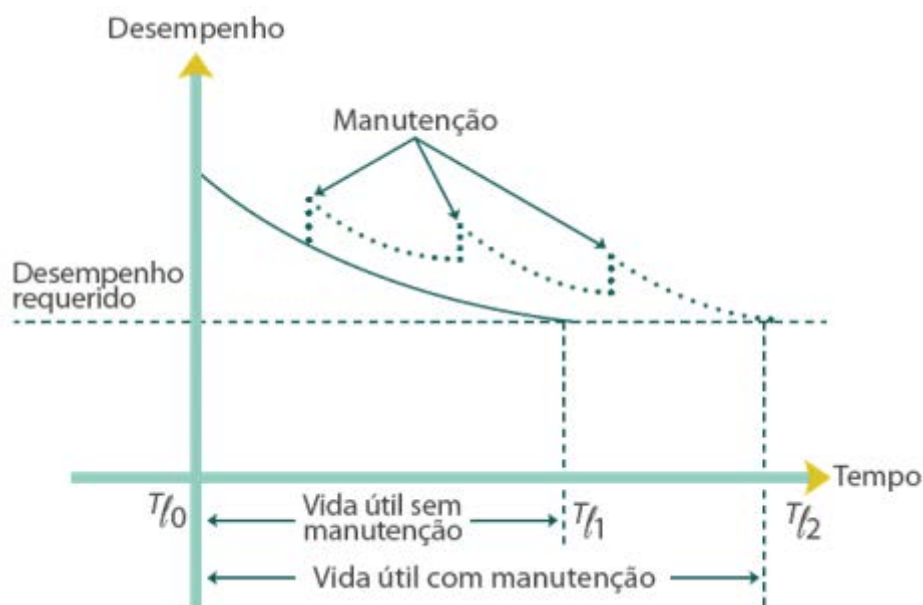


Figure 1 - Performance recovery by maintenance actions.

Source: NBR 15575-1, 2013.

The performance of constructions shall guarantee the builder to the owner a backing as to the proper functioning of the construction over a minimum service life. Once for the construction process, the current requirements and technical standards are met.

## **2.6 The Origin of Problems in Buildings**

As soon as the building is delivered to the residents they must have preventive maintenance and monitoring during its useful life. These pathological manifestations have several characteristics, and can be described as to nature, based on visual observations, and can be classified according to symptoms and likely consequence.

Degradation is due to lack of proper maintenance schedules, lack of periodic inspections, damage to structural elements by impact, erosion by abrasion, cement shrinkage, excess deformation of reinforcement (PINA, 2013).

Second CROITOR (2008):

Buildings undergo a natural degradation process due to the action of climate agents and the use of the building. The natural deterioration of improvements can be delayed through preventive maintenance actions, but cannot be stopped. Therefore, eventually any and all construction will need to undergo rehabilitation.

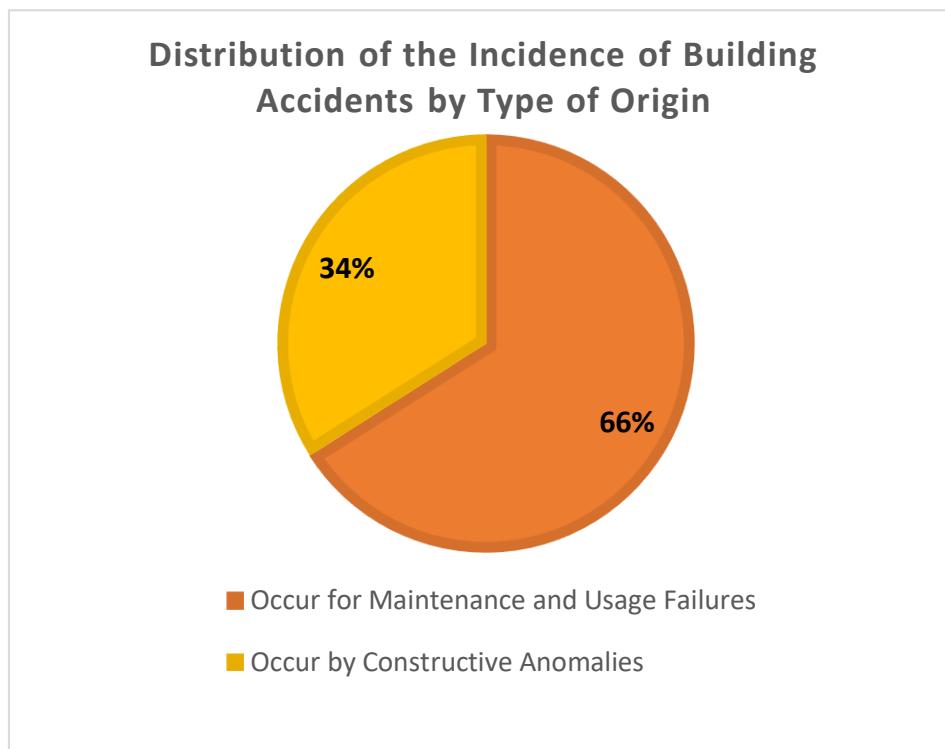
“The renovations in buildings aim to recover, improve or extend the conditions of habitability, performance. These changes made to the existing building can be with or without change of function”(CLEIDE, 2016).

According to NBR 15575 (2013), “buildings must have a life span of at least 50 years, and due to lack of maintenance and improper use, buildings are experiencing problems well before this deadline, and most are related the execution of the work ”.

The IBAPE 2015 presents in graph 1, the possible causes of the appearance of pathologies, and the early loss of performance and constructive addictions. About 66% of incidents of building accidents occur due to failures during maintenance and use and 34% occur due to constructive anomalies due to the material used or errors during the execution.

Graph 1 - Distribution of the incidence of building accidents by type of origin.





Source: IBAPE / SP, 2015.

The lack of maintenance of these buildings causes deterioration of the building, as the surrounding areas, and may be affected by the type and quality of materials used, poor proportion of the trace, lack of technique and care in execution. In these cases, the renovation can be done in order to upgrade the building systems and to meet the changing needs of the environment.

The main problems presented in the buildings are: cracks, dislocations, concreting failures, moisture stains, mold, infiltration, among others;

- Cracks are narrow cracks, shallow and without continuity. They may appear after years, or a few hours after execution.
- Cracks are caused by material stresses, which can occur on beams, pillars, slabs and others.
- Moisture does not occur on walls, floors and slabs and can occur at any stage during execution and degrade construction quickly.

## **2.6 Preparation of User Manuals**

Standard NBR 14037 (2014), establishes the minimum requirements for the preparation of the operation manual, use and maintenance of the buildings, the preparation of the manual, must be made by a company or technical responsible and the delivery of it must be made by the builder to the owner. informing the following observations:

- Inform the owners and the condominium of the technical characteristics of the built building;
- Describe recommended procedures for the conservation, use and maintenance of the building;
- In didactic language, inform and guide the owners and the condominium regarding their obligations and the maintenance and conservation activities;
- Prevent the occurrence of failures or accidents resulting from improper use;

- Contribute to the building achieving the project life. This manual should be written in a didactic form so that the owner understands his obligations regarding use and maintenance information.

If the union does not have the manual CREA of the city under study has the model to download, there is information on the need for regular and preventive maintenance by companies and qualified professionals, all information is to facilitate the management of the condominium.

### **3. Methodology**

The methodology used was the qualitative does not seek to enumerate and / or measure the events studied, is more a collection of descriptive data about people, places and seeks to understand the phenomena according to the perspective of participants of the situation under study (GODOY, 1995). For the development of the study was taken into account the visual aspects of the manifestations found in the external area of the condominium and used as bibliographical references books, articles, technical standards on the subject of poor conservation of buildings and the importance of maintenance in buildings. The case study was based on the problems encountered in the residential building, and through these surveys a form of maintenance for the building was proposed.

#### ***3.1 Preliminary Visit to Building***

The Residential Building under study is located at Avenida Buriti S / N - Industrial District - Manaus - AM, Internal Address Rua 3. Each block has 16 apartments with an area of 45m<sup>2</sup>, with the right to a parking space.

Block H was used as a basis for study, as shown in figure 2, the choice was due to the services provided to the liquidator for surveys and records of non-compliance found on site, this checklist will provide the responsible professional to prepare the inspection report of the necessary services, for possible preventive and corrective maintenance, which will be performed by specialized companies.

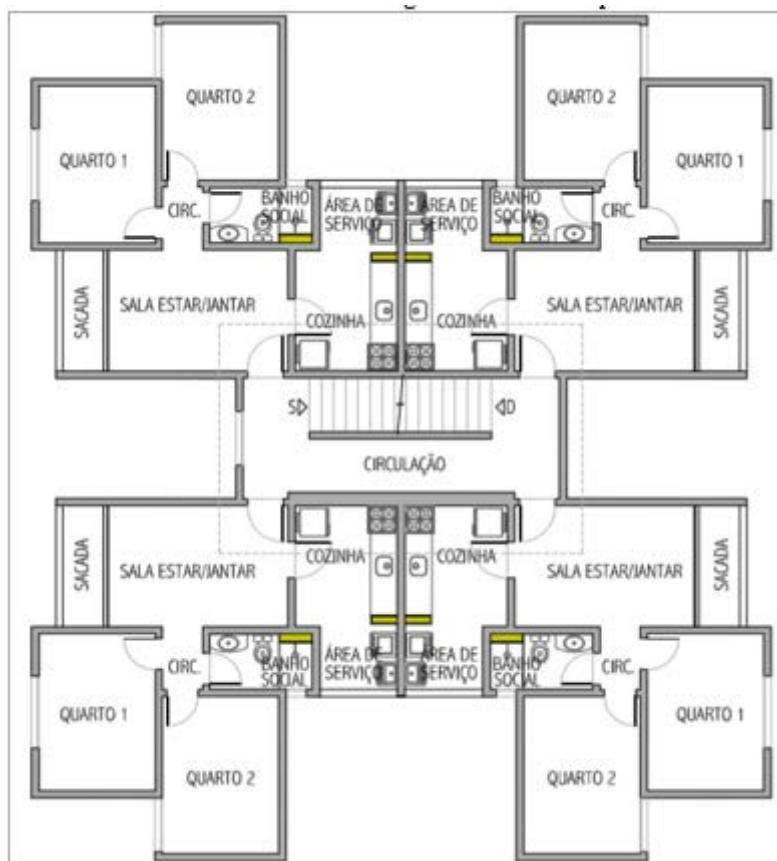


Figure 2 - Architectural plan of block H.

Source: Author's Collection, 2019.

### 3.2 Visual Aspects

During the on-site visits, it was possible to make a photographic survey of the current situation of the residential building, which served as a reference and proof of the pathological manifestations found. The data collected during the technical visit allowed the identification of some manifestations found and classified according to the studied references and the descriptions will be presented in the results.

### 3.3 Classification and Proposals for Corrective Measures

The step is to determine which executive method should be applied in solving the problems encountered, taking into account constructive, economic and time aspects, thus ensuring the effectiveness of the service performed. A misdiagnosis will imply interventions that will not be able to cure the disease, hindering the analysis and future problems to the structure table 2.

Table 2 - classification of anomalies and failures.

ANOMALIES	FAILURES
Endogenous	Planning
Exogenous	Execution
Natural	Management

Functional	Operational
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Source: IBAPE, 2012.

After listing the anomalies will be classified according to the severity being critical, medium and minimum, which consist in correcting the damage, recovering the original performance of the structures and increasing their reinforcement.

## 4. Results and Discussions

For the preparation of data collection during the technical visit the liquidator must make available to the supervisor all the necessary documentation, and with this the professional must plan the entire inspection taking into consideration the building's constructive characteristics.

From this building inspection, a checklist was prepared with the necessary annotations for the collection of photographic data covering all equipment of the building systems to be inspected, which show in more detail the anomalies found in the building. This step is based on the presentation of the necessary information to understand the problem occurred according to the results found in the building inspection survey.

### 4.1 Crack Appearance

Figures 3 and 4 show the facades with paint peeling, cracking, seepage, breakdown and mold. Paint aging is a functional anomaly that needs care every 3 years at a minimum.

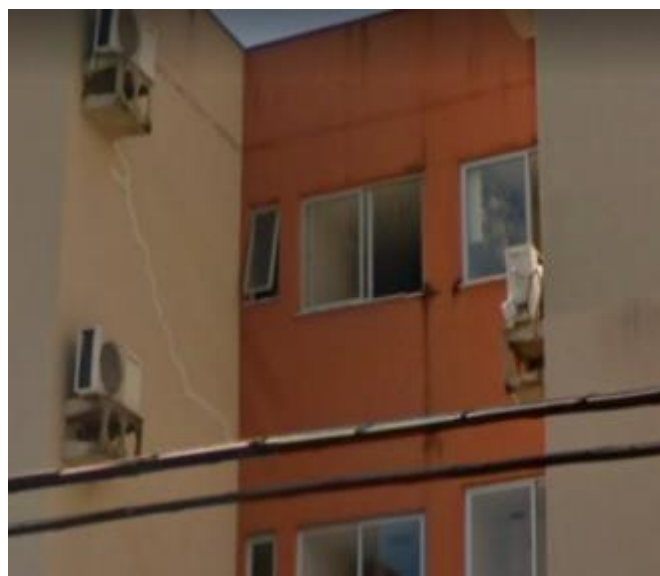


Figure 3 - Cracks in the facade of the residential building.

Source: Author's Collection, 2019.

The anomalies found in the façade were the diagonal cracks in the masonry caused by repression, due to improper use of materials and possible errors during execution, so it was classified as Endogenous.



Figure 4 - Cracks in the facade of the residential building.

Source: Author's Collection, 2019.

The recommended technical recommendations for the correction of cracks are:

Remove the affected coating, Clean all region and loose materials, Ap Cleave the area to be coated, Apply mortar for external plaster, And finally sanding and painting.

Figure 5 shows the walls with intense mildew stains, seepage and cracks. Most of the incidences are due to humidity caused by rain, lack of care. It is considered a natural anomaly, occurring by nature phenomena, the technical recommendations indicated for correction are:

To clean the mold is indicated the use of high pressure jet, Remove the affected coating, Clean all region and loose materials, Ap Cleave the area to be coated, Apply mortar to plaster, Apply waterproofing, Apply sealing cracks and then sand and paint.



Figure 5 - Infiltration and mold.

Source: Author's Collection, 2019.

Figure 6 presents cracks that are caused by infiltration, excessive sun, rain, poor execution of plaster, overloads or differential repressions. The recommended technical recommendations for the correction are:

Remover Remove the affected coating, Clean all region of dust and loose materials, Pass 2 coats of acrylic sealant, Iron acrylic paste, Paint with latex paint.



Figure 6 - Appearance of cracks.

Source: Author's Collection, 2019.

The porcelain tile showed detachment in the tip figure 7, the replacement will be performed. We request from the Union the Reform Plan and the Technical Responsibility Annotation - ART for the construction and execution of the floor settlement, where it informed us that it does not have the requested documents.



Figure 7 - Porcelain tile with a detached tip.

Source: Author's Collection, 2019.

The fire fighting equipment is in perfect working order and within the expiration date, there is a raised reservoir with the volume of 60 thousand liters of water which under no circumstances can be used or emptied (except for cleaning it). The water in this reservoir feeds all fire hydrant systems through a

unique pumping. Periodic maintenance of extinguishers should be in accordance with table 3.

Table 3 - Periodic maintenance of extinguishers.

EXTINGUISHER TYPE	MAINTENANCE		
	LEVEL 1	LEVEL 2	LEVEL 3
	INSPECTION	RECHARGE	SURVEY
Pressurized Water - AP	12 months	12 months	5 years
Carbon dioxide	6 months	12 months	5 years

Source: Author's Collection, 2019.

These were the anomalies found in the building under study, are described the manifestations and their diagnoses, very common and with direct consequences of the behavior of concrete substrate, either by natural movement through joints, or by the unexpected behavior of the base due to various deficiencies. After the surveys observed in the building was prepared a table highlighting the item inspected the classification according to severity, estimated value for correction and days required for repairs.

It can be noticed that there are variations in the days and values presented in table 4, this is due to the materials adopted for the repairs, because the choice of the appropriate treatment system greatly influences the cure time of each material, the estimated value for repair is R \$ 42,480.00 and will take 15 days to complete the reform in block H.

Table 4 - Order for Repairs.

ELEMENTOS VISTORIADO	CRITICO	MÉDIO	MÍNIMO	VALOR	DIAS
Fissuras, descascamento da pintura e bolor		X		12.250,00	6 dias
Limpeza da fachada		X		5.230,00	3 dias
Pintura		X		25.000,00	6 dias
Total =				42.480,00	15 dias

Source: Prepared by the author, 2019.

After all the building inspection processes, a technical report will be prepared exposing the general conditions of the building and the items that will be inspected according to the current Norms, presenting the following information: owner, location, description of the object of study, constructive standard, typology, date of the report and ART name and number of the technical responsible.

The corrective maintenance process was in accordance with the anomalies found and the diagnoses of the

causes, in order to intervene with appropriate measures to solve the problems. The importance of performing preventive maintenance avoids unnecessary expenses, when the construction company moves the incorporation of the property to the condominium, in this process is sent the owner's manual indicating the necessary care with the project, failure to comply will cause damage and excessive expenses for corrective maintenance. , becoming more expensive than preventive maintenance, because the building elements are already in an advanced state of deterioration.

## 5. Final Considerations

Every building must have a maintenance system, aiming to identify and correct the anomalies that occur, diagnosing their causes, presenting the necessary recovery techniques to restore the established performance, increasing the useful life. Given this study it is verified the importance of building inspection and preventive maintenance indicated in the owner's manual delivered before the incorporation of the construction company to the condominium. Maintenance is an obligation of the union and management, as it must comply with the periodicity periods of the maintenance program and have contracts with specialized companies for all equipment that is subject to wear and tear or that require specific maintenance.

During the technical visit to the residential building, it is clear that the major problems encountered are due to cracks, infiltrations, paint peeling and porcelain peeling. Problems detected were manifested by lack of condominium management, which could be prevented early on with proper treatment. Finally, it is concluded that due to failures in the administration of condominium fees there was a neglect on the part of the union, requiring a maintenance plan for recovery activities in accordance with the action strategy established by a specialized and qualified professional.

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# **Comparative Analysis of the Constructive Process with the Drain Manual in a Project in Manaus City**

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## **Abstract**

*This paper aims to make a comparison of the construction method of the drainage implanted in the Peace Alley, between Raimundo Saraiva Street and Santa Helena Street, in the Cidade de Deus neighborhood, Manaus-Am, with manuals and urban drainage rules in which their The objectives are to verify the constructive way of the device implanted there, to make comparisons with norms and manuals of urban drainage and to present the proper way to implant the urban drainage device in the place. To this end, searches were conducted based on bibliographic sources, with data collected through research in libraries and current legislation and searches in digital sources and consultations to academic articles, in order to describe the installation procedures and equipment involved in microdrainage, method used is associated with the development of these works, in order to define the correct form for proper installation of drainage devices according to the Urban Drainage standards and manuals.*

**Keywords:** Urban drainage; Micro drainage; Devices;

## **1. Introduction**

Currently, in Brazil, many cities suffer from flooding problems, due to some factors that contribute to this, in which we can mention the disordered growth of cities, the lack of urban planning and occupations. But the biggest problem is not this phenomenon, but the works executed to contain this problem, which does not follow established norms for this type of construction.

The problems generated by urban drainage can be solved through a feasible urban drainage policy, a policy that determines the occupation of floodplains, financial resources and technical solutions, that chooses a qualified and capable company to set up the work, that creates and meets criteria, laws and standards; Finally, a policy that encompasses entities capable of developing social communication activities and promoting collective participation. (CARDOSO NETO, 2014)

Urbanization is one of the anthropic actions that generate the greatest environmental impacts, especially from the consequences of changes in occupation and land use. Cities suffer from flooding, accumulating various economic and social losses: damage to infrastructure and housing, degradation of the natural environment and devaluation of buildings built, spread of water-borne diseases, impoverishment of the population with successive losses, among others, (MIGUEZ, VEROL AND PRAY, 2016).

In making a list of infrastructure projects and works, it can be seen that many are no longer being as efficient at solving the flow issue, due to the lack of study of the site, the collection of data and adequate materials for this type of work, even for the irresponsibility of not following the parameters established by law that aim to ensure the buildings and facilities, minimum conditions of safety, hygiene, harmony, aesthetics and accessibility.

According to Canholi (2014), most developing countries, including Brazil, have experienced in the last decades an urban expansion with poor drainage infrastructure, consequently bringing flood problems mainly due to the rapid expansion of the urban population, the low level of awareness. the problem, lack of long-term plans, poor use of non-structural measures and inadequate maintenance of flood control systems.

In the Cidade de Deus neighborhood in Manaus, specifically in the peace alley, located between Raimundo Saraiva Street and Santa Helena Street, this execution problem will be evaluated and some collections made to report errors during the placement of the devices. drains in the area for stormwater runoff.

## **2. Methodology**

To reach the proposed objective, a case study was performed. The case study is characterized by the thorough and exhaustive study of one or a few objects, in order to allow their broad and detailed knowledge, a task practically impossible through the other types of designs considered (GIL, 2007).

In the search for a brief analysis of the collected data, as previously mentioned, the information was collected through published printed works related to the subject and comparing the actions observed in the Peace Alley, in the stretch that corresponds between St. Raimundo Saraiva and Santa Helena Street, in the Cidade de Deus neighborhood, Manaus - Amazonas, where one of the authors performed his

internship period.

The following research is bibliographic in nature, with its objectives developed descriptively, involving bibliographic technical procedures, with a qualitative approach to the problem. The information was attributed to this work through internet searches, books, magazines, newspapers, articles, among other existing media and safe and reliable content.

During the research, about the data of the area needed for the elaboration of a project of micro drainage network, that the responsible for the work did not have the necessary information to know about flows that flow the network, dimensioning of the duct network and no measures. of control. May waste materials and major problems with housing, such as: repression of soil causing collapse of nearby structures and also causing greater flooding.

This lack of data was stated during the site visit, with the person in charge of the work, who asked that most of the time the works happen without projects and even without a concrete study of the area, as he says that he has many years of experience. experience with this type of loose work, ensuring to do the work only empirical.

Table 1 - Steps chart.

<b>DATA FOR THE PREPARATION OF A PLUVIAL NETWORK PROJECT</b>
<b>SITUATION MAPS; CONTRIBUTING BASIN PLANT; PLANIALTIMETRIC PLANT.</b>
<b>TOPOGRAPHIC SURVEY.</b>
<b>REGISTRATION OF EXISTING WASTE NETWORKS.</b>
<b>SELECTION OF THE FOLLOWING ELEMENTS CONCERNING THE URBANIZATION OF THE CONTRIBUTING BASIN.</b>
<b>RECEIVING WATER COURSE DATA.</b>

Source: Elaborated author.

According to the drainage manual (TOLEDO, 2017), the main data necessary for the elaboration of a micro drainage rainwater project are those listed in the table above, which provides the basic details for an efficient micro drainage system for the population.

Jabor (2012) says that drainage has the function of promoting the adequate flow of volumes from the precipitations that fall in urban areas, ensuring public transit and the protection of buildings, as well as avoiding the harmful effects of flooding and flooding.

For this comparative micro drainage study, the peace alley, located between St. Raimundo Saraiva and Santa Helena street, in the Cidade de Deus neighborhood located in the new city, Manaus - Amazonas, will be studied, according to Figure 1.

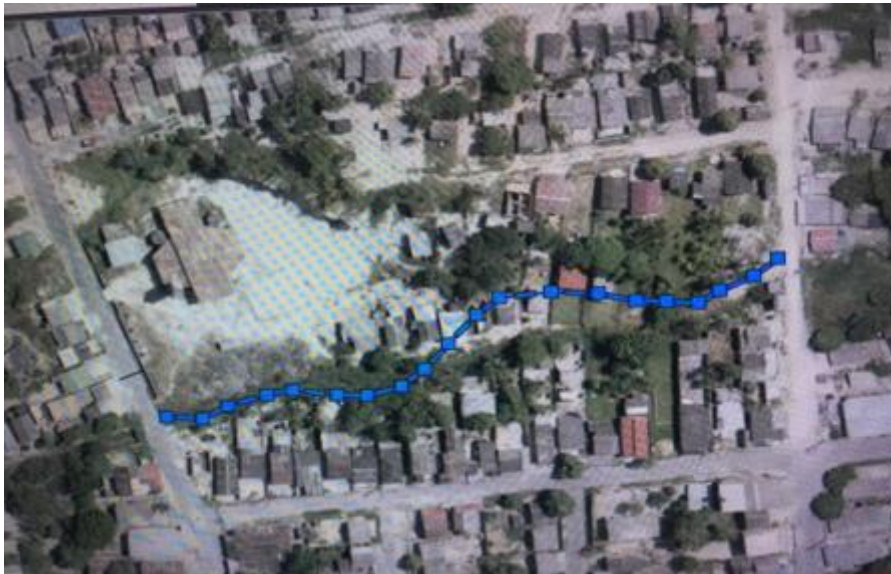


Figure 01: Alley of peace highlighted.

Source: Google maps, 2019

Although already established as a neighborhood, Cidade de Deus still suffers from the precariousness of effective infrastructure in many of its streets.

The site under analysis has an area of 1489, 79 m<sup>2</sup>. For channeling the extension area is 180 m, located in the peace alley, between Raimundo Saraiva and Santa Rosa streets, in the Cidade de Deus neighborhood, Manaus-Am. The neighborhood is cut by the Tarumã-Açu basin, which has its springs coming from the Ducke Reserve, which also cuts other neighborhoods in the city of Manaus-Am. During surveys to improve analysis, the lack of topographic surveys of the area was found, with insufficient basin and spring information for a flow study that is essential for the proper and satisfactory implementation of an urban drainage network. pipes that do not meet the demand for rainwater in the area.

It was verified that those responsible are excavating the site and placing the shackles directly in a humid place, without any base for the pipes, which may cause the misalignment of the shackles, compromising the piping annealing, in addition to the excavation without lateral spacing of 60cm. established by the norm, which may damage the nearby structures, with sliding of the slopes and consequently collapse of structures in the place, as can be observed in figure 2.



Figure 2: Laying of drainage pipes.

Source: Elaborated author

It was found installation errors that do not follow urban drainage norms and manuals, which can cause a result of precariousness in the place. As for example, we can mention the flooding of the area due to clogged shackles, because the pipes are being grounded with inadequate soil, composed of many types of waste and utensils that take time to degrade. In addition, it is ascertained on site that the landfill layers do not comply with the specifications provided by the standard.

### 3. Results and Discussions

The main focus of this work is to show the step by step and the correct way to build the microdrainage system, specifically the pipes, so that it will not cause damage and will not have the possibility of larger losses by the inhabitants of the area that is located. getting the solution.

It was found that for the beginning of a constructive process there must always be a preliminary study to survey some information, in which we can mention that there is a need for a topographic survey of the area, information of the basin that cuts the site and also have a site visit to survey the contribution area, where it is this contribution area that will determine the amount of water that the pipeline will drain to an appropriate location.

When excavating, it is necessary to calculate the exact amount to be excavated as it must take into account the thickness of the pipeline laying cradle, the diameter of the pipes and the thickness of the landfill so that the amount excavated will not cause problems in the excavation. plumbing. A very common example that happens is that workers have little digging so that they have to have little landfill on top of the pipes, which can cause ruin and lead to pipe clogging, which will require rework to correct these problems, that could be avoided.

A not less important stage, but that has been ignored by the drainage managers, is the settlement cradle, because it will be the one who will support so that the piping does not come to ruin, it is necessary that the bottom of the excavation be mechanically compacted and then the laying cradle can be placed, in which the DNIT 030/2004 standard states that the laying of the pipes will be done on the concrete cradle with mortar base with 30% of hand stones thrown over the natural terrain when it presents adequate

characteristic resistance conditions, adopting the (minimum  $f_{ck}$ ) at 28 days of 15 mpa, which can be seen in figure 6 below. An important observation to be made in which would explain, but not justify, the lack of this base layer is the number of days to be expected to fully cure this layer, in addition to the increased cost of the work.

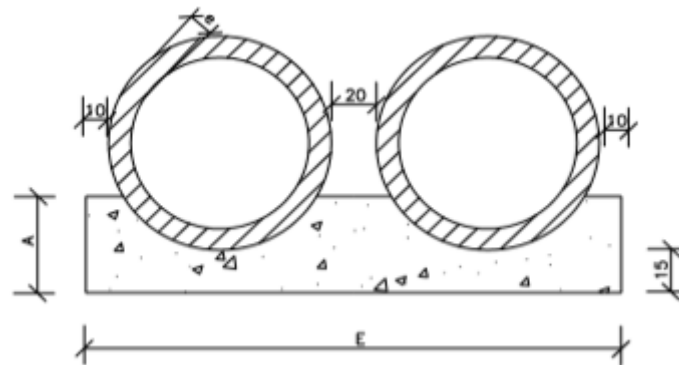


Figure 3: Pipe Laying Model

Source: DNIT, 2006.

To make grouting is necessary that the pipe is completely free of water, so that the mortar will have its full cure and that there are no leaks, the standard says that this mortar must be in the 1: 4, and For pipes larger than 900 mm in diameter, this grout must be made inside and outside the pipes for a better connection between the pipe.

The last step of this process is the landfill, in which the DNIT 030/2004 standard has been clarifying everything that should be done in this pipeline grounding and the first step it says is that a manual compaction of 15cm by 15cm should be done. reach the height of 60cm high, so that only thereafter there can be a mechanical compaction, in which this mechanical compaction must be done carefully so that it will not damage the pipe. This problem was soon observed at the beginning of this landfill as the material was not of good quality and was not sufficiently grounded as described in the standard.

#### 4. Conclusion

To finish the study, it was verified that the execution of the drainage stages in Brazil still has much to evolve regarding the subject addressed in this work, especially when it is a service that is primordial for the population, an area was defined. to do this study, in which the Peace Alley was chosen, in the stretch between Santa Helena Street and Raimundo Saraiva Street, which is an area that was being piped, and so a case study was made of the construction process that was being implemented there.

It was necessary to consult the DNIT (National Department of Transportation Infrastructure) standard to make a comparison and to conclude if the way drainage was being performed was in accordance with the specifications stipulated by the standard. It was found that many things did not agree, practically all steps were being performed incorrectly.

Therefore, it is suggested that the public authorities continue to do this kind of work, but it should be done correctly, so that people in the area involved will not have this type of problem with rainwater runoff in the future. cannot suffer the loss of material goods, etc.

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## **Management in Production of Fish Farming Using Arduino**

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### **Abstract**

*Monitoring of indicators in fish farming is an essential factor for profitable production, the more intense the production system is, the more important monitoring becomes. In the methodology, a bibliographic research was performed and an exploratory research was used to implement a prototype using arduino and monitoring sensors. The goal was to develop a system that assists the management of fish farms, ensuring the accuracy of monitored data, the quality of production and cost savings for the fish farmer. The project has a low implementation cost, provides more convenience in the management of fish ponds and contributes to the reduction of inputs during production, generating a greater profit for the fish farmer.*

**Keywords:** Monitoring; Real time; Arduino; Sensors.

## 1. Introduction

In 2018, according to the Brazilian fish farming association [1], 722,560 tons were reached, with revenues of around 5.6 billion. Brazil is the fourth largest world producer of tilapia, a species that represents 55.4% of the country's production. Native fish led by Tambaqui, participate with 39.8% and other species with 4.6%.

In fish farming there are four types of farming systems: extensive, semi intensive, intensive and super intensive. The extensive is the system used by small producers, in most cases it is intended for family food or for recreational purposes. In the semi-intensive nurseries and bushes are used, but there is a supply of food for the fish, which consists of balanced feed and live food. The intensive feature is the use of small tanks with high stocking density and high water renewal, is used in high productivity, and aerators are used to keep oxygen levels stable at night due to lack of photosynthesis generated by algae. Already in the super intensive concrete tanks are used, concrete tanks with greenhouse, among others and has the highest productivity of the four systems. Fish are fed balanced diets and aerators are turned on 24 hours a day to maintain water oxygenation. In northern Brazil, the most used system is the intensive one. Operating cost includes travel to nurseries to periodically measure all biological, physical and chemical indicators. There are also time outlays due to the need to measure the levels of all nurseries. Inaccurate parameter measurements or periodic measurement failures that lead to loss of production, excessive or insufficient use of resources such as food, energy used by aerators, substances to control chemical indicators.

With scenario exposure is ideal to develop metrics as an alternative to control the process of fish breeding and monitoring, and can apply automation for handling reduction and application for monitoring and prevention of ponds assisting in cost management, as the result of monitoring would help in taking decision

## 2. Materials and methods

In the first phase, a market price and quality study was done to find out which components would best fit the project. Are they:

The Arduino pH Sensor (Figure 1), model PH-4502C, is a practical sensor specially designed to work in conjunction with microcontrollers.



Figure 1: PH-4502C Arduino pH Sensor

Source: Authors (2019).

The DS18B20 temperature sensor (Figure 2) with 9 to 12 bit programmable digital output.



Figure 2: DS18B20 Temperature Sensor.

Source: Authors (2019).

The turbidity sensor (Figure 3), model LGZD Sensor V1.1, is an electronic monitoring module specially developed to work with Arduino microcontroller platforms.

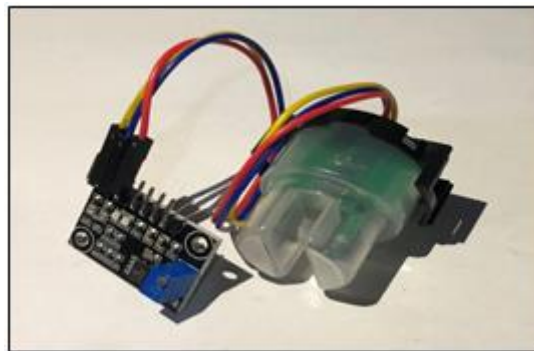


Figure 3: Arduino Turbidity Sensor LGZD Sensor V1.1

Source: Authors (2019).



Figure 4: Arduino UNO board.

Source: Authors (2019).

The UNO arduino board (Figure 4) uses a 5 volt power supply, but is acceptable in the range of 7 volts to 12 volts, the power connector will correct to 5 volts when connected to the board. It has six-pin analog inputs from A0 to A5 that can be used to control the voltage being applied to the sensor pin. There are

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also 0 to 13 pin digital connections with inputs and outputs, these connections can provide 40 mA with 5 volts. all of this being controlled by a microcontroller, the ATmega 328, which will be the brain of arduino. For storage of embedded codes EEPROM flash memory is used and non-volatile [10].

Shield W5100 Ethernet Card (Figure 5) allows the arduino to communicate to a local network or internet using the RJ45 network cable [10].

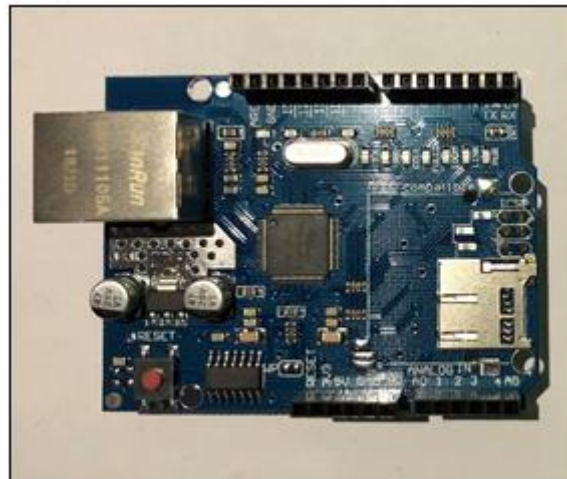


Figure 5: Shield W5100 Ethernet card.

Source: Authors (2019).

Through a bibliographic search, all the information referring to the production and monitoring systems used and the problems that are inserted in them were gathered. The research used is classified as exploratory, researched references in articles and websites such as the Brazilian Fish Association [1] and was also made a visit to the INPA Aquaculture Center, where several production scenarios were exposed and through them it was possible to collect information on types of production systems and the most farmed fish species in the region, the market, advantages and disadvantages of these systems, and the difficulty of obtaining real-time information on monitored parameters.

### 3. Development

#### 3.1. Theoretical Referential

##### 3.1.1. Aquaculture Production

In the production processes in psychology, constant monitoring of the environment is necessary, so that there is no damage to production due to significant changes in water quality parameters. Should any variation in water quality occur, rapid action must be taken to restore the environment to a prosperous condition for production. Currently, the measurements of the psychoanalysis sites are made only where they are located, the person in charge needs to regularly measure the main water quality parameters using chemical analysis sensors.

By developing in the aquatic environment, aquaculture can be considered one of the most complex productive activities in interactions between the physical, chemical, biological and climate [2].

Water quality is of utmost importance and it should be considered that temperature, turbidity and pH

level, among other factors, are very important for rich production.

Temperature is one of the most important features of the aquatic environment. It characterizes much of the other physical parameters of water such as density, viscosity, vapor pressure and solubility of dissolved gases. In addition to influencing factors such as decreased oxygen solubility. Temperature is one of the factors that directly influence the existence of aquatic organisms and species such as bacteria, fish, algae and aquatic plants [5].

PH is the negative logarithm of hydrogen ion concentration expressed in moles per liter, pH equation:

$$pH = \frac{\log 1}{[H]} \quad (\text{eq 1})$$

Its value varies between 0 and 14. Being pH less than 7 called acid, above 7 alkaline and when it is 7 is called neutral. This parameter is vital because the pH level indicates whether water has a toxic effect on fish being farmed [5].

Determining water turbidity is important because turbid waters are not considered good for fish farming as it prevents sunlight penetration, hindering phytoplankton development and photosynthesis that generates the main source of oxygen in the aquatic environment.

### 3.1.2 Technologies

The use of technologies in fish farming helps to reduce costs as they provide a better use of the chemical conditions of the environment, prevent loss of production due to human failures such as not measuring the indicators for any reasons, erroneous measurements, omission of problems in the owner's environment.

The evolution of technology has made it very easy to access the internet, there are many ways to access it from smartphones, tablets, notebooks, desktops and other devices that can connect to the network. This flexibility has shown how powerful web development has become. today [6].

In view of this thinking, the following technologies were used in the project in order to create software to increase the practicality of fish management.

HTML (Hypertext Markup Language), in Portuguese, markup language, is translated by browsers for website creation for the purpose of visual or behavioral characteristics [8].

Sascading Style Sheets (CSS) works in conjunction with the browser to enhance html by improving its appearance. With changes in titles, definition of images, creation of tables, borders among others [7].

To be able to access HTML pages it is necessary to use Transmission Control Protocol (TCP) and Internet Protocol (IP) in order for computers to communicate from the host that is located on the web page to the requestor. [9]

The arduino is a computer that can hold programming codes for processing inputs and outputs between it, and can have external components attached to the arduino, such as temperature sensors, LEDs or any other controllable component, and there is possibility of communication to a computer or network to exchange data collected by sensors on the web page [10].

For the creation of the codes we used the Integrated Development Environment (IDE), Arduino Software, based on the C ++ programming language [10].

The system, in short, uses sensors to monitor the indicators and sends the data to the arduino board which is responsible for sending the data to web application where the owner and owner can have access to all information in real time.

### 3.2. Results

Development has been divided into three phases.

The first phase comprised the choice of items needed for the project. In the bibliographic study, the types of production systems, the indicators monitored during each production and the Arduino platform for electronic hardware prototyping were studied. It was also defined which sensors would be used in the project, considering the accuracy of the measurements and costs.

#### 3.2.1 Software Development

The second phase was the application of the Arduino platform with the Uno board with pH, temperature and turbidity sensors that will measure water quality, coupled with the SHIELD board that communicates via the network using the TCP / IP protocol for access to information. collected by the sensors installed on the arduino. It will be controlled through the Arduino-hosted C ++ programming language. For monitoring we used web pages containing the markup language HTML and CSS (Figure 5).

```
client.println("<title>Dash</title>");
client.println("</head>");
client.println("<body bgcolor='#000000'>");
client.println("<div class='linha'><div class='titulo'>Piscina 1</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>Temperatura</div>");
temperature(client);
client.println("</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>Turbidez</div>");
turbidez(client);
client.println("</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>pH</div>");
ph(client);
client.println("</div>");
client.println("</body>");
client.println("</html>");
```

Figure 5 - Software Development

Source: Authors (2019).



Figure 6 - Web Application

Source: Authors (2019).

#### 3.2.2 Structure Development

The third phase consisted of incorporating the sensors and the arduino board, where the sensors will be



responsible for capturing the input data (pH level that will indicate if the water is acidic, neutral or alkaline, temperature level in degrees celsius and quality). the arduino board will be responsible for managing the collected data and hosting the HTML page where the parameter information will be made available. During this phase, prototype tests were performed

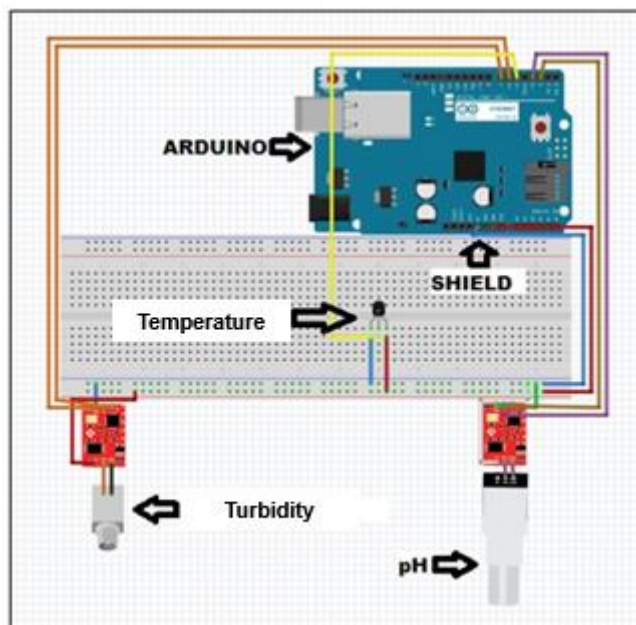


Figure 7 - Interconnected Components

Source: Authors (2019).

Each species has a temperature at which it best adapts and develops, this temperature being called the optimal temperature. Fish metabolism is increased as temperature increases. Tropical fish generally live well at temperatures between 20 ° C and 28 ° C and their maximum appetite is between 24 ° C and 28 ° C [2] [4].

The temperature sensor works through a one-wire bus that communicates between the microcontroller and the sensor, from which its power can be derived. It can operate from -55 ° C to 125 ° C.

The pH indices, in turn, are influenced by respiration, photosynthesis, fertilization, liming and pollution, making the water alkaline, neutral or acidic. The desired concentration range is between 6 and 9. The arduino PH sensor is made up of a PH electrode and an electronic module that mediates the arduino, so that the electrode can be submerged in water with only the exposed external cable.

Table 1: Description of stress and mortality rates of P.H

PH LEVEL				
Lethal	Increased Stress	Desirable Range	Increased Stress	Lethal
0 to 3,9	4 to 5,9	6 to 9	9,1 to 10,9	11 to 14

Source: Authors (2019)

Regarding turbidity, the use of turbid waters in fish farming is contraindicated, as it prevents the

penetration of sunlight and consequently impairs the development of phytoplankton.

The green color of the water is the most suitable for fish breeding, as it demonstrates maintenance of aquatic life. Bluish or greenish blue also indicates good productivity.

The Arduino turbidity sensor emits infrared light at its end and is capable of detecting particles that are suspended in water.

The testing phase was carried out using a fish tank provided by the National Institute of Amazonian Research (INPA) and proceeded as follows.

Data readings are taken in real time by the sensors and sent to the web application for authentication of the information on the screen of the device used. Hot and cold water was then used to assess the temperature change. At pH, hydrochloric acid and soda ash (sodium carbonate) were used to decrease and increase the pH level, respectively. The turbidity sensor was tested using a turbid water tank and a water tank under ideal production conditions and comparing the information shown on the screen.

The sensors noticed the parameter changes and showed the information correctly in the web application.

### **3.2.3 Discussion**

The project is feasible to use in fish ponds due to safety, practicality in management and low cost of components.

Through the use of sensors, the prototype becomes a very important application as it contributes by increasing the production level and decreasing the fish mortality rate. From an administrative point of view, it contributes to reducing the waste of inputs, generating a higher profit. In addition to facilitating management, as the farmer will have all the necessary information of the parameters through monitoring generated by the prototype on the screen of your mobile or computer

## **4. Conclusion**

In the research we concluded that the types of production systems used in fish farming use techniques that require the maximum dedication of the fish farmer to avoid irreparable losses in production and development, they require constant monitoring of water quality, today requiring displacement to the fish. collection of monitored data mainly in nurseries and captivity, where sudden changes in water temperature occur.

The development proved the relevance of this tool in the daily production, because it directly assists the fish farmer in the management of the nurseries, continuously controlling the pH, temperature and turbidity level thus providing greater practicality in the management of fish ponds, higher quality of the fish. water and more quality in production.

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# **Health, Behavioral and Social Characteristics of Nonagenary And Centenary Elderly People**

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## **Abstract**

*The aim of the study was to describe the health, behavioral and social characteristics of nonagenarian and centenary elderly. This was a quantitative, descriptive and cross-sectional study with the participation of 41 nonagenarian and centenary elderly, of both sexes, enrolled in the Family Health Strategies. It was used a questionnaire of sociodemographic characteristics of health and falls, the Mini Mental State Examination (MMSE), International Physical Activity Questionnaire (IPAQ) and the Daily Living Activity Index developed by Katz. Data were analyzed by descriptive statistics. The results show a predominance of females (65.9%), elderly people living with relatives (48.8%), no pathologies (56.1%), and falls in the last year (53.7%). , have a good perception of their health (70.7%), have low functional*

capacity (66.0%), cognitive impairment (75.6%), do not use tobacco (75.7%) and are physically inactive (83.0%). The relevance of this theme requires further studies and the development of strategies in order to provide quality of life and health to the long-lived population.

**Keywords:** Aged 80 years or older; Health conditions; Lifestyle; Quality of life;

## 1. Introduction

The worldwide demographic transition shows that in most countries the proportion of elderly people aged 80 and over is unquestionably increasing (PEREIRA *et al.*, 2015) due to reduced mortality and birth rates, leading to significant changes in the age structure of the population (MIRANDA; MENDES; DA SILVA, 2016) and important implications, especially in health (PEREIRA *et al.*, 2015).

Data from the Brazilian Institute of Geography and Statistics (IBGE, 2017) show that Brazil, in 2016, had 1,81% of its octogenarian, nonagenarian and centenarian population. The projection for 2030 is that this percentage will rise to 2,93% (IBGE, 2017). In this way, centenarians represent the maximum expression of human longevity, as a result of improved health, sanitation and income (NETTO; KIRADAI, 2015).

Along with the demographic transition, there is the epidemiological transition characterized by the reduction of morbidity and mortality due to parasitic infectious diseases and the predominance of morbidity and mortality due to noncommunicable chronic diseases (NCDs) (MARINS; SLOB, 2018). These changes in age profile have a qualitatively important impact on the morbidity and mortality landscape. Thus, care management, interdisciplinary care focused on prevention, promotion and health protection is extremely important, developed and applied by the Family Health Strategies (FHS) (XAVIER; NASCIMENTO; JUNIOR, 2019).

Studying on the theme of aging has become a challenge in order to understand the increase in life expectancy and how to approach the elderly with chronological age above 80, 90 and 100 years, which are termed as very old, older elderly, elderly, older and long-lived elderly, in addition to octogenarians, nonagenarians and centenarians, referring to the decade of life in which the elderly are (NAMAN *et al.*, 2016).

Understanding aging as a complex phenomenon, one realizes the need to reflect on the importance of sociocultural, health and life trajectory issues of the elderly, in order to promote healthy aging. This condition depends as much on the circumstances of life as on the role of the State and civil society in defining appropriate policies and assisting the elderly in order to favor the (re) significance of their longevity (DEBIA; SILVEIRA, 2019).

Therefore, care for the very elderly is extremely important, so that they have conditions to live well, with health, autonomy and quality of life, which favors the decision-making of the health team in primary care, where FHS are places aimed at preventing diseases and promoting health care actions in this population (SOUSA *et al.*, 2018).

Thus, the aim of the present study was to describe the health, behavioral and social characteristics of nonagenarian and centenary elderly registered in four FHS in Santa Rosa / RS.

## 2. Method

This is a quantitative, descriptive and cross-sectional study. Forty-one non-aged and centenary elderly men and women participated in this study. Were selected to participate in this study elderly people aged 90 years or older, registered in four FHS in the municipality of Santa Rosa / RS. The municipality currently has 17 FHS, but the four that had different socioeconomic contexts were chosen. All elderly patients enrolled in these selected FHS were included in the study.

The identification and location of the addresses of the elderly included in the study was performed by searching the IPM® electronic medical record. Data collection was performed in August 2018. With the report generated by the system, home visits were made according to the registered address. The elderly who were at home, were invited to participate in the study, signed the Informed Consent Form and were followed the ethical aspects for research with human beings. For the elderly who were not at home, a second attempt was made. Thus, 112 elderly were identified, in which 35 elderly were not found at the address provided and 36 elderly had died, totaling 71 losses.

The instruments used for data collection consisted of:

- Questionnaire of sociodemographic characteristics (gender - male and female, age - 90 to 99 years and 100 years and over, marital status - married, widowed, single, education - illiterate, incomplete elementary school and complete elementary school) health and downfalls of users.
- The Mental State Mini-Exam (MMSE), prepared by Folstein *et al.* (1975), validated for the Brazilian population by Bertolucci *et al.* (2014) was used to assess cognitive functioning. It is one of the most widely used tests for assessing cognitive functioning worldwide. It examines temporal and spatial orientation, short-term memory (immediate or attention) and evocation, calculation, movement coordination, language and visospatial skills. The cut-off point for cognitive decline is less than or equal to 15 for illiterate, less than or equal to 22 if the subject has between one and eleven years of schooling, and less than or equal to 27 if more than twelve years of schooling (BERTOLUCCI *et al.*, 2014).
- The International Physical Activity Questionnaire - IPAQ in short form tested and validated by Matsudo *et al.* (2001) which allows estimating the weekly time spent on physical activity and physical inactivity. It is composed of four open questions and its information allows to estimate the time spent per week in different dimensions of physical activity (walking and physical exertion of moderate and vigorous intensity) and physical inactivity (sitting position). Physically active ( $\geq 150$  minutes) and physically inactive ( $< 150$  minutes) were considered cutoff points suggested by the authors of the instrument used (MATSUDO *et al.*, 2001).
- Daily Life Activities Index developed by Katz *et al.* (1963) to assess the functional capacity and autonomy of the elderly was used. Scale that allows to assess the autonomy of the elderly to perform the basic activities and essential to daily life, called Basic Activities of Daily Living (BADV). Functional assessment is performed from the sum of the points, totaling a score, using the cutoff point suggested by the Hartford Institute for Geriatric Nursing (1998), which is considered independent (6 points), moderate dependence (4 points) and dependent (2 points or less points).

After conducting the pilot study, which took place in the months prior to data collection and was conducted with elderly people who did not belong to the FHS that were included in the study, the

assessment of vision perception and structural adequacy of the questionnaire was included. The identification and location of these elderly people was performed by electronic medical records and the interview was conducted at home.

Data were tabulated and further analyzed by relative and absolute frequency. This study was approved by the Research Ethics Committee under Consubstantiated Opinion number 2,758,805. The recommendations of Resolution 466/2012 of the National Health Council were followed.

### 3. Results and Discussion

Forty-one nonagenarian and centenary elderly participated in the study, most of them female (65.9%), with incomplete elementary school (65.9%), widowed (73.2%), receiving a minimum monthly salary (53, 7%) and was between 90 and 99 years old (92.6%). Still, 48.8% of participants reported living with relatives (Table 1).

Table 01. Social characteristics of nonagenarian and centenary elderly registered in four FHS in the municipality of Santa Rosa / RS. 2018. (n=41).

<b>VARIABLE</b>	<b>n</b>	<b>%</b>
<b>SEX</b>		
Male	14	34,1
Female	27	65,9
<b>AGE RANGE</b>		
90 a 99 years	38	92,6
+ de 100 years	3	7,3
<b>SCHOLARITY</b>		
Illiterate	13	31,7
Incomplete Elementary School	27	65,9
Complete primary education	1	2,4
<b>CIVIL STATUS</b>		
Married	4	9,8
Widowed	30	73,2
Single	7	17,1
<b>INCOME</b>		
1 minimum wage	22	53,7
2 minimum wages	16	39,0
3 or more minimum wages	3	7,3
<b>WHO LIVES WITH</b>		
Alone	10	24,4
Relatives	20	48,8
Caregivers	2	4,9
LSIE	9	22,9

LSIE – Long Stay Institution for the Elderly.

Source: Authors (2019).

In this study, a higher prevalence of women was observed, which reflects the higher female

longevity, a phenomenon known as feminization of old age. This is due to lower exposure to certain occupational risk factors, greater female concern for their own health and self-care, and frequent use of health services in search of care (JÚNIOR *et al.*, 2019). Naman *et al.* (2017), reinforce that this phenomenon has been following the population aging in the world, being more evident in the older age groups. When reporting this phenomenon, the authors state that older women are more likely to be widowed, which can be observed in the data of this study where they reported by 73.2% the widowed marital status.

There was a preponderance of low education among the participants in this study Júnior *et al.* (2019) points out that in the mid-twentieth century there was no appreciation of formal education and socioeconomic conditions were precarious, reflecting the difficulty of access to schools. Furthermore, the authors show that low education may influence cognitive impairment, ie, elderly with low education may have a higher cognitive deficit compared to elderly with more years of schooling, in addition to being associated with negative outcomes, such as, mental health problems, chronic conditions and frailty.

Also, regarding the participants' income, most of the elderly reported receiving only a minimum monthly salary. The low income of the elderly, in a way, may be related to low education, as it hinders the insertion and access to the labor market, a job that would guarantee higher income and, consequently, a better retirement (ALMEIDA *et al.*, 2015). This finding corroborates the results of the research by Pimenta *et al.* (2015), where the sample consisted of elderly people with low socioeconomic status. The research showed that low-income elderly have worse health conditions compared to individuals with higher incomes. Thus, the study showed that in Brazil the disparities between health conditions and socioeconomic status of the elderly still prevail.

Most of the elderly interviewed live with family members. According to Pimenta *et al.* (2017) this reflects the reality of many developing countries, where the percentage of older people living with their children remains high, even with increasing longevity. Widows in need of physical and cognitive assistance and with insufficient income are the largest contingent among the elderly living with the family of a son or daughter, who are responsible for the care of the elderly (PEDRAZI *et al.*, 2010).

Observing the data in table 2, it is noted that 53.1% of the elderly participants claimed to have no pathology diagnosed by the doctor, however, the majority (78.0%) used medication regularly. This fact can be explained in this study because the sample is made up of very elderly elderly attending FHS, considering that Forsetlund, Eike and Gjerberg (2011) explain that the increased demand for health services due to the aging process consequently causes the greater use of medications as a health site action.

Table 02. Health characteristics of nonagenarian and centenarian elderly registered in four FHS in the municipality of Santa Rosa / RS. 2018. (n=41).

VARIABLE	N	%
<b>PRESENCE OF DISEASES</b>		
Yes	18	43,9
No	23	56,1
<b>USE OF MEDICINAL PRODUCTS</b>		

Yes	32	78,0
No	9	22,0
<b>USE DEAMBULAR AID</b>		
Yes	14	34,1
No	27	65,8
<b>FALLS IN THE LAST YEAR</b>		
Yes	22	53,7
No	19	46,3
<b>FUNCTIONAL CAPACITY</b>		
Very dependent	27	66,0
Moderate dependence	12	29,4
Independent	1	2,5
<b>COGNITIVE DEFICIT</b>		
Likely cognitive impairment	31	75,6
No cognitive impairment	4	9,7
Did not answer	6	14,6
<b>HEALTH PERCEPTION</b>		
Good	29	70,7
Regular	10	24,3
Bad	2	4,9

Source: Authors (2019).

Regarding the need for walking aid, 65.8% of the elderly reported not needing assistance for such activities. These results are similar to those found in the study by Bortoluzzi *et al.* (2017) aimed to assess the prevalence and factors associated with functional dependence of long-lived elderly living in small municipalities. The survey showed that 74% of the oldest old were independent for basic activities, which included the ability to walk, as well as the 94.2% cited by Pinto-Júnior *et al.* (2016). The authors show that independence in these basic activities is associated with the absence of chronic pain and multimorbidities, a case that also occurs in the present study, considering that most of the elderly people surveyed had no diagnosis of disease.

The New England Centenarian Study (NECS) demonstrated that most centenarians markedly delay the presence of life-threatening illnesses until the end of their lives, and better support the onset of chronic disease. The hypothesis suggested by the authors is that with increasing age, there is not so much decline in the prevalence of disease-associated genetic variants, but there is a selection of variants associated with longevity, which can not only counteract the deleterious effects of genetic and environmental factors. but also provide protection against basic aging mechanisms, slow the rate of aging and delay the onset of age-related diseases and syndromes (SEBASTIANI; PERLS, 2012).

Regarding variable and declines in the last year, 53.7% of the oldest old reported having suffered at least one fall in the last 12 months. According to the World Health Organization (WHO,2010) global report, falls are defined as an “inadvertent displacement of the body to the ground or other lower level caused by multiple factors”. A study conducted by Smith *et al.* (2017) where 240 elderly residents of the

urban area of João Pessoa were interviewed, Paraíba (Brazil) showed that individuals aged 80 years or older suffer more falls compared to other age groups. The authors associate these results with alterations in cognitive status (or that do not correspond to the present study), reducing the willingness to perform tasks and causing muscle weakness, resulting in difficulty in gait execution. Exposing or exposing cannot cause seriousness in view of the possibility of health damage such as abrasions, bruising, dislocations, fractures, and the fear of a new fall. All of these factors can trigger a difficulty in performing basic and instrumental activities of daily living. (LENARDT *et al.*, 2019).

The basic and instrumental activities of daily living are linked to the functional capacity of the elderly (FREITAS; SOARES, 2019), given that only 2.5% of participants consider themselves functionally independent, it is noteworthy that this functional decline present in the process aging should not be understood as a synonym of dependence or disability, but rather associated with clinical-functional vulnerability, ie, greater susceptibility to functional decline in life. These organic alterations comprise the main dimensions of functionality, resulting, consequently, in locomotor deficit, dysfunctions in mood, cognition and communication, directly affecting the autonomy and independence of the elderly to perform basic daily tasks. (FREITAS; SOARES, 2019).

Most of the nonagenarian and centenary elderly studied (75.6%) were classified as having a probable cognitive deficit. According to Esteves *et al.* (2018), the decline in cognitive skills is influenced by age, genetic, sociodemographic and lifestyle aspects. Still, the mentioned authors show that one of the causes of decreased cognitive skills is the decline of executive functions. According to Lopes, Bastos and Argimon (2017) executive functions are responsible for managing behavior such as decision making, mental monitoring, planning, initiative, inhibition and organization, being highly sensitive to the effects of human aging. Thus, executive functions are related to a series of mechanisms of cognitive process optimization to solve complex problems.

Regarding the participants' health perception, it was observed that the majority (70.7%) reported good health. Health perception is a multidimensional indicator that aggregates sociodemographic, environmental, social, cultural and clinical factors and is therefore considered an effective and reliable method to measure health aspects of the population. In this sense, negative self-perception of health was associated with dependence on functional capacity, which reinforces its validity as an indicator that demonstrates the real health conditions of the elderly.

According to Garcia *et al.* (2018), the elderly may associate self-rated health with autonomy and the presence of family and social relationships, considering the ability to act on these environments. The study by the above-mentioned authors, whose objective was to evaluate the relationship between self-perception of health, sociodemographic data, nutritional status and perception of quality of life of 110 elderly people under follow-up in two Basic Health Units of Vinhedo / SP showed that 55.5% of the elderly perceived their health as good. Still, the authors point out that self-rated health is associated with the social and psychological aspects of the elderly.

Table 3 shows the variables related to the behavioral characteristics of the very elderly in the study. The results showed that most of them do not use tobacco (75.7%), are physically inactive (83.0%) and spend four hours or more sitting during a normal week (65.9%).

Table 03. Behavioral characteristics of nonagenarian and centenary elderly registered in four FHS of



Santa Rosa / RS. 2018. (n=41).

VARIABLE	N	%
<b>TOBACCO USE</b>		
Yes	10	24,3
No	31	75,7
<b>PHYSICAL ACTIVITY LEVEL</b>		
Physically active ( $\geq 150$ minutes)	7	17,0
Physically inactive ( $< 150$ minutes)	34	83,0
<b>SITTING DURING THE WEEK</b>		
$\geq 4$ hours	27	65,9
$< 4$ hours	14	34,1

Source: Authors (2019).

Regarding tobacco use, similar studies have shown that with advancing age the percentage of smokers tends to decrease (BARBOSA, *et al.*, 2018). According to data from Vigitel (2016), in 2016, smoking had a prevalence of 13.5% in individuals aged 55 to 64 years, however, when analyzing people aged 65 and over, the percentage of smokers was of 7.7%. In this sense, older people who are still smokers, who have survived the excessive rates of premature tobacco deaths, tend to be poorly motivated to quit smoking, underestimating their own risks and considering themselves relatively immune to the harm caused by tobacco (BARBOSA *et al.*, 2018).

Regarding the level of physical activity, the majority, 83.0% of the participants were physically inactive, performing less than 150 minutes of physical activity per week. Similar results were found in a study conducted by Streit *et al.* (2015) whose objective was to verify the association between the level of physical activity with the health conditions of centenary elderly. Thus, it was observed that the centenarians are poorly physically active, since their daily activities are of light intensity, without regularity and orientation and are usually performed within the home environment.

According to Vigitel (2018), physical inactivity is considered one of the main risk factors for noncommunicable chronic diseases, being considered the fourth main risk factor for global mortality, causing 6% of all deaths (WHO, 2018). Thus, it is estimated that 3.2 million people die each year as a result of physical inactivity (WHO, 2018). Against this background, WHO recommends its Member States to develop, implement, update, evaluate and monitor policies and programs to promote health through the optimization of nutrition and physical activity (REZENDE *et al.*, 2015).

From this perspective, the association of sedentary habits, such as spending more than four hours sitting during the day, corroborates physical inactivity (MAZO *et al.*, 2018). In a study by Mazo *et al.* (2018), whose objective was to associate sitting time with the main diseases affecting the elderly over 64 years, it was found that sitting time is a risk factor for the occurrence of diabetes and dyslipidemia. In addition, chronic diseases were associated with this sedentary behavior. Furthermore, the results showed that 1710 minutes per week in the sitting position can predict the occurrence of diabetes and sitting for more than 1380 minutes per week can predict the occurrence of dyslipidemia.

#### 4. Final Considerations

The results of this study indicate that although the elderly have achieved longevity, they have poor quality of life due to functional disability, cognitive impairment and number of falls. However, they have a good perception of health, a positive fact given the situation identified.

Given this, the evaluation and characterization of this long-lived population becomes relevant, as the identification of this information can contribute to the planning of interventions and care actions in order to ensure a successful aging. The importance of this theme is reinforced, and further studies are needed, especially of a longitudinal nature.

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# Intelligent Systems as Tools for Measuring Residential Energy Consumption

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## Abstract

*The implementation of intelligent systems in homes for measuring energy consumption are possibilities that owe their viability to the IoT (Internet of Things and investments in R&D). Becoming fundamental for this change in the way of thinking and using electric power in households, buildings and especially in industry 4.0. The present work demonstrates an experiment focused on a residence for the analysis of energy consumption measurement, with the use of a nano arduino plate, current and voltage sensors, internet connection and use of the MQTT protocol making the integration in the Blynk platform. Obtaining as results voltage approximately 224V, electric current close to 3.89A, 356 points of samples for measurement of consumption and 255 points for preparation of graphs. Minimums for voltage and current 207.75V and 0.62A respectively and maximums 233.22V and 25.31A. A standard deviation of 5.54 for voltage and 3.33 for current. Analyses performed by Blynk, from estimates by mathematical modeling, considered by means of tests and it was observed that the behavior of current and voltage signals are close to the realities of energy distributors.*

**Keywords:** Energy Efficiency; IoT; Arduino; MQTT Protocol; Blynk Platform;

## 1. Introduction

The potential of renewable energies in Brazil is indisputable, in addition to providing a global financial

return in the sector, public incentive from research and discovery of new sources of energy generation fundamental to the continuous development of the sector. A consequence of this incentive are embedded systems that enable the consumer to improve the energy consumption of the home, avoiding waste and serving as an instrument in reducing the electricity bill.

Camimoto et al (2016) measured and analyzed the total energy efficiency of factors in the BRICS countries (Brazil, Russia, India, China and South Africa), providing information on benchmark countries, a market reference for investors to monitor the performance of their investment. Within this group, Brazil stood out as the country with the highest GDP growth and reduction in the emission of pollutants to the environment, characterizing the advance of energy models through new technologies.

With the technological advance and improvement in the connection of mobile networks, a new concept has been diffused to about projects in homes, buildings and intelligent industries the IoT (Internet of Things).

Jara et al (2014) defines the IoT as a technology composed of the so-called intelligent objects, i.e., small physical devices and highly restricted in terms of memory capacity, computing capacity, energy autonomy and communication capacity. In addition to reiterating the objective of the IoT, the integration and unification of the systems that form the communication that surround us. Therefore, the systems will be able to obtain total control and access to other systems, providing communication and ubiquitous computing.

For Palatella et al (2013) the IoT requires software architectures that are able to handle large amounts of information, queries and computing, making use of new paradigms of analysis of collected information, flow, filtering, aggregation and data mining, supported by communication standards. Because existing Internet protocols such as HTTP (Hyper Text Transfer Protocol), TCP (Transport Control Protocol), and IP (Internet Protocol) are not optimized for communication on devices that require low power consumption, this has led to the standardization of instprotocols for the IoT.

Guimarães (2017) portrays the attractive aspects about the IoT that occurs through the monitoring of processes instantly, in addition to access to information across multiple platforms, regardless of location, requiring at least network communication. In the sphere of energy consumption in households, such characteristics can help users to identify the profile of their consumption and do it more effectively.

For the modernization of the electrical system, a new system was developed, the Smarts Grigds (SG), which for Yan et al (2013) are sets of devices, applications and communications, enabling the creation of a widely distributed and automated electrical power supply.

For Brito (2016) GS are intelligent electricity grids that allow the improvement of electric power management working as an integrated network, providing real-time and two-way consumption information between the consumer and the generating units and allowing the readings of electric power consumption to be made remotely.

Given the need for protocols for communication of embedded systems with low energy consumption, the Message Queue Telemetry Transport (MQTT) was developed, where Barros (2015) defines in a protocol for message exchange for IoT. Working on a standard for message exchange publisher/subscriber (Figure 1).

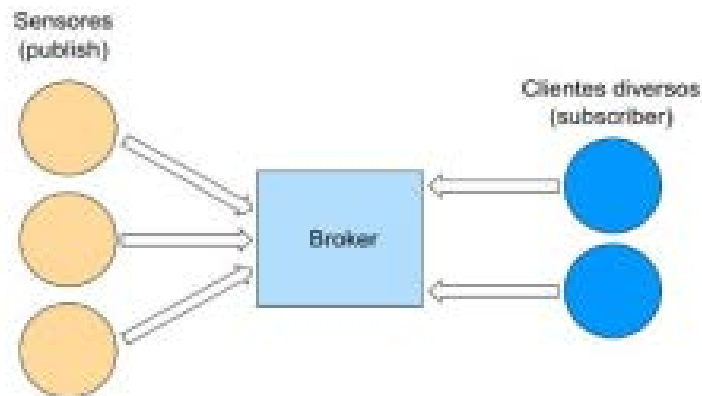


Figure 1. Message exchange manager (broker) of the MQTT protocol.

SOURCE: BARROS, 2015

In this way, when a network device needs information, it subscribes to it, generating a request for another element of the network responsible for managing publications and subscriptions. Within a MQTT network, being this managing element is known as a broker. The publication of information is also done through the broker. Developed by International Business Machines (IBM) in the late 1990s. Originally created to supervise and collect Supervisory Control and Data Acquisition (SCADA) systems, MQTT found its place in the extensive IoT market.

In line with the advance of circuits in real time, which provide information to the consumer in divergent cases, from what occurred to certain electronic generators of energy expenditure, Massimo Banzì, in collaboration with students from the areas of engineering and design developed the arduous embedded system in 2005 (SOUZA, 2013).

The arduino is composed of an Atmel microcontroller, input/output circuits and has the ease of connection to a computer and programmed via IDE (Integrated Development Environment) using a language based on C/C++, without the need for extra equipment besides a USB cable (THOMSEN, 2014).

The Arduino platform (2019) conceptualizes its product as open electronic development and has didactic hardware and software, which facilitate the learning process. Soon the arduous is interested to all who aim at the development of projects for interactive communication with the environment, besides being compatible with IoT technology (Figure 2).





Figure 2. Uno arduino plate.  
SOURCE: ARDUINO cc, 2019

Brito (2016) explains that for the development of the arduino IDE, will need a computer, where the necessary programming will be performed for the operation of the project, the sketch is responsible for uploading the information to the Arduino board, either via USB, Bluetooth or Wi-Fi. With this information the developer will perform the interaction of the board with the medium, following the principles of IoT.

The following study aims to investigate an intelligent system in arduous connected to the home network showing the user its consumption of electrical energy enabling the same together with this technology use energy in a more rational and sustainable way.

## 2. Methodology

The prototype for monitoring energy consumption in a household is a system that can be inserted into its energy table, in a non-invasive way and that will collect the necessary information for the analysis through tests of consumption behavior in this house (Figure 3).



Figure 3. Integration of current sensors to the residential distribution board.

SOURCE: Own author, 2019

This device was implemented in a two-phase input. But for testing purposes only. The prototype does the analysis instantly and sends the information through Ethernet Shield, the Blynk platform for analysis through mathematical modeling of the information collected by the current and voltage sensors.

The manufacturing of the device is divided into stages: implementation of the system to the power board, data capture through current and voltage sensors, allocating and enabling the analysis through the arduous. After the reading and execution of this information, the integration between Arduino UNO and Ethernet Shield is done through the internet connection, which enables the sending of these data to the Blynk platform to estimate the consumption in this residence (Figure 4).

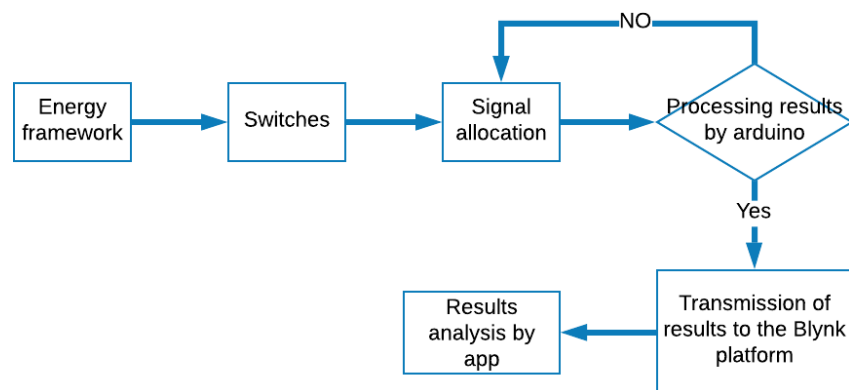


Figure 4. Application flowchart.

SOURCE: Own author, 2019

The prototype will be non-invasive, due to the sensors used and its embedded modules, The system will be integrated to a residence, by means of current and voltage sensors integrated to the energy frame, internet connection (either by wi-fi or internet cable), the Ethernet Shield module, the Blynk platform to estimate the energy consumption of the residence by means of mathematical modeling (Figure 5).

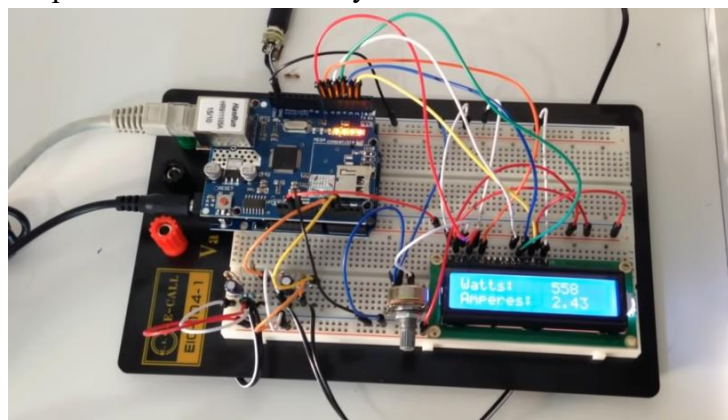


Figure 5. Current meter module in operation.

SOURCE: Own author, 2019

Blink. In this platform, all analysis of the sine wave behavior of current and voltage is performed. To determine if its performance is acceptable, such analyses can prove the efficiency of the results to the consumer to improve the use of their energy.

Before the implementation at the residence, analyses and tests were performed in the laboratory to measure possible mishaps in the actual application, taking into consideration a simplified version of the AC energy meter (Figure 6).

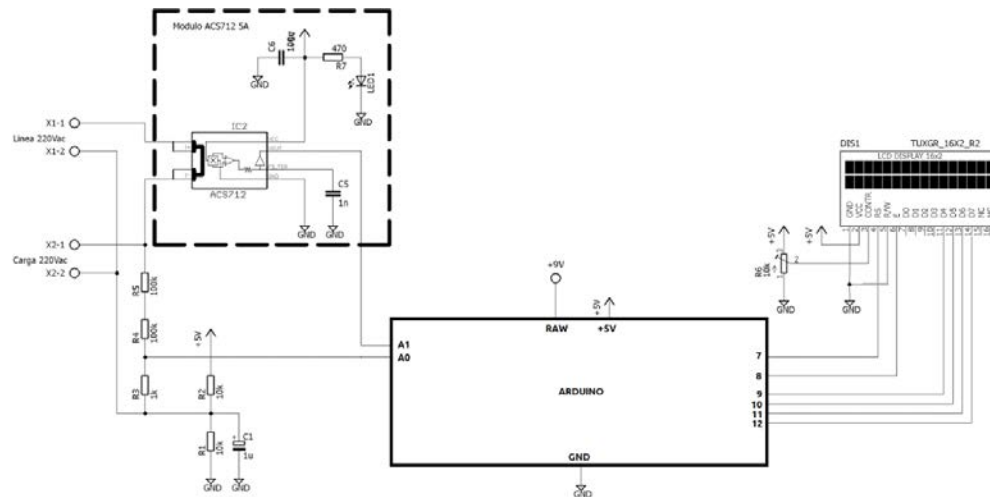


Figure 6. Simplified version of the AC energy meter.

SOURCE: Own author, 2019

It has no operational amplifier stage to perform full wave precision grinding. The method used was based on the assembly of an alternating signal to be measured at 2.5 V continuous (Figure 7).



Figure 7. Experiment without RC filter.

SOURCE: Own author, 2019

A MDS 160 LCD display was connected to the circuit, with a possible visualization of the consumption of an LED lamp. The measurement signal was analyzed without the use of an RC filter and connected to the circuit-breaker and an ASC712 voltage module, with noises that interfere with the measurement analysis.

A RC filter was integrated into the circuit and it was found in a new analysis a more proper signal for abstraction of results, proving that the electrical scheme for the proposed energy meter is close to the



measurement of the energy suppliers (Figure 8).

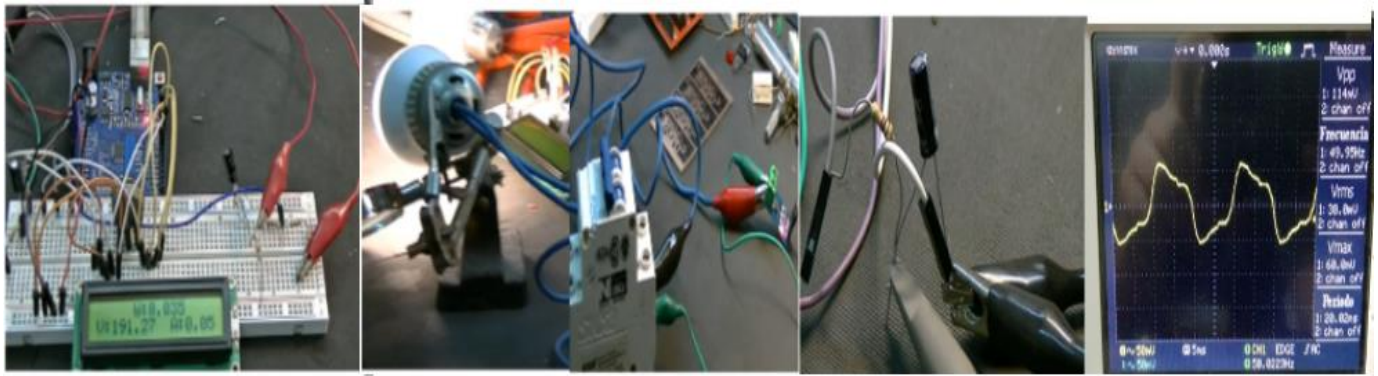


Figure 8. Experiment with RC filter.

SOURCE: Own author, 2019

### 3. Results and discussion

After validation of the effectiveness of the proposed energy meter. There was the implementation of this system based on the electrical circuit schemes, technical specifications and codes for programming in the IDE platform of the arduino according to the Open Energy Monitor (Figure 9).

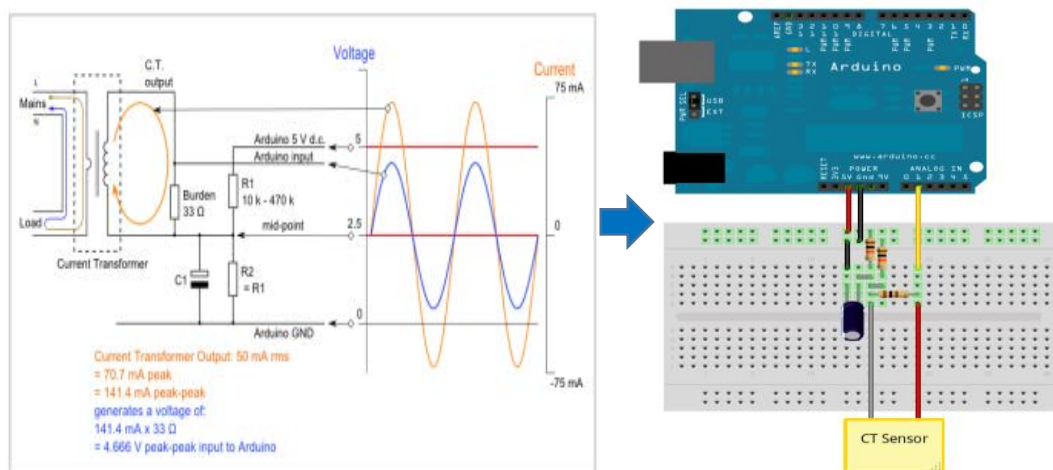


Figure 9. Open Energy Monitor.

SOURCE: openenergymonitor.org, 2019

It was made an analysis for a period of 4 hours of the variation of electric current consumption in the residence to verify the effectiveness of the operation of the project, where from estimates made by Blynk, by means of mathematical modeling considering the tests, it was possible to obtain an estimate of the energy consumption of the residence (Figure 10).

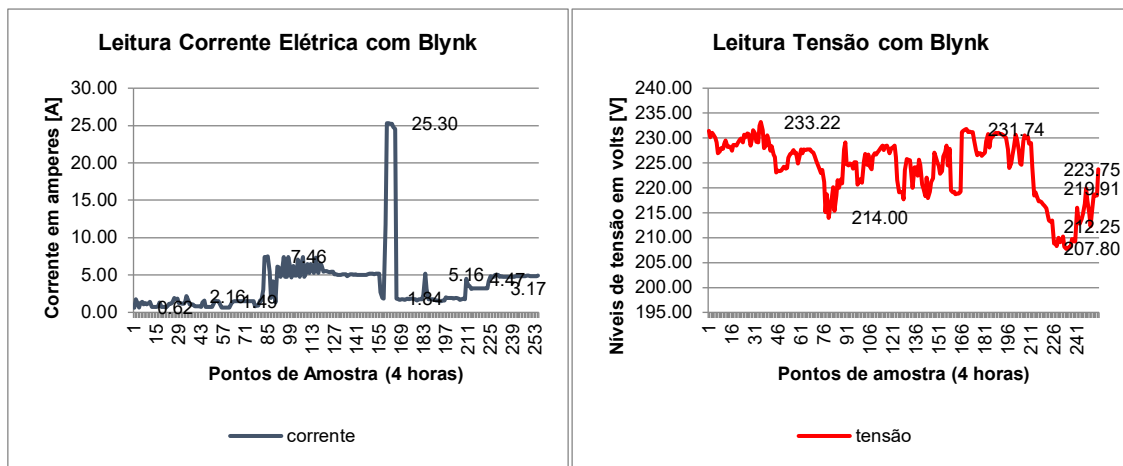


Figure 10. Measurement of residential energy consumption.

SOURCE: Own author, 2019

The voltage considered was approximately 224V, electric current close to 3.89A, 356 points of samples for measuring consumption and 255 points to prepare the graphs. Minimums for voltage and current 207.75V and 0.62A respectively, and maximums 233.22V and 25.31A. A standard deviation of 5.54 for voltage and 3.33 for current.

The Blynk platform provides a simulation of power consumption in real time thanks to the internet connection and the MQTT protocol, not having the same level of accuracy as the utility because they use highly complex software to analyse the consumption of the UC they monitor. But for the purposes of experiments, the platform proved to be useful for presenting data close to reality.

According to Piovesan (2017) circuit simulation has been increasingly accepted as a normal tool in electronics equipment projects. For this reason, simulation is recognized as a practical necessity, becoming an indispensable tool in the training of technicians and engineers, especially in the part related to projects and interpretation of electro-electronic equipment.

The current sensor used in the project can measure the current that is going through a certain phase, through the effect of the magnetic field that goes through its coils and the relationship of these coils already presented as a K factor, collect a sample proportional load in their terminals.

Guimarães (2017) clarifies that the sensors are devices that change their behavior under the action of a physical magnitude, thus, can directly or indirectly provide a signal that indicates this magnitude. In turn, when they operate directly, it converts the energy and another, whose are called transducers.

For Piovesan (2017) the non-invasive current sensor is a circuit for voltage acquisition, collect the energy consumption data in the experiment, these collected data are treated by the microcontroller, thereby obtaining the total consumption of the residence for the invoice comparison with the analysis of the device developed in the project.

The voltage sensor conditions the AC signal obtained in the experiment in analog signals due to the arduino input. Thus, due to the arduino having an operating range of 5 V that cannot be exceeded, there will be damage to the microcontroller. The conditioning is done so that the working range respects the limit of the microcontroller.

The voltage divider serves to raise the reference signal by approximately 2.5 V, eliminating the negative voltage of the sinusoid, just as the electrolytic capacitor is responsible for filtering the signal that will be sent to the AD (Analog / Digital) of the arduino.

Therefore, the experiment demonstrates a real behavior, expected by the literature, relating them to the current and voltage analysis in the residential energy consumption. If implemented to measure the consumption of specific equipment in this residence will become a new technology for the user to estimate with approximation its energy consumption.

#### 4. Conclusions

The conscious use of electric energy avoids its waste, taking into account the exponential growth of consumers of the electric grid. So this work will contribute not only as a scientific study for new developments, but awareness of consumers about their energy consumption and that, from this, can be taken some actions so that besides the reduction of energy consumption, contribute to the environment.

In the tests performed, it was noted the reading of energy consumption in a real way, provides greater knowledge to the customer of their profile of electricity consumption, also disseminating the importance of awareness in energy consumption.

It is worth mentioning that the application of the modules that make up this work is not limited to a single application. The platform with cloud connection is ready to ship several other functionalities and monitor other quantities. It can also be applied for the purpose of power quality sampling or consumption patterns composing a geographically installed data network.

At the end of the development of the work and based on the results obtained, it can be concluded that the installation of the system is a tool that assists the user in the management of electricity consumption. It can be of great value in reducing energy waste. Even if the prototype was developed to measure energy consumption, it can be used in buildings to control various luminaires creating an automatic lighting system.

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# **A Proposal to Implement a Business Guidance Service (BGS) Manual Based on Business Process Management (BPM) Methodology: A Case Study in a Public Company in the Amazonas State**

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## **Abstract**

*The public company operates directly focused on providing services to clients operating in the Amazon trade sectors. This paper aims to present a previous study on the proposal to implement a Business Guidance Service Manual (BGS) in a public company in the State of Amazonas through the Business Process Management (BPM) methodology.*

**Keywords:** Business Process Management (BPM). Business Guidance Service Manual (BGS). Public Company - Amazonas - Brazil.

## **1. Introduction**

The continuous changes in the organizational and economic scenario require managers to have some decision-making power to try to follow the administrative process in this scenario. In this regard, there is a great need for adaptability of organizations to meet this demand, whether for competitiveness or for survival in the market.

Given this scenario, the client's figure is fundamental for a more accurate study on how to serve him and thus be able to meet his needs to ensure his satisfaction. An effective customer relationship requires a set



of aspects of the organization: flexibility, good communication, knowledge of the market profile and a good customer relationship.

This paper aims to present a previous study on the proposal to implement a Business Guidance Service Manual (BGS) in a public company in the State of Amazonas through the Business Process Management (BPM) methodology.

## 2. Theoretical References

### 2.1 Processes

The concept of process, in a broader sense, can be explained as transforming a system's input into an output. The concepts about the word “process” are defined by several authors according to their scope or area, such as: systemic, structural, semi-structural, administrative, organizational, among others.

Tiniila (1995) mentions that a process is the interconnection of logically organized elements for the operation of a certain task execution in an environment. It is then understood that a process works on an input - output - output logic. The process is based on the achievement of a certain result to achieve a goal or objective (MEGARD, 2002).

Maranhão and Macieira (2008) presents a theoretical framework of definitions by authors and institutions (Chart 1):

Table 1 - Process Definitions

AUTHORS AND INSTITUTIONS	DEFINITIONS
<b>National Quality Foundation (2009)</b>	Set of activities and operations that meet an objective or goal.
<b>Association of Process Management Professionals (2012)</b>	Chaining of actions synchronized or not that meet a certain demand for results.
<b>From Sordi (2005)</b>	These are subsequent stages or stages of evolution that suggest transformations.
<b>Adesola and Baines (2005)</b>	Input and output transformations for the elaboration of a service or product.

Source: Adapted from Maranhão and Macieira (2008)

In short, process definitions present it as a set of steps that are linked to a logical chain of steps to perform a given transformation, ie the process suggests that there is a transformation from a current state to a different state.

### 2.2 Business Process Management (BPM)

Business Process Management, or Bussiness ProcessManagement (BPM), is an organizational process-oriented enterprise management tool that aims to reduce lead time - to ensure greater efficiency and quality effectiveness. in the relationship with the customer (BRITTO, 2012).

BPM broke out in a scenario of market globalization with a strong inclination for consolidation mergers

of multinationals and large corporations, especially in the business sector. Brokeman and Rosemann (2013) state that business networks and the growth of outsourcing have boosted organizations' use of the BPM methodology to make the customer relationship more objective and clear.

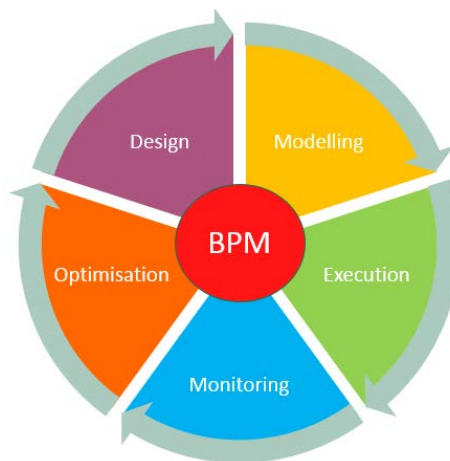
The fusion of business management with technological apparatuses makes BPM a multifaceted process, as Santana (2015) approaches by analyzing that it deals with a management typology that focuses on process optimization impacting various areas of the organization, so that the results observed at all decision layers.

Organizations are increasingly seeing that the business landscape offers the greatest competitive advantage when the market and customer are closer together. Simões (2006) states that market strategies in BPM are widespread through process management, ie reducing lead time means increasing production, feedback effectiveness and ensuring Business business goals.

The BPM Cycle (Figure 2) develops in four steps:

- Development and validation: process of preparing the model proposal for application;
- Execution: application of the model;
- Analysis and continuous improvement: model evaluation stage through performance analysis and improvement tools (quality tools);
- Design and modeling: process of model improvement through adaptability and adjustments to the organization's molds.

Figure 2 - BPM Cycle



Source: Adapted from Simões (2006)

Santos and Robaina (2014) argue that BPM involves strategies, objectives, goals, policies, implementation, development and governance tools for the organization. It is a tool that envisions the complete fulfillment of customer needs, so that there is a more systematic reach of demand responses through process flow management.

### 3. Methodology

The observational case study was based on an on-site analysis of the sector responsible for assisting the International Educative Research Foundation and Publisher © 2019

taxpayer companies in the process of collecting the compulsory tax collection from the public company. The purpose of this step was to analyze the profile of the companies and evaluate their level of education about their knowledge about the benefits and advantages as contributors, thus being important to elaborate the BGS Manual.

## **4. Application of Study**

This section presents the *modus operandi* defined for the structuring and elaboration of the BGS manual for the company. Given that this is an ongoing proposal, the data presented are the result of the first analyzes and evaluations of the BGS team based on studies conducted since 2016.

The proposal to implement a Business Guidance Service (BGS) Manual in the company started from a need observed in the last 10 years. The concern to disseminate to the trader the importance of contributing to the system has always been a major concern of the institution, given that its fundamental role is to ensure social welfare for employees and family members in the commercial area.

Based on this holistic analysis by the BGS, preliminary studies were conducted on the elaboration of a technical and administrative manual to explain, in detail, the whole process of compulsory collection, pertinent legislation supporting the institution and the company, as well as a clearer explanation of the advantages and benefits for the taxpayer.

### **4.1 Company Background**

The public company operates directly focused on providing services to clients who work in the Amazon trade sectors. It is a private institution, maintained by private sector entrepreneurs in the areas of commerce, tourism, goods and services.

The company's activity is focused on the niche of supplying goods, services and products that serve members, whose advantages are offered in accordance with the collection policy through companies that are affiliated to the capitalization system.

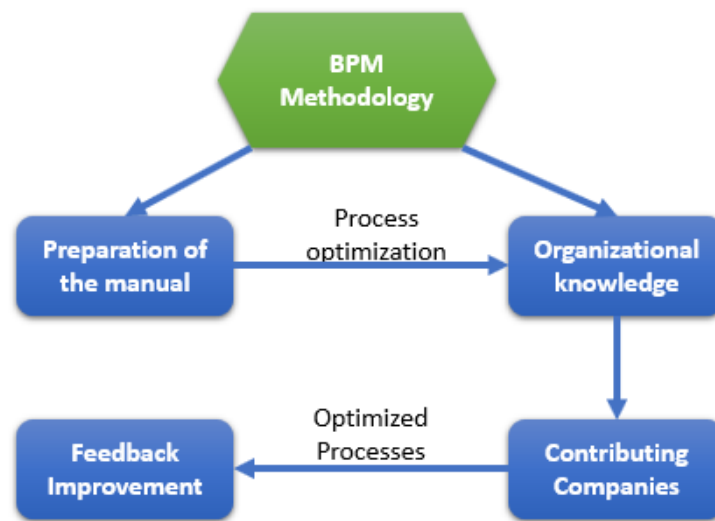
It operates throughout Brazil, and in Amazonas it serves more than 450 member companies through a collection policy. On the other hand, the company provides services aimed at the well-being and quality of life of the company's employees and entrepreneurs and investors.

### **4.2 Bpm Model Flow**

In the midst of this initial technical study, a working tool was proposed to manage this process. Thus, BPM was chosen as the tool to be used in the process due to some characteristics, the main one being its integrated management and ease of propagation in the communication and information flow in the organization.

A previous model was designed to work the proposal (Figure 4):

Figure 4 - Proposed BPM Model



Source: Prepared by the author (2019)

The illustration above shows the chain of steps in the process flow thought from the proposal with BPM:

a) Organizational Knowledge

The process of organizational knowledge is the beginning of the methodological cycle of implementation of a BPM methodology. It corresponds to the knowledge phase of the company through the experiences, experiences, relationships and the organizational practice developed by its employees. For the elaboration of the proposal the relevance of the organizational knowledge was thought to realize a strategic mapping of the responsible of the company in intermediating the relationship between the institution and the contributing client-company. The development of this work team started from the choice of members who are directly interconnected with taxpayer service and who forged in a better business communication profile, which facilitates the relationship between the organization and the client.

b) Contributing companies:

This step in the BPM methodology concerns companies that have failed to contribute to the company and those that have not yet contributed for specific reasons. One of the main reasons detected in companies that do not contribute to the compulsory collection is the lack of knowledge about the process. This factor, observed by the BGS work team, can be verified by the still massive presence of small and medium companies that do not contribute to the collection because they do not know the advantages that their workers and the company itself gains from the system.

c) Feedback Improvement

Improved communication between the company and the taxpayer is defined as an optimized process in the BPM methodology. The absence of noise in this process allows the organization to get closer to its taxpayer, which leads to greater adhesion by the company's employees and openness to new partners. This stage of the process derives from the results that will be presented by the elaboration of the BGS Manual, which will bring more detailed and concise clarification to the taxpayers and new contributors of

the company's association system.

#### d) BGS Manual

The methodological process based on BPM aims, at the end of its flow, to elaborate the BGS manual. This manual aims to present to the taxpayer all the advantages, benefits, legal protections and methods of adhering to the compulsory tax collection process. It will basically address the following aspects:

- General presentation of the “S” system;
- compulsory income;
- Brazilian Federal Revenue Authority - RFB;
- Forms of collection for third parties;
- Presentation on the process of transfer of compulsory revenues to the Entities;
- Tax Recovery Program (REFIS);
- Direct Collection;
- Improper collection to third parties;
- Refund proceedings under the SESC;
- Monitoring of compulsory revenues by SESC;
- Presentation of Basic Legislation.

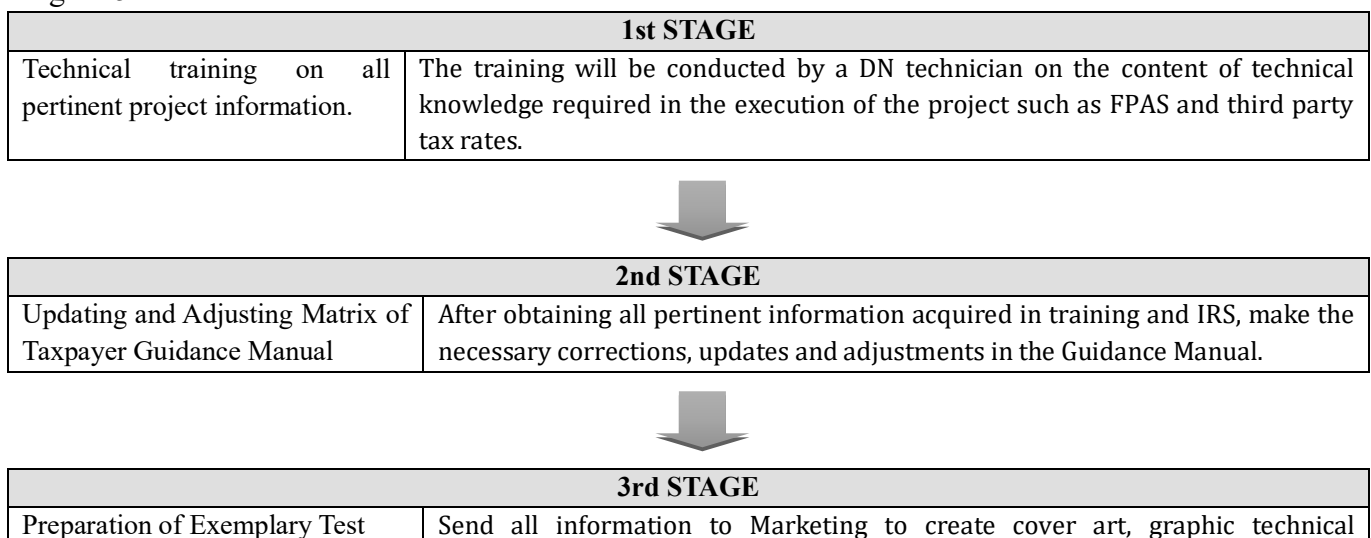
All this structure designed for the BGS manual will aim to make an overview of all the legal and administrative information of the compulsory tax collection process for companies, both for those who are already taxpayers, and to attract those who are not yet taxpayers. and want to participate in the system.

## 5. Results and Discussions

After the preliminary studies and initial preparation of the project roadmap, the BGS Handbook based on long-term application (2019-2021) was built according to the company's institutional policy.

The project guidance plan (BGS Manual) was prepared according to the following action plan guidelines (Figure 5):

Figure 5 - BGS Manual



Higher Authorization Final adjustment and manual printingary Test	adjustments, and test copy printing. Forward copies for aurotization.
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4th STAGE	
Improvement on tools. Conducting Forum (Workshops) Guidance Manual launched	Seek from the IRS ways to identify the trading companies. Organize event for project presentation and partner acquisition.



5th phase	
Company Taxpayer Guidance Handbook launched Dissemination of the manual in partner companies Submission of Monitoring Reports (Quarterly and Annual)	Realization of the event. The beginning of the process will be done by sending a letter of orientation regarding the contribution and the Business Orientation Manual. Report through project results (quarterly and annually).

Source: Prepared by the author (2019)

The results show that the institution has been using BPM as a tool to improve the relationship with its taxpayer, demonstrating a better effectiveness in the knowledge of the advantages and benefits offered by the company.

The planning of actions in the three-year period (2019-2021) from the elaboration of the BGS manual demonstrates that the company will be expanding the dissemination of its services and products to its customers and associates niche, in order to make them obtain them. greater knowledge about what is offered by the company.

It is observed that the action plan involves the entire training process of the servers, employees and outsourced workers that make up the company's structure, as well as the entire marketing and dissemination apparatus of the services that will be offered.

## 6. Final Considerations

The conclusion of the research allows us to analyze that BPM is a fundamental corporate tool to implement an improvement in relationship management in the organization, focusing in particular on the client (beneficiary) of the services and products offered by the institution.

It was observed that with the elaboration of the BGS Manual from the actions and guidelines based on BPM brought a systematic dynamization in the company's processes. The implementation of the model based on process management optimized the decision making process and allowed the company's information to serve customers by integrating the observed needs with the demand captured in the initial diagnostic process and, later, in the implementation of the manual.

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## **Analyzing Accidents in Civil Construction for Safety Work at Height**

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### **Abstract**

*In civil construction any and all services must be performed objectively and safely, especially the services at the height of the painter, where the employee is more exposed to the risk of falls and impacts of the user's own objects on lower limbs. Both the employee and the employer are responsible for everything that happens at the construction site, the employer providing safety devices and plans to minimize the risk of accidents while performing the services and the employee must obey any and all safety orders and plans aimed at not only your physical integrity but that of your colleagues doing services around you. Therefore this work will address the NR-6 regulations dealing with single use equipment, NR-18 which work conditions and environment in the construction industry and NR-35 work at height, which regulate service at height with the main focus.*

**Keywords:** Risk of falls; Safety; Brazilian Regulatory Norm;



## 1. Introduction

The most frequent accidents are those associated with the Construction industry, especially those involving falls of workers such as bricklayers, carpenters, janitors and painters, who were performing services on stairs, roofs, scaffolding and facades. Civil Construction in Brazil will always be a good indicator of the country's economic growth, in the 70's the average Gross Domestic Product (GDP) reached 8.8% [1], but together with this growth, there is a sharp increase in the number of accidents at work, especially those related to fall in height, for various reasons.

Falls are said to be responsible for the largest number of fatal accidents, along with accidents caused by electric shock and burial, associated with various activities in the construction of buildings, such as coatings, painting, maintenance and conservation of building facades, in addition to shape assemblies, concreting and deforming in the phase of structures developed by carpenters, masons and blacksmiths.

Most deaths are the result of falls at frequent times in construction, and from these occurrences the Ministry of Labor and Employment has updated the regulatory standards, and is applied to any above-ground activity established by rule [2].

According to Law 8.213 / 91, art. 20, of the National Institute of Social Welfare [3], an occupational accident is what occurs when working at the service of the company or the work of special insured persons, causing bodily injury or functional, permanent or temporary disturbance that causes death, loss or reduced ability to work. They are also considered as an accident at work.

Accident and the injury agent, concluding that the accident involving fall in service in height is in 1st place in the frame of accidents. One study found that technological advances, when associated with workers' well-being and safety, greatly reduce accidents on construction sites, and consequently the cost of production, leading to the conclusion that the amount invested in occupational safety and workers' welfare are rewarding to the company [4].

Therefore in this sense the work will address the painter's risks at height, alerting the dangers and informing the regulatory norms such as the NR 35 [5] of work at height, NR 18 of conditions and environment of the construction industry, besides the NR 6 equipment for individual use to establish the duties of the employee and the employer. Demonstrating devices for collective and individual use to minimize the risk of accidents that can lead to death.

## 2. Theoretical References

These activities are performed above two meters above ground level, containing risks of falls, and are called height work according to [5]. These are activities that require the assistance of ladders, ropes, platforms or scaffolding, such activities require more care and planning from the employer as it is he who should look for ways to analyze alternatives in order to avoid any risks, and if any, make use of all resources. to avoid as much as using PPE while raising awareness.

Accidents caused by a fall in construction occur for several reasons, among them the collaborator, often having a vicious cycle, that is, after doing so in an improper way ends up not obeying the rules of use and safety, and also the work environment itself, because many of them, are not able to work with low

lighting, slippery floors, lack of signage of slab openings, floors among others, lack of collective protection and when there is protection is not installed correctly as defined by the norm [4].

The [6] is responsible for regulatory standards, which aim to prevent risks to the life and health of workers when performing their activities in the field, comprising in each standard the technical procedures and minimum safety measures that must be strictly followed. The NRs have another function than teaching CLT (Consolidation of Labor Laws) in order to fulfill them correctly.

According to [7], personal protective equipment is important in reducing injuries and illness, but its distribution is not enough, making them sometimes inefficient due to lack of knowledge on the part of the worker. even claim that the risks are minimal and that they are sufficiently prepared to perform that activity, which they have been doing for a long time without the use of PPE, in their view they believe that the use of PPE will only hinder productivity by limiting their movements.

According to [8] it is extremely important to observe and predict any type of risk in order to eliminate them early on, so it is necessary to have a quality management that can plan the use and how To guide the employee about its use and its importance for occupational safety and health, in which the use of EPI involves three actions: technical, educational and psychological. Technical action encompasses technical understanding and understanding for the type of use; educate workers about how PPE works properly; and the psychological is to make the worker aware of the importance of its use in the safety of their physical integrity.

The construction conditions and environment programs (PCMAT) should be prepared prior to the commencement of work, but as a safety management program, it should not be viewed as a static document; It may change as the work progresses. However, no stage of the work should be performed without identifying the risks involved and their control measures. And this forecast must be included in PCMAT, it is mandatory to elaborate and comply with establishments with more than 20 (twenty) workers or more. It must be prepared by a legally qualified professional in the area of occupational safety, its implementation in the establishments must be done by the employer or owner, and the PCMAT must be kept in the establishment at the disposal of the regional agency of the ministry of labor, according to [9].

### **3. Methodology**

The method chosen in this research was the case study, which aims at a qualitative approach, aiming to interpret the information in order to build a solution to the problem. The research instrument applied is the observation and a questionnaire designed with 9 questions, intended to describe the painter's activities and the risks of accidents in the construction industry, aiming at safety at work, with the purpose of showing the importance of equipment and devices. , collective and individual do within the scope of the work.

To perform the research steps was divided into 4 phases:

The first phase was the definition of the place having as criteria what happens most often, that is, what is present with daily life of the Amazonians, after defining the place, the collaborator answered some careful questions in order to verify its use and understanding, then the observation of the act itself,

concluding all the study methods, gathered the collected statements, finally analyzing, arguing and interpreting the data in order to propose appropriate solutions for both the employee and the employer, presented in table 1.

<b>1<sup>a</sup> Phases</b>	<b>Definition of analysis site Preparation of the interview</b>
<b>2<sup>a</sup> Phases</b>	Interview with the employee
<b>3<sup>a</sup> Phases</b>	Application of research instruments; Gather all collected materials.
<b>4<sup>a</sup> Phases</b>	Analyze, argue and interpret the data collected during the research in order to present possible solutions to avoid risks.

Table 1: Research Phases

Source: Own Author

### 3.1 Case Study

Held in a confectionery, Bolo e Cia, located at Avenida Camapuã, 2332, east of Manaus-AM. The work performed is privately linked, being only the agreement between employer and employee, a service in a short period, as well as many that exist in the city.

At the beginning of the painting work, images were recorded and the procedures performed were annotated, and all the details of the execution were observed, for a better detail at the end of the process, and could reach a conclusion to propose appropriate solutions to both the worker and employer.

## 4. Results and Discussion

At the end of the execution a set of questions was asked to the worker, composing 9 questions, in order to understand why he does not use PPE or question his employer of the availability of this equipment. The table 1 below shows the painter's answers to be analyzed and discussed.

Table 1. Employee Interview

<b>1. Age?</b>	<b>38</b>
<b>2. What is your education?</b>	High school
<b>3. How long in this branch?</b>	About 19 years old
<b>4. Do you have a qualification course? Which are?</b>	No, what I know I learned in practice.
<b>5. Was there a PPE available at the places you worked? Which are? In some places yes.</b>	Gloves, and helmet.
<b>6. Do you have any guidance on how to correctly use PPE?</b>	Not
<b>7. When working, are some fall protection devices used?</b>	Not
<b>8. Have you had an accident? Was using PPE?</b>	Once the scaffolding I used was misplaced, the floor was uneven, I ended up falling. He wore only his boots and gloves.

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**9. What do you think about PPE?**

I think it's important sometimes and sometimes it's unnecessary, it doesn't help, it gets in the way of work and it bothers you,

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Source: Own Author

It is notorious that the lack of responsibility, the non-compliance with the laws and the self-confidence acquired over the years, even after accidents occurred, continued to commit the same recklessness as observed in Figure 1, one can notice the lack of signs in which the Standard Regulatory 26 [11], in item 26.1.1, establishes the use of colors for safety in establishments or workplaces, in order to alert the existing risks to the people who travel nearby and the employee himself, even in the use of this device that not being used, the use of this resource does not dispense with the use of other preventive means in accordance with NR 26 [11], item 26.1.3. The need to isolate and signal the site is to try to minimize risks and accidents.

Scaffolding shall consist of shims, fixed base, diagonal, ladder, safety ring, railing, floor, baseboard and screen. According to norm NR-18 [12], item 18.15.6 states that scaffolding should have a railing and skirting system, including headboards, all around the perimeter, reducing the risk of falling objects and the employee himself, obeying the protective measures are the height of 120 cm for the upper crossbar and 70 cm for the intermediate, a footer with a height of 20 cm, in addition to the screen fills ensuring the safe closing of the gaps (item 18.13.5). In item 18.15.7 it is forbidden to remove any safety device from scaffolding or to nullify its purpose.

The scaffolding used by the employee is the simply supported fixed scaffolding without baseplate, used outdoors, which is where the structure remains rigid preventing its displacement, for each type of scaffolding can be modified as for facade, is the scaffolding fachadeiro therefore allows the access of people and materials to the work. The used note the lack of a baseboard and the lack of regularity of the floor, making it even more necessary to use shims to increase strength and ensure more stability, which according to NR 18 [12], in Item 18.15.10 which states that the scaffolding risers must be supported by solid and level base shoes capable of withstanding the stresses and loads transmitted.



Figure 1. Irregularities

Source: Own Author

According to NR-18 [12], Item 18.15.3 The working floor of scaffolding shall be completely lined, non-slip, level and securely fixed and locked, and the floor may be all metal or mixed with metal structure. and synthetic material or wood or all wood, item 18.15.3.1, the sizing should be done by a qualified professional, according to item 18.15.3.2. The use of wood shavings in scaffolding is also prohibited, item 18.15.5.1, that is, it is not possible to use leftovers of wood that are in bad condition, with cracks and wet, compromising its resistance and cannot be painted. in order to hide the deformities, item 18.15.5, the user being totally irregular according to the safety standard as shown in figure 2.



Figure 2. Scaffolding floor

Source: Own Author

In addition to all the mentioned items there is still the risk of scaffolding close to the wiring of electric wires as seen in figure 3, the NR-18 standard [12], in item 18.15.4 informs that precautions should be inserted in PCMAT. Taken when assembling, disassembling, and moving scaffolding near power grids, due to the risk of shock, parts of a scaffolding frame carry electricity and may be hazardous if exposed to power cords or conductors.

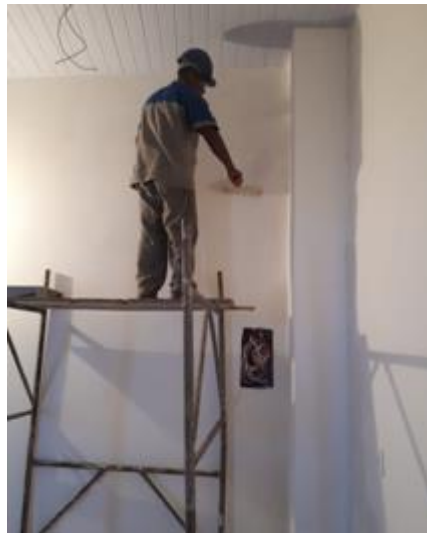


Figure 3. Worker near electricity

Source: Own Authorship, 2019.

The work had several nonconformities such as lack of PPE, irregular scaffolding, no supervision, no training or guidance from employer to employee, or any risk assessment that might have been made, contrary to NR- 6 [13], Item 6.6.1, related to work safety at height, characterizing a serious and imminent risk, which may cause accidents and even lead to death of the worker.

According to [14], to some extent the risk may be acceptable or not, to obtain this response is passed through the risk assessment process, it is considered the use of preventive means. Risks are considered a combination of possibilities that exist in that activity, and may lead to the worker the occurrence of serious accidents with injuries, illness or death. The way to avoid accidents is with preventive and corrective actions, preventing actions and avoiding new events. The main causes are human or material, for lack of knowledge of its importance, use PPE not corresponding to the risks etc.



Figure 4. Worker at eminent risk

Source: Own Authorship, 2019.

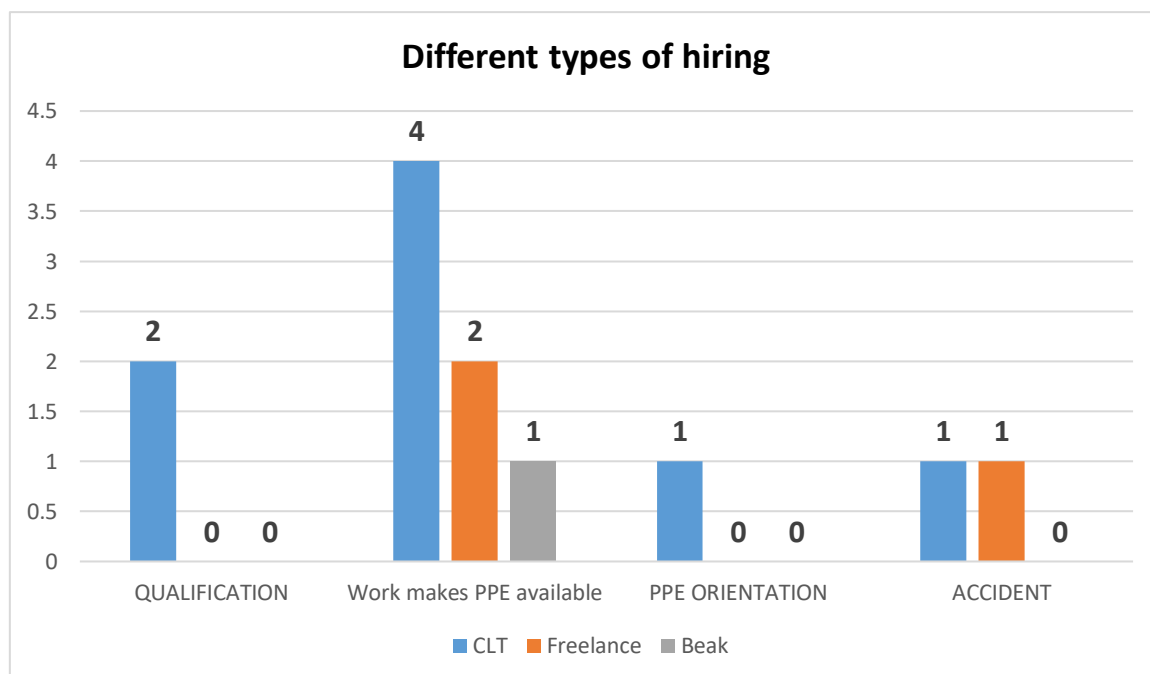
The image shows that the employee does not have the proper PPE, because the user was at a height of approximately 2.5 meters and were totally of the standard that the NR-35 standard [5] determines to have the minimum safety, in which If activities above 2 meters are already considered work at height, it is of fundamental importance to strictly follow the established law, because most of the accidents registered are work at height. As shown in figure 4, when wearing a helmet, he does not use it with a jugular, risking that he detaches if his head, also has no seat belt, protective glove, lanyards or parachute, going against all safety laws.

#### 4. Comparison of Painters in Different Conditions

For a better view of working conditions, comparisons were made of different types of working conditions, the first is CLT (Consolidation of Labor Laws) that supports the worker, safeguarding all his rights by law; the second is self-employed, but has no signed wallet, has been working for a long time with painting; and lastly it's the nozzle worker, it's not his only job, he does anything that comes along.

For each item a weight was placed, for example, in question number 5, in which the PPE is questioned the employee answers the equipment such as helmet, glove, mask and boot, thus 4 EPIs being placed the number 4, already For accident the number 1 is the maximum.

The comparison was shown in graph 1 below, made only with 3 employees who work in this area.



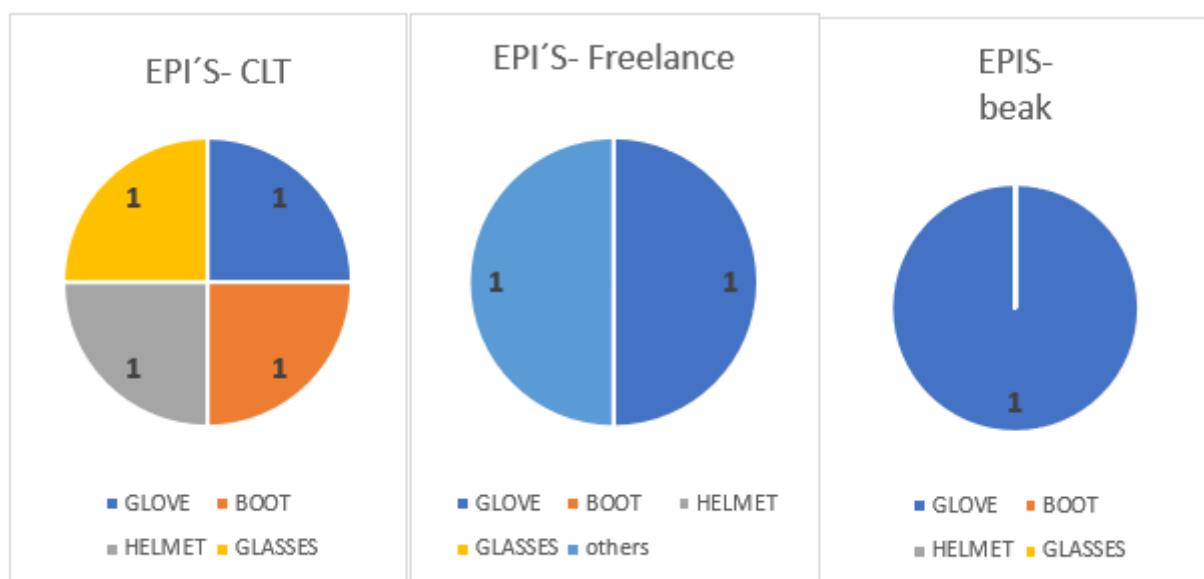
Graph 1. Comparison

Source: Own author

It can be observed that in the three cases only the contractor with a formal contract has qualification,

which according to norm is necessary to avoid the risk of falling by owning knowledge. The equipment available is the minimum, being only gloves only, and the employer should provide the equipment should provide guidance on how to use it. In the above cases only the signed card has guidance, leaving the other two respondents without, because such laws and regulations are not disclosed, nor is there a strict supervision on renovations or even construction, leaving many at the mercy of luck and taking risks. serious. In the following pie chart 2, you compare the PPE.

According to [7], personal protective equipment is important in reducing injuries and illness, but its distribution is not enough, making them sometimes inefficient due to lack of knowledge on the part of the patient. even claim that the risks are minimal and that they are sufficiently prepared to perform that activity, which they have been doing for a long time without the use of PPE, in their view they believe that the use of PPE will only hinder productivity by limiting their movements.



Graph 2. Comparison of employer-provided PPE

Source: Own Author

The lack of commitment between the parties diminishes the responsibility of both employer and employee, leaving both and especially the employee at risk. The use of this equipment is not for decoration, but for life protection, but should be used correctly, its misuse or misuse, makes the epi useless according to what the manufacturer informs.

## 5. Solutions for Possible Identified Risks

During this research several factors were demonstrated that influenced to increase the risks of falling of the collaborator, of objects, besides the dangerous access, electric shocks and collapse of the structure. For each danger there is a prevention solution which are:

Risk of falls: the use of devices as a railing; avoid leaning over it; avoid working in bad weather; close any opening; comply with current safety standards; possess knowledge; maintenance.



Falls of objects: signaling; accumulate things on scaffolding; use of protective equipment such as skirting boards, nets and flooring in good condition.

Dangerous access: Must be signposted and in accordance with regulatory requirements.

Electric shock: keep distances from mains because the scaffolding are conductors of mains; use of inappropriate equipment.

Structure collapse: Risk of scaffolding load: the floor must be in good condition; drag and drop materials; overload the structure and floor; On loads: know the limit of scaffolding; do not put unnecessary things;

### **5.1. Training**

Training is another factor that contributes to the reduction of accidents, the skydiver training indicated by giving skills to the employer, and the employee must know their equipment, procedures that control and minimize the risks.

Courses and Techniques of Work at Height According to the norm, it is the employer's duty to promote a program to train workers to perform work at height. With a minimum workload of eight hours, the theoretical and practical training must include presentation of the rules and regulations, risk analysis, collective protection systems, equipment and procedures, personal protective equipment, typical accidents and emergency conduct, including rescue and first aid.

Work at Height for Facade Painting: Work at heights as an activity that should be planned, avoiding, if possible, exposure of the worker to risk, either by performing the work in another way, by measures that eliminate risk of falling or even measures that minimize its consequences when the risk of falling with level differences cannot be avoided by applying the standard and enabling the painter to perform a certain service.

### **5.2. Technological Innovations**

According to CIPA [15], he published an article on innovation in the PPE management system: 3M Connected Safety - Inspection and Management Module, which includes the emergence of a management system for workers' health and safety in the complexity of their work. activities. 3M has developed an information control of equipment, users of PPE and work areas, aims to provide a control placed information in a software that stores the data in a cloud, its access can be made through mobile phones and computers.

In this tool you can have information such as manufacturers, type, validity, exchange routine, among others, about the PPE. For users puts the right equipment for activity, proper training and exams.

The main advantage is an up-to-date report, helping to make the best decision any time you are asked. They are easy to store, as well as being able to control users' access to PPE, ensuring that they know how the equipment is being used correctly so that its useful life is as determined by the manufacturer without waste. It informs about the best equipment for activity to be performed and its mode of use.

## **6. Final Considerations**

Because of the facts mentioned, knowledge and information can save lives, possessing them reduces the

risk of accidents and prevents them. The standard NR-35 [5] is related to work at height, in this work refers to the service of the painter, in which they must understand and understand all the risks that he is exposed by not using protective equipment or devices. Not only should the employer be aware of his duties, but as the employer who is obliged to pass the knowledge on to him, despite this one of the contributing factors is the lack of supervision becoming something of concern for the amount of works that exist.

Besides presenting the risks, the necessary equipment was placed and its importance, but the improper use to what the manufacturer recommends, ends its purpose and the user continues with the risk. These devices are put in a preventive way one of them is the human factors because it is unpredictable, as some of them end up not wanting to use it because they believe it hinders the execution of their activities. Also for better visualization were made comparisons of different types of employability one being CLT, Autonomous and Nozzle, showing the differences they have and the distribution of PPE.

In this course completion research, risk protection devices and equipment have been shown for activities at heights, seeking to show the problems and measures required in accordance with current regulations for work at heights. Therefore it is necessary to give priority to lectures, accident reduction measures, availability of equipment and individual and collective devices, so that the activities performed occur safely and in accordance with the planned.

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# **Rainwater Use in the FAMETRO Manacapuru Unit for Non-Potable Purposes**

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## **Abstract**

*Water is the fundamental element for the existence of life on earth is one of the essential natural resources used by humans. The use of alternative sources of water in public and private bodies has been the most constant form in recent years, this time aiming to reduce the demand for drinking water. The management of water use and the search for alternative sources of supply such as rainwater use fall within the context of sustainable development, which proposes the use of natural resources in a balanced way and without harming future generations. Thus, the design of the reservoir for the use of rainwater at the Manacapuru Metropolitan Faculty of Manacapuru - UEA, by the methods provided by the NBR 15527/2007 guidelines were satisfactory. With ten-year rainfall data from 04/2008 to 12/2017, in the municipality of Manacapuru, the volume found for the reservoir to meet the analyzed rainwater demand was 37.17 m<sup>3</sup>, with a supply of approximately 80% of non-potable water consumption at Manaus Metropolitan Faculty Manacapuru unit. Thus the economic advantages, the implementation of this sustainable system can bring benefits to the environment, so all the water collected will help to minimize the occurrence of floods and the improper consumption of treated water.*

**Keywords:** Rainwater, reuse of water, Use of rainwater;

## **1. Introduction**

Water is the fundamental element for the existence of life on earth. It has no smell (odorless), no color

(colorless), no taste (tasteless) and is formed by two gases: hydrogen (H) and oxygen (O<sub>2</sub>). All living beings depend on it to survive and ensure the permanence of the species. The average human body needs, on average, four liters of water a day to stay healthy, acting, along with other body functions, to exchange substances, acting on approximately 70% of its body mass. The aqueous solution has the responsibility of transporting the mineral salts of substances, both inside and outside the cell, and other functions such as body temperature regulation [1].

In addition, water is also indispensable for meal preparation, essential for personal and environmental hygiene. Thus, it is everyone's duty not to allow any kind of waste and to guarantee a pure and crystal-clear quality water, since the water makes it possible to quench the thirst, it is used in agriculture, industries, restaurants and in every house. Water is also indispensable for energy generation, transport, recreation, health and employment of the population.

Drinking water found in nature is one of the most essential resources for the growth and multiplication of living organisms that inhabit planet Earth. The dissemination of information regarding the risk of water scarcity has increased the population's awareness regarding the use of this resource [2]. Nowadays this natural resource is increasingly limited due to the population growth which as a consequence consumes more than nature can replenish.

Thus, the search for alternative sources of water supply such as rainwater use is of utmost importance to reduce drinking water consumption and thus contribute to sustainability.

Rainwater harvesting is a new technology that is being used in recent years to collect and store rainwater for human use through gutters that are deployed on roofs, roofs, which are on the earth's surfaces, applying more accessible techniques like buckets, jugs and basins, as well as engineering techniques.

Thus, this work aims to design a system for the use of rainwater to save water and reduce environmental impacts and use for noble purpose in the Manaus Metropolitan Faculty Manacapuru-AM unit. With the specific objective of diagnosing and estimating the volume of non-potable water use and applying methods according to the guidelines NBR 15527/2007 to determine the preliminary design of the system for the storage of rainwater in the Faculty.

## **2. Theoretical References**

### ***2.2 Use of Rainwater Use Throughout History***

The use of rainwater is not a new practice, there are reports of this type of activity millions of years ago. Rainwater utilization has been practiced for over 4,000 years through the temporal and spatial variability of rainfall. It is an alternative source of water in many places where there is no conventional type of water supply system, so of utmost importance in places where water is of good quality, surface or underground. The rainwater harvesting system has been in use since ancient times, and there is evidence of rainwater harvesting systems dating back to the early Roman times [3].

Rainwater harvesting systems are also found in pre-Columbian civilizations. Mexico as a whole is rich in ancient and traditional rainwater harvesting technologies dating from the Aztec and Mayan times. To the south of the city of Oxtutzcab, at the foot of Mount Puuc, one can still see the achievements of the Mayans. In the tenth century, there was an agriculture based on rainwater collection. People lived on the

slopes and their drinking water was supplied by cisterns with a capacity of 20,000 to 45,000 liters. These cisterns had a diameter of approximately 5 meters and were excavated in the limestone basement, lined with waterproof plaster. Above them was a catchment area of 100 to 200 m<sup>2</sup>. Other rainwater harvesting systems were used in the valleys, such as watery (artificially dug rainwater reservoirs with a capacity of 10 to 150 million liters) and Aquadites (small artificial reservoirs for 100 to 50 thousand liters) [4].

With the introduction of modern supply technologies that were emerging, the collection and use of rainwater lost strength. Nowadays, due to the need to search for alternative sources of water, the use of rainwater has become a reality and is a widespread technique mainly in European countries.

### ***2.3 Availability of water resources in the world***

We consider the planet on which we came as planet water, since its surface is mostly composed of this substance. It is estimated that 97.5% of the world's water is salty and not suitable for our direct consumption or irrigation.

Of the total volume of water on the planet, it is estimated that only 2.5% is potable water or simply fresh water, and much of this volume is not easily accessible. Only 0.266% of this total is found in lakes, rivers and reservoirs, the remainder being distributed in biomass and in the atmosphere as steam. Thus, it is estimated that only 0.007% of all freshwater on the planet is in places with simple access for human consumption [5].

Water on the planet is unevenly distributed, with the largest volumes available in Asia and South America. Asia has the largest share of this resource in the world, totaling approximately 31.6% and reaching flows of 458,000 km<sup>3</sup> / year. The lowest potentials are found in Oceania, Australia and Tasmania [6].

### ***2.4 Availability of water resources in Brazil***

Brazil is home to the largest river in length and volume: The Amazon River. This is located in the northern region of the country. In addition, over 90% of the national territory receives rainfall throughout the year and its geological, climatic and geographical conditions favor the formation and development of a wide river network, except in the semiarid region, where rivers are temporary.

Brazil has an estimated water availability of 35,732 m<sup>3</sup> / inhab / year, being considered a “water rich” country. Moreover, in relation to world water potential, Brazil accounts for 12% of the total amount of fresh water in the world [7].

Brazil's water availability is mostly distributed in watersheds. The main river basins in Brazil are the Amazon River, Tocantins-Araguaia, San Francisco, Northeast North Atlantic, Uruguay, East Atlantic, South and Southeast Atlantic, Paraná and Paraguay Rivers [8].

The largest hydrographic network in the world is the Amazon Basin, which covers a drainage area of about 6,112,000 km<sup>2</sup>, occupying about 42% of the surface of the Brazilian territory, extending beyond the border from Venezuela to Bolivia [8].

Although Brazil is rich in the availability of this water resource, these are unevenly available throughout the country.

In Brazil, it is verified that the most populous regions are precisely those with the lowest water

availability, on the other hand where there is a lot of water, a low population index occurs. An example of this is the Southeast Region of Brazil, which has a water potential of only 6% of the national total, but has 43% of the country's total inhabitants, while the Northern Region, which comprises the Amazon Basin, It has 69% of available water, accounting for only 8% of the Brazilian population [9].

### **2.5 Water scarcity issues**

Today the planet is already facing a water crisis as a result of the disorderly growth of pollution that often expands without adequate infrastructure causing pollution of water resources, of industrial growth that eventually lead to an increase in demand for clean water.

Water distribution in the world varies significantly over time and space, making many regions vulnerable to frequent water shortages. In 2005, approximately 8% of the planet's total population was vulnerable to water shortages and, according to estimates made at the time, about 25% more were heading in the same direction. The reduction in water availability due to the constant contamination of water resources and the increase in consumption in the industrial, agricultural and municipal sectors is quite visible when comparing data from 1950, where world reserves were 16.8 thousand m<sup>3</sup> / inhab. whereas in 2005 this value was reduced to 7,300 m<sup>3</sup> / inhabitant, and may be further reduced to about 4,800 m<sup>3</sup> / inhabitant. by the year 2030. From 1950 to 2000 the number of inhabitants in the world tripled, per capita consumption doubled and the total volume of water withdrawn from available reserves increased approximately nine times [10].

The differences between developed and developing countries are shocking and show that the global water resources crisis is directly linked to social inequalities.

Importantly, there is an unequal distribution of water resources in the world. According to data from the Ministry of the Environment, Brazil owns about 13.7% of all surface water, of which 70% is located in the Amazon region and only 30% is distributed to the rest of the country [11].

### **2.6 Utilization of rainwater**

The use of rainwater is inserted in the context of sustainability, since it proposes the use of natural resources in a balanced way and without harming the future generations. Being conceptualized as all the water resulting from atmospheric precipitation collected on roofs, roofs, where there is no circulation of people, vehicles or animals [12].

One way to prevent the sharp decline in drinking water availability is to reuse or use rainwater. Unfortunately, many people even consider joining some of these alternatives, but do not know how this can be done and whether this habit can harm their health. Rainwater, for example, has great potential for reuse, but is wasted by many.

It is very important to note that the saving of drinking water through the use of rainwater reduces the waste of clean, pure water in activities such as car washing, watering plants and lawns, flushing toilets, cleaning sidewalks, streets and patios, water mirrors and some industrial applications [12].

## **3. Materials and Methods**

### 3.1 Determination of the study area

The place of study of this work was the Manaus Metropolitan Faculty Manacapuru unit - AM - FAMETRO, located at Travessa Cristiane Azevedo, 2295 - Terra Preta, Manacapuru - AM.

The building has a floor, having a total built area of 700 m<sup>2</sup>, where are distributed classrooms, laboratories, library, cafeteria and bathrooms, found that FAMETRO does not currently exist - and has never been used - any kind of system rainwater use in the building.

### 3.2 Materials

#### 3.2.1 Rainfall Data

The historical series of eleven-year daily precipitations from 04/2008/12/2018 / were analyzed, using the monthly average of precipitation, in millimeters, obtained for the city Manacapuru - AM, which will be made available by the National Institute of Weather - INMET.

## 4. Methods

### 4.1 Study Area

The catchment area was accomplished by the simple collection, through gutters, of the rainwater flowing into the slab of the study area of the Manaus Metropolitan Faculty of Manacapuru - FAMETRO. From the collection data, the rainwater reservoir was dimensioned in accordance with the survey of rainfall data from the city of Manacapuru - AM, considering the coverage areas of the horizontal plane surface building following the guidelines. NBR 10844/89 [13], for the calculation of the contribution area was 700 m<sup>2</sup> according to Figure 1, extracted through the Google Earth program (2019).



Figure 1: FAMETRO Study Area

Source: Google Earth Program Mosaic, 2019.

#### 4.1.2 Runoff coefficient



The amount of rain that can be used is not the same as the precipitation due to the losses to the roof material, but also infiltration and evaporation.

According to the INTRANET Rainwater Primer [14] prepared by FEAM - Minas Gerais State Environmental Foundation, the initial volume of water discharged depends on the size of the catchment area, and usually 1 to 2 mm of rainfall is adopted. for each square meter.

Runoff coefficient (C), also called surface runoff coefficient always varies according to the building material (slab), according to Table 1. However, the value to be adopted in this study was with coefficient  $C = 0.9$  [15].

Table 1: Runoff Coefficient

MATERIAL	RUNOFF COEFFICIENT
Ceramic tiles	0.8 to 0.9
Enameled tiles	0.9 to 0.95
Corrugated Metal Tiles	0.8 to 0.9
Asbestos cement	0.8 to 0.9
Plastic	0.9 to 0.95

Source: Adapted from [15].

#### 4.1.3 Rainwater Volume in the Fametro

The calculation of the volume of rainwater in Fametro that can be used was performed by equation 1, according to [15].

$V = P \times A \times C \times \text{Capture factor}$  Equation 1.

Being:

V = monthly volume of rainwater used;

P = monthly average precipitation (mm);

C = Runoff coefficient = 0.9;

$\eta$  uptake factor = water intake system efficiency 0.8; and

A = projecting roof area (m<sup>2</sup>).

#### 4.1.4 Flow in the rail design

To perform the chute flow calculations was following the guidelines of ABNT NBR 10844/89 [13] which is given by equation 2:

$$Q = I \times A / 60$$

Being:

Q = Peak flow (liters / min)

I = Rain intensity (mm / h)

A = Contribution area (m<sup>2</sup>)

#### 4.1.5 Reservoir Sizing

To calculate the reservoir sizing was followed the guidelines of ABNT NBR 15527/2007 [12]. Therefore, we adopted three methodologies for comparison, the Rippl method, the English practical method and the practical method of Professor Azevedo Neto.

#### 4.1.6 Ripp Method

The Rippl Method was used for monthly demand and historical series of monthly rainfall, this method aims to ensure constant water supply in both rainy and dry periods. As a basis for this method, table 2 was used.

Table 2: Rippl Method

RIPPL METHOD							
1	2	3	4	5	6	7	8
Month	Average Monthly Rain (mm)	Monthly Demand (m3)	Capture Area (m3)	Monthly Rainfall (m3)	Difference between demand and rainfall (m3)	Column 6 difference from positive values (m3)	OBS

Source: Adapted from [15].

Equations 3, 4 and 5 will be used.

$S(t) = D(t) - Q(t)$ ; Equation 3

$Q(t) = C \times \text{rainfall}(t) \times \text{catchment area}$ ; Equation 4

$V = \sum S(t)$ , only for values  $S(t) > 0$ ; Equation 5

Where:  $\sum D(t) < \sum Q(t)$

Where:

$S(t)$  = volume of water in the reservoir at time  $t$ ;

$Q(t)$  = usable rainfall volume at time  $t$ ;

$D(t)$  = demand or consumption at time  $t$ ;

$V$  = reservoir volume in cubic meters; and

$C$  = surface runoff coefficient.

#### 4.1.7 English Practical Method

For the design of the rainwater reservoir by the English Practical method, according to NBR 15527 [12], Equation 6 was used.

$$V = 0.05 \times P \times A \text{ Equation 6}$$

Where:

$P$  = Average annual rainfall, in millimeters;

$A$  = Collection area, in square meters;

V = Volume of usable water and volume of water of the tank in liters.

#### **4.1.8 Practical Method of Professor Azevedo Neto**

For the method of Prof. Azevedo Neto from the rainwater reservoir, Equation 7 was used.

$$V = [(P / 2) / 12] \times A \times T \text{ Equation 7}$$

Where:

P = average annual precipitation in millimeters;

T = number of months of little rain or drought;

A = collection area, in square meters;

V = usable water volume and the reservoir water volume in liters.

### **5. Diagnosis of rainwater use at Manaus Metropolitan College - Fametro**

To estimate the demand for non-potable water at FAMETRO, the use of the system by 350 students, 6 staff and 9 teachers according to the Faculty Secretariat - FAMETRO, with 1.5 uses per capita per day of discharge into the basin was considered, for the consumption of 20 working days.

Table 3: Parameters for estimating water demand for the study site.

INTERN USE	UNITS	PARAMETERS	
Discharge in the basin	Descar / person / day	Lower	Upper
		4	6
Discharge Volume	Liters / discharge	6,8	18

Source: Adapted from [15].

#### **5.1 Diagnosis of non-potable water use**

The calculation was performed through the consumption of non-drinking water following the methodology of [15] by equation 8.

$$(0.03 \times \text{built area}) + (0.07 \text{ employee No.}) + (0.8 \text{ No. Basins}) + 50$$

#### **5.2 Average volume spent on toilets**

The most economical sanitary basin in Brazil is 6 L / flush, but as we can have leakage of around 30%, therefore the rate of 9.0 L / flush will be used. As TOMAZ [15]. The average monthly volume spent on toilets was estimated by equation 9:

$$\text{VMM} = (\text{Employees}) \times (9 \text{ L / discharge / day}) \times (5 \text{ times / day}) \times 20 \text{ days} / 1000$$

## **6. Results and Discussion**

### 6.1 Rainfall data and rainfall in the Fametro.

In Table 4 we can see that the year of 2013 had the highest rainfall intensity with 2,454.60 mm, so the month of October to May was the most precipitation.

Table 4: Average monthly rainfall from 2008 to 2017 - Manacapuru-AM.

Average monthly rainfall from 2008 to 2017 from Manacapuru-AM													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Sum
2008				448,4	292,4	135,8	0	56,4	64,6	192,4	262,8	166,2	1619
2009	24,6	14,4	16	0,8	0,8	0,2	0	0,6	89	81,2	38	152,8	418,4
2010	13,6	2	1,4	1,8	1	0,2	0	3,8	92,2	84,8	212	224,4	637,2
2011	236,4	247,8	327,4	412,4	186,2	129,8	47	48,2	35,4	0	130	308,6	2136,2
2012	546,8	211,6	280,6	370	114,2	47,8	94,6	30,8	55,8	37	180,6	269,2	2239
2013	266,4	264,6	319,6	199	194,4	44	193,2	82,6	42,4	233	424,8	190,6	2454,6
2014	319,8	193,4	570,8	298,6	342,6	133	0	71,8	52,4	71,8	196,4	47,2	2297,8
2015	471,2	128	482	211	230,6	115,8	124	33,8	46,6	37	146	178,8	2204,8
2016	162,2	224	273,8	268,2	189,4	84	52,6	83,6	96,2	139	210,8	521,4	2305,2
2017	353,4	433,4	301	226,8	0	0	31,4	68,4	141,8	145	201	337,8	2240

Source: Adapted from INMET, 2018

We can observe an irregular distribution of rain in the city Manacapuru-AM, with rainfall rates greater than 200 mm from November to April. So, then the driest months in turn are from June to October.

The rainwater volume calculation of the Fametro catchment area is 700 m<sup>2</sup>, with the monthly rainfall of November 2013 of 424.80 mm, using in Equation 1 the volume of rainwater that can be harnessed is 214.099 liters. The gutter design flow then results in 4,956 L / m

### 6.2 Diagnosis of non-potable water use at Manaus Metropolitan College - Fametro.

Non-potable water consumption at Manaus Metropolitan College Manacapuru - Fametro unit was calculated by Equation 8, with a per capita demand per day of 99.75 liters / day or 0.0997 m<sup>3</sup> / day.

### 6.3 Average volume spent in toilets

With the total of 365 people who flush toilets at Fametro Manacapuru - AM unit was calculated by Equation 9, thus water consumption in the toilets for 20 school days of the month is 328.5 m<sup>3</sup> / month.

### 6.4 Reservoir Sizing by the Rippl Method

The reservoir sizing by the Rippl method is shown in Table 5, the maximum reservoir volume was defined by analyzing the behavior of column 7, with the peak value (highest value) being 2395m<sup>3</sup>. So, when the values in column 6 are positive, the reservoir water level is falling and this is happening throughout 2013. Thus, the reservoir volume of 3000m<sup>3</sup>, corresponding to a supply of 69 days of supply, was adopted. dry (3 months). It stands out the Rippl method provides high values for the reservoirs.

Table 5: Reservoir Sizing by the Rippl Method

Runoff coefficient (CR) =		0,9					
Months	Average Monthly Rain	Monthly Demand	Catchment area	Monthly Rainfall	Difference between demand volume and rainfall volume	Cumulative difference from column 6 of positive values	Reservoir situation
	(mm)	(m <sup>3</sup> )	(m <sup>3</sup> )	(m <sup>3</sup> )	(m <sup>3</sup> )	(m <sup>3</sup> )	
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
January	266,4	328,5	700	168	160,5	160,5	D
February	254,6	328,5	700	167	161,5	322	D
March	319,6	328,5	700	201	127,5	449,5	D
April	199	328,5	700	125	203,5	653	D
May	194,4	328,5	700	122	206,5	859,5	D
June	44	328,5	700	28	300,5	1160	D
July	193,2	328,5	700	122	206,5	1366,5	D
August	82,6	328,5	700	52	276,5	1643	D
September	42,4	328,5	700	27	301,5	1944,5	D
October	233	328,5	700	147	181,5	2126	D
November	424,8	328,5	700	268	60,5	2186,5	D
December	190,6	328,5	700	120	208,5	2395	D
Total	2444,6	3942		1547	Volume =	2395	

### 6.5 Practical Method English

By the English Practical Method, the reservoir water volume is 14,868 liters or 14.86m<sup>3</sup>. It is noted that the English Practical Method provides Average Volume values.

### 6.6 Reservoir Sizing by Professor Azevedo Neto's Practical Method

By the Azevedo Neto Method, the reservoir water volume is 37,170 liters or 37,17m<sup>3</sup>. It is shown the great importance of the variable (T) that represents the number of months with little rain in the city of Manacapuru -AM, which in the present study is 3 months, so randomly adopted values may result in reservoirs larger than ideal size.

## 7. Final Considerations

The implementation of rainwater harvesting systems is an incentive for the population. Today this system is a matter of great importance for water resources management. With these systems of water use in public or private universities and colleges, in addition to reducing environmental impacts, is of great importance in environmental education and sustainability. Therefore, this work was important to contribute to this discussion. It should be noted that rainwater systems may have a positive impact not only at the University and College, but also for the municipality of Manacapuru - AM.

The reservoir sizing for the use of rainwater at the Manacapuru Metropolitan Faculty of Manacapuru - International Educative Research Foundation and Publisher © 2019

UEA, by the methods provided by the NBR 15527/2007 guidelines were satisfactory. With ten-year rainfall data from 04/2008 to 12/2017, in the municipality of Manacapuru, the volume found for the reservoir to meet the analyzed rainwater demand was 37,170 m<sup>3</sup>, with a supply that will be approximately 80 % of non-potable water consumption at Manaus Metropolitan College Manacapuru unit.

Thus, given all the information presented, it is correct to reaffirm that this system of water use is very important, as it is possible to reduce the use of drinking water as well as the expenses, not to mention the reduction of floods, flooding, future rationing. water, and still help the environment with that.

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## **Waste Reuse in a food establishment for the production of organic fertilizer in Manaus - Amazonas**

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### **Abstract**

*Organic waste has been a threat to society and the environment, both by the amount generated and the inadequate treatment. Seeking solutions to these wastes, composting becomes an efficient process through accelerated biodegradation. The present study aimed to analyze the reuse of organic waste generated in a food establishment in Manaus-AM. The quantitative methodology presented two steps, weighing for three (3) weeks daily, (i) the waste generated in the kitchen and (ii) discarded by consumers, in addition to the total compost generated by the compost, as a basis for treatment of this material, as way of minimizing the amount of these wastes, analyzing the productive activities of this establishment. Given the results obtained it was observed a disposal of almost 30 kg / week, which if estimated, can reach a value of 0.5 tons / year, for each type of disposal evaluated, totaling a value that can reach 1 ton of organic waste disposed of by this small food establishment. Analyzing the composting process, the data show that there is a reduction in the amount of materials generated, due to their transformation into organic fertilizer, obtaining 50% of the total value produced from the waste, thus indicating a solution to the problems arising from the incorrect disposal of waste. organic matter, which is close to 54% of this waste generated in Brazil. In addition, currently about 1.3 billion tons of food is wasted and there are on average about 815 million hungry people in the world, proving to be an alternative of economic, social and ecological viability.*

**Keywords:** Organic waste, Composting, Organic fertilizer;



## 1. Introduction

In today's society it is observed that consumption goes beyond the search for comfort and well-being, inciting people to consumerism, a society that values personal recognition and the degree of success, since the population is increasingly using products and services, given by the acquisition of goods. The problem is that the more we consume the more garbage is generated and thus the more natural resources are used to satisfy these boundless processes. Even knowing that this excess waste produced causes serious damage to the environment, there is still no control and no proper model to follow.

Changes in consumption habits combined with individual responsibility result in sustainable development, which aims to find molds that meet current needs without compromising future generations. Making use of natural resources without depleting it, knowing that the quality of life of the future generation depends on environmental awareness, has become a premise for the maintenance of quality of life and resources, presenting measures such as recycling, reuse of waste, new technologies from renewable resources, among other steps necessary for sustainability.

In the city of Manaus - AM, the waste has been a great challenge, from the aesthetic and environmental side. They are usually found in public areas, especially in fairgrounds, serving as a source of food for rats and insects, or causing harm to human health. These materials are collected by municipal waste collection and disposed of in the municipal mixed landfill, causing even more environmental problems, since many of these wastes could be reused because they are sources of raw material in the production of organic compounds [1].

Solid wastes are materials, substances, objects or goods disposed of as a result of human activities in society, whose final destination is mandatory and should seek technical or economically viable solutions, given the best technology.

In the case of organic waste, we can characterize it as food waste: vegetables, fruits, eggshells; and other products: paper, wood, seeds, among others, which are usually generated at fairs, homes and restaurants. These residues can be reused in some ways, such as composting, making nutrients available to plants in higher concentrations and assisting in microbiological composition, along with energy production, in which the decomposing biogas generates the gas. methane, renewable source [2].

Waste has therefore been a major problem in today's society with population growth, contributing significantly to increased waste generation under different conditions. Even with all the legislation that tries to combat environmental pollution, there are still few actions linked to this theme and application of awareness and awareness through environmental education, aiming to be an attenuating in this process.

Thus, this study aims to analyze the reuse of organic waste generated in a food establishment in Manaus-AM, making the quantification of waste generated, dividing into kitchen materials and waste consumed by customers, thus comparing the amount of waste material produced by the establishment through the production of compost purchased through the composting process.

## 2. Material and Method

### 2.1 Type of Study

The types of methods used in the research were descriptive and exploratory. Descriptive research studies, analyzes the facts and exploratory research aims at discovery, the confirmation of phenomena [3]. This work is characterized by qualitative methods, relating the objective to the results, and the descriptive as well as quantitative collected data promoting reliable results through data collection [4].

### **2.1 Area of Study**

The study was conducted in a food establishment located in the city of Manaus / AM, which initially did not apply any type of solid waste destination, and most of these generated wastes is organic. The property serves its customers five days a week, from Tuesday to Saturday, lunch only.

### **2.3 Data Collection**

Organic waste samples were counted for three weeks from April 2 to 20, 2019, divided into kitchen materials and customer waste. The method used for the waste reuse process was composting, a practical, agile and effective method used today, with many benefits, such as the reduction of material disposed in landfills.

### **2.4 Collection Instruments**

The composting process took place by means of a compost made from 15 kg plastic buckets, stacked one under the other, one at the base to receive the slurry liquid generated during the process. The base bucket was drilled only the lid, to allow the liquid to enter, the others above, the sides were drilled in the upper part as well as the lids and bottoms, thus allowing the air to enter the inside of the buckets, in we used a one millimeter drill to drill these holes.

### **2.5 Segregation of Organic Waste**

For the segregation of waste, some measures were adopted: a) identification of waste types; b) Weighing the waste.

#### **a) Description of waste types**

According to [5] one of the types of waste is organic, those that have animal or vegetable origin, being the type that was analyzed in this study.

In this context, the organic waste was divided into: a) cooking materials characterized by potato peels, carrots, onions, garlic, bananas, pineapples, coffee grounds, kale, lettuce, cabbage, tomatoes, eggshells, seeds and b) leftovers consumed by customers leftover meat, chicken, pepperoni, boiled rice, pasta, beans, seasoned salads, crumbs, paper napkins (not used for paper recycling).

#### **b) Waste weighing**

During the waste weighing process, the PPE were used: gloves, goggles and apron; and the 40kg Premier Digital Scale, then minced and introduced daily into the compost. From this initial process was interspersed with dried leaves, for verification and evaluation of composting, this evaluation lasted three (3) weeks.

Each weighing, performed every day of the restaurant activity, being five days a week, totaled 15 measurements, making the data and subsequent tabulation via Microsoft Excel.

During the activity, after the introduction of the residues in the compost, and during these three weeks, the monitoring began that did not present a bad smell, and every once a week the need for overturning was observed and if there was the presence of insects and other vectors that might cause some alteration of the result.

### 3. Results and Discussion

Population growth in just 25 years has grown by two billion, and with it the increase in the amount of natural resources for both production and consumption, resulting in large amounts of discarded waste, directly related to environmental degradation.

Thus, most of the time, organic waste is incorrectly disposed of in landfills, representing a threat to both society and the environment, which can cause imbalance to the population's health. Thus, it was observed a disposal of almost 30 kg / week, which is estimated, reaches a value of 0.5 tons / year for each of the measured materials, totaling about one (1) ton of organic waste disposed through this small food establishment (Figure 1).

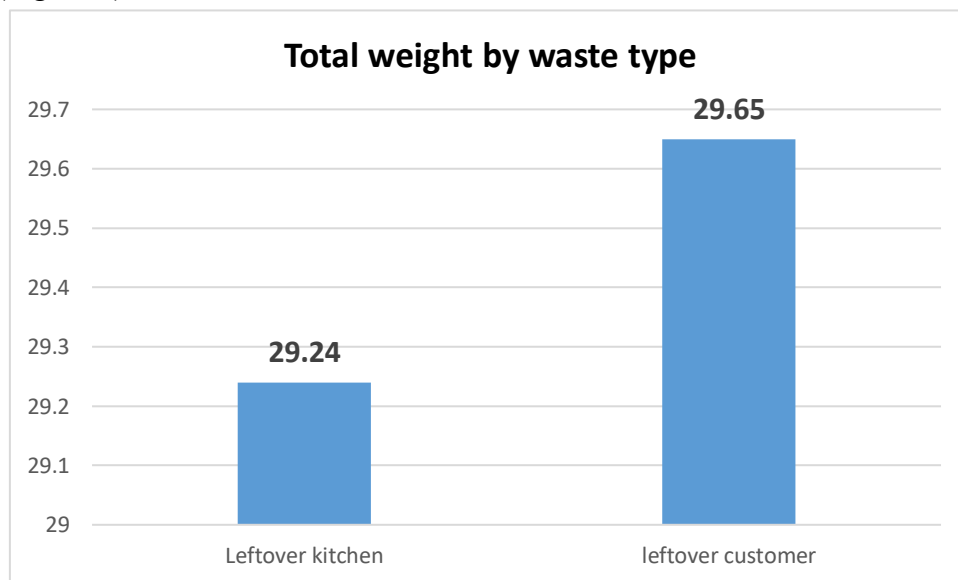


Figure 1. Total weight by type of waste in the three weeks of collection.

A family of approximately four people generates, on average / day, 2 (two) to 7 (seven) kg of organic waste, a value slightly higher than that found in this study. Thus, it is important to understand the proper treatment and disposal process, as they are often mixed with other waste and disposed of without any treatment [6]. In Brazil the amount of food thrown in the trash daily could feed an average of 10 million people, showing that urgent measures need to be taken [7].

Table 1 shows the average values of the 15 days of collection (3 weeks), separated from each type of waste generated in the establishment, both kitchen waste and customer waste.

Table 1. Quantity of waste measured in the restaurant for composting, along with their respective statistical measures.

Measures	Kitchen Leftovers (kg)	Customer remains (kg)
----------	------------------------	-----------------------

Average / day	1,949	1,977
Standard Deviation (s)	0,396	0,902
CI (95%)	0,200	0,456
LI	1,140	0,530
LS	2,600	4,080
AMP	1,460	3,550

Caption: CI (95%): 95% confidence interval; LI: Lower Limit; LS: Upper Limit; AMP: Amplitude.

[8] states that restaurant waste can negatively impact the environment, both due to the amount generated and the inadequate treatment, with a higher organic percentage.

Currently there are several measures linked to environmental education that is supported by the Ministry of Environment, among them the proposal of 3R's: reduction, reuse and recycling that are important actions for the environment.

Reducing the source as well as reducing energy use, and the amount of raw materials become more rigorous in choosing the material applied for manufacturing, where reusing or reusing waste becomes an idea of product valorization and gain. In addition, the recycling process, where new products will be produced from the material purchased on the market, demonstrates environmental responsibility [9].

Citizens play a key role in solving environmental problems. As much as public policy creates incentives and mitigating measures, society needs to be engaged as a whole, being aware of reuse or reuse where disposal should be the last option as long as efficient recycling is available [10].

Figure 2 shows the values from the percentage of residues generated in the food establishment, after being transformed into compost produced compost for each evaluation week.

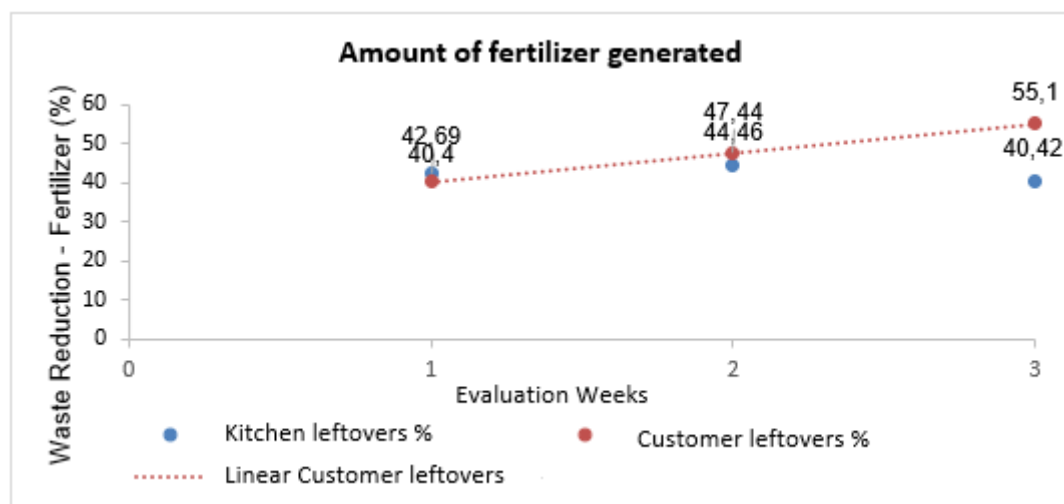


Figure 2. Amount of fertilizer generated (%) from material deposited on compost.

Through the obtained data it is observed that there is reduction of the quantity of materials. However, the organic fertilizer reaches 50% of the total value produced from the waste.

In search of more favorable solutions for the use of natural resources, accelerated biodegradation technology has been a waste management model, aiming at reducing environmental impacts [10].

The composting process occurs with the decomposition and biological stabilization of organic substrates through the action of different microorganisms. It can be a fundamental element in solving this problem,

thus bringing benefits by reducing the release of waste into landfills, as well as promoting the treatment of the organic fraction with the final production of a fertilizer compound [11].

Currently about 1.3 billion tons of food is no longer consumed per year, due to waste, and is worrying when data show that there are some 815 million hungry people in the world, showing that hunger is far from being deleted [12].

#### 4. Conclusion

Waste is still one of the main environmental problems today, especially when it comes to generation (increased consumption), disposal (incorrect) and treatment (few actions).

The total waste generated in the 3 (three) weeks of evaluation in a small food company was 58.89 kg, with little difference (less than 1%) with what is generated in the production of food and its disposal, presenting an average of 2 (two) kg of organic waste / material.

Alternatively, there is compost generation via compost ranging from 40 - 50% of the total material deposited per week. Extrapolating this value to 1 (one) year, can reach 1 ton if we consider kitchen waste and leftovers.

Thus, finding alternative ways, it is mandatory to reduce the amount of waste disposed and optimize use, given the number of people at risk of hunger, caused by the lack of food in the world.

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# **The Socioeconomic Impact of Paralyzed Public Works: Analysis on the University City of the State of Amazonas**

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## **Abstract**

*The presente research refers to the analysis of the socioeconomic impacts caused by the stoppage of the University City of the State University of Amazonas in the Community Our Lady of Nazareth Lake Test with the objective of investigating the consequences of not observing the principle of efficiency in execution of the work of the University City by its managers, verifying the current socioeconomic situation of this local population, and finally propose ways to mitigate problems and losses resulting from the stoppage, which is a matter of common interest as it covers all social classes. The research approach is quantitative because it intends to describe a phenomenon of a particular group or Society, its research instrument was the interview. To be efficient during the execution of a work, it is necessary to have management during the process, so the Executive Branch has instituted laws for the public Works to be managed efficiently, namely: the Growth Acceleration Program (PAC), instituted by the Decree n°*

6.025/2007; the Differential Contracting Regime (RDC), launched by Law nº 12.462/2011; and the Bidding Law, introduced by Law nº 8.666/1993. These measures sought to reduce delays and stoppages in public Works and the social and economic impacts that might be generated.

**Keywords:** Socioeconomic impacts, Public Works, Principle of efficiency;

## 1. Introduction

Public administration has had problems caused by paralyzed works for years, so it is a recurring theme of interest to society. Several efforts have been made to mitigate the adversities arising from work stoppages, as the inherent losses are difficult to measure. The difficulty of public agencies and federative entities in efficiently completing a work, whether small, medium or large in complexity, is explicit.

According to [1] the public works sector has always been prominent and many investments made by the Public Administration, considering the material and social importance that the completed project brings to the community. The money invested in what has already been executed and in the maintenance of the paralyzed work causes damage to public coffers. In addition to depriving the population of the benefits that the venture would generate, causing social and economic impacts.

To understand the problems arising from the mismanagement of public resources that should be allocated to the infrastructure, it is necessary to analyze each case separately, considering the particularity of each standstill.

The stoppage of the University City was a decision that significantly damaged the population of the communities that were in the area where the venture would be implemented. The Nossa Senhora de Nazaré community of Lago do Teste was the one that suffered the most socioeconomic impacts of this stoppage, due to the fact that a large part of the local properties were expropriated.

Construction management comes as a tool to achieve efficiency in the provision of public services, aiming at the collective interest. With this there is the optimization of resources, increased productivity, all to ensure the delivery of the project on time, and within budget. Proper management is able to identify problems and spot solutions in advance.

Deficiencies in the planning and management phase of public works can result in serious consequences for the project, where negligence in one phase can lead to delays and increased costs, leading to uncertainty regarding the success of the work [2].

## 2. Theoretical Reference

### 2.1 Public works management as a tool against administrative leniency

The delivery of a public enterprise depends on several steps, started even before the bidding process so that you can be assured of the success of the projected work. Thus the management of the work enables an orderly execution of the steps resulting in obtaining secure information that is useful to have lower risks to the Public Administration.

According to [3] in order to carry out a work, prior studies must be done to verify the technical and financial viability of the project, as well as the source of funds and the deadlines for the execution of the



project.

## 2.2 Efficiency Principle

The principle of efficiency came to combat managers' neglect of public funds, so Constitutional Amendment 19/1998 modified Article 37 of the 1988 Federal Constitution, including efficiency as an expressed principle, along with legality, impersonality, morality and advertising. According to [4] this “modifies the regime and provides for principles and rules of public administration”.

According to [5], it also established permanent mechanisms for performance and results evaluation of civil servants and public agencies, with the aim of improving the quality of public services.

The principle of efficiency, for [6], has two aspects: the first is related to the performance of the public agent, from which the search for superior results is expected; and the second is related to the way of structuring and disciplining the Public Administration, aiming to provide better and better quality public services.

Thus, it needs to be considered in a comprehensive sense, that is, it must be present both in the services provided and in all acts performed by the Public Administration servers. Thus, the control of public money, especially in the construction sector, was strengthened, as administrators were required to apply management tools in order to optimize available resources, so that services could be performed promptly, quality, on a regular basis, economically and within the legal and moral norms.

## 3. Methodology

This research aims to analyze the socioeconomic impact caused by the stoppage of the work of the University City in the community of Our Lady of Nazareth Lake Test. Research being characterized as a case study, which according to [7] is appropriate to investigate new concepts and to examine how the components of a theory are employed in practice.

In this research we used the quantitative approach, which is directly linked to the measurement and control of data. According to [8], it is a research modality that operates on a human or social problem, based on variables quantified in numbers, which will eventually be analyzed statistically.

To analyze the problem, the interview was applied as a research instrument. 10 questions were prepared for each interviewee in the Nossa Senhora de Nazaré community of Lago do Teste. With this technique it is possible to make an analysis through the data obtained from the subjects involved in the research, with the acquired answers could be made a survey of the socioeconomic impact of the work stoppage of the University City in this community, were interviewed 364 residents. The questionnaire is presented in Table 1.

Table 1: Interview Questionnaire

INTERVIEW QUESTIONNAIRE	
1. Level of education:	
<input type="checkbox"/>	Child education
<input type="checkbox"/>	Complete primary education
<input type="checkbox"/>	Elementary school incomplete
<input type="checkbox"/>	Complete high school
<input type="checkbox"/>	Incomplete high school

<input type="checkbox"/> Higher Education
<input type="checkbox"/> Incomplete higher education
2. Does the family benefit from any social program?
<input type="checkbox"/> Yes <input type="checkbox"/> No
3. How old are you?
4. What's your profession?
5. What is your household income?
<input type="checkbox"/> Up to 1 minimum wage
<input type="checkbox"/> 1 to 2 minimum wages
<input type="checkbox"/> over 3 minimum wages
6. Did you suffer expropriation because of the University City?
<input type="checkbox"/> Yes → <i>received compensation</i> ? <input type="checkbox"/> Yes; <input type="checkbox"/> No
<input type="checkbox"/> No
7. Did the construction of the university town hurt your family income?
<input type="checkbox"/> Yes <input type="checkbox"/> No
8. Mark the negative social impacts suffered due to the work stoppage of the University City:
<input type="checkbox"/> Difficulty accessing public transportation
<input type="checkbox"/> Difficulty of access to education
<input type="checkbox"/> Difficulty of access to health
<input type="checkbox"/> Increased crime
9. In your opinion, was the construction of the University City a good investment of public money?
<input type="checkbox"/> Yes <input type="checkbox"/> No
10. Gostaria que as obras da Cidade Universitária fossem retomadas?
<input type="checkbox"/> Yes <input type="checkbox"/> No

Source: Own Authorship (2019)

The planning and execution of a scientific research must be part of a systematized process, so the research was divided into phases as presented in Table 2.

Table 2: Research Phasing

<b>Phase 1</b>	<b>Survey of bibliographic data; Research of the University City project for analysis; Preparation of the interview;</b>
<b>Phase 2</b>	Interview with the residents of the Nossa Senhora de Nazaré community of Lago do Teste;
<b>Phase 3</b>	Union of all materials collected, interviews and official documents of the work;
<b>Phase 4</b>	Analyze, argue and interpret the data collected during the research in order to reach the conclusion of the problem;

Source: Own Authorship (2019)

## 4. Results and Discussion

### 4.1 Current situation of the population affected by the works of the University City, in Iranduba.

Our Lady of Nazareth Lake Test Community had much of its area expropriated because of the

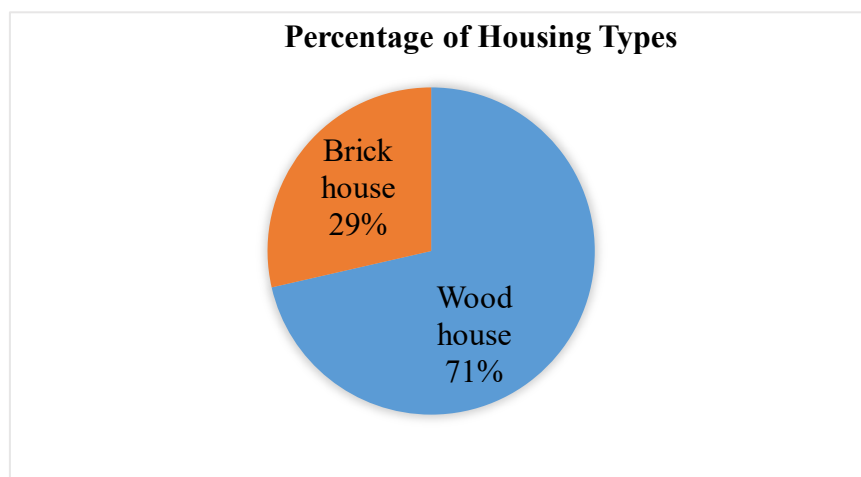
construction of the University City, so residents were removed from their homes and founded a new community located at a branch of the road that leads to the Campus da UEA, which received the name of New Test Community Bela Vista Community in honor of the previously inhabited place. For the founding of this new community, in 2013, 48 families were joined, who with the help of indemnities re-raised their homes.

The new area in which the community is located was purchased in 2012 at the initiative of the residents, who divided the site into 81 lots, which measures 20 meters wide by 50 meters long each, sold for R \$ 4,000, currently these lots. were subdivided to meet the needs of families. The total area of the community is 120,000 square meters.

The expropriation was a painful process for the community, as there was no adequate project for the removal of residents from the site that was affected by the construction of the University Campus. For the construction of the new community the residents did not have the support of the government nor for the construction of basic health, education or urban infrastructure units.

The public administration only after six months of negotiations paid compensation that was stipulated by an agreement between the residents and the state government brokered by the state prosecutor. The indemnities amounted to R \$ 50,000 passed on to 48 families and R \$ 70,000 passed on to 18 families. However, there were 31 families who had their land expropriated and received no compensation for not having documents proving ownership of the land.

The community was divided into 8 streets, namely: Marias Street, Eva Street, Francisco Elaine Street, Graça Feitosa Street, Itysu Street, Mariana Street, Teresinha Street, São João Street and a main avenue called José Lima. Containing a total of 91 families, 65 wooden houses and 26 brick houses.



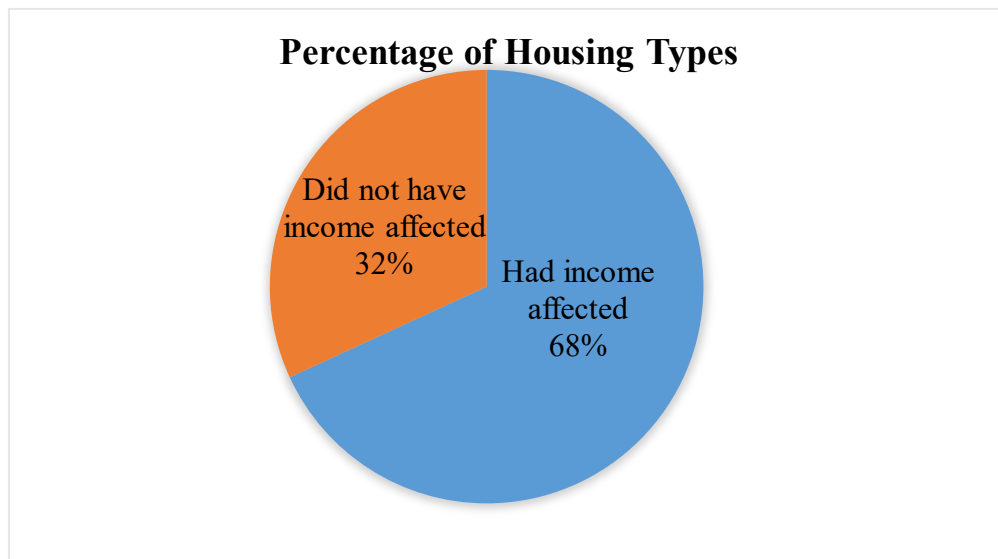
Graph 1: Percentage of housing types

Source: Own Author

#### ***4.2 Socioeconomic impacts suffered by the Lago do Teste community caused by the work stoppage of Cidade Universitária - UEA / Iranduba.***

Due to the fact that the residents of the Lago do Teste community were moved to a location farther from the river, there was a loss of family income for most of the interviewees, as shown in Graph 2, 68% of the

residents were farmers and depended directly on the water in the area. river to grow crops and to raise small animals such as poultry and pigs. Without the old income and the benefits that the University City would bring to this community, there was damage to the incomes of many families.



Graph 2: Percentage of residents who had their family income damaged due to the expropriation of their lands and the subsequent stoppage of the work.

Source: Own Author

As shown in Graph 3, all respondents pointed out the difficulty of access to public transport, since the community is not served by this service, so the only way out of the community is by own transportation or requesting transportation. private. The only means of transport provided by the public service is the movement of students with the aid of a school bus.

With regard to access to education, the community has a school that caters for students in kindergarten, elementary school, high school, high school technology, and the EJA (Youth and Adult Education) who live in the community and at Residential Maria Zeneide, totaling 260 students. There are 14 teachers and 12 assistants working in this teaching center.

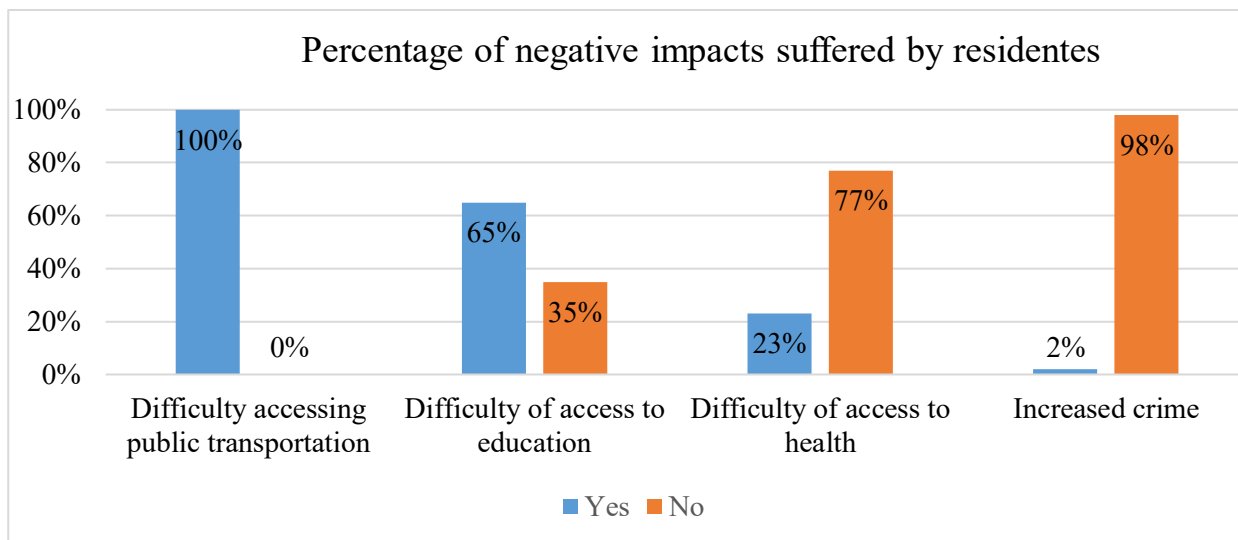
The headquarters of the only community school was installed at the community leader's house in 2013, as the public administration did not provide a suitable headquarters. Thus, currently the municipality of Iranduba passes the amount of rent to the owner so that school activities are carried out on site. The school has 7 classrooms, but not all benefit from central air-conditioning. As shown in Graph 3, 35% of respondents reported not suffering from access to education because, despite being a makeshift school, there was the benefit for many families living in the community that was formed.

In the community it is necessary to make a sewage treatment plant, install an accessibility system at school and design a leisure space for students, in addition to the finishes that the building did not receive. Today students have only one makeshift table to use during breaks to play table tennis, which is the only leisure activity.

Regarding access to health, despite the difficulties and the community does not have a Basic Health Unit (UBS), currently, the care that residents receive is considered better, because before the expropriation the

community had a UBS, but not If there were doctors in the new locality, doctors go once a month to provide various types of care that are performed at the school headquarters. Thus, 77% of respondents reported not having difficulty accessing health.

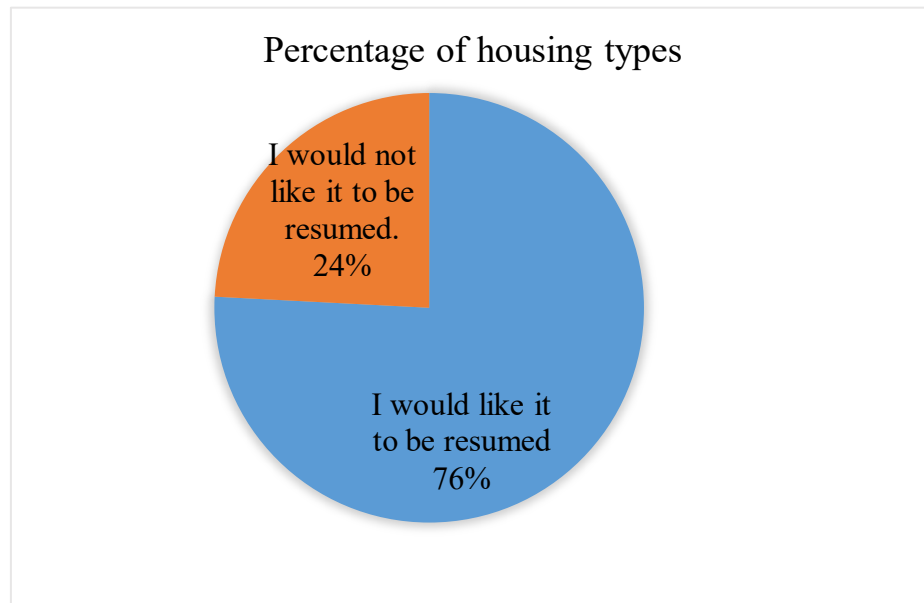
Regarding the crime rate, shortly after the stoppage of the University City work, residents had complaints about the spawning of bodies in the region, because it is an isolated and distant place, however, nowadays, these complaints have decreased. 98% of respondents reported that crime in the area is low.



Graph 3: Percentage of negative impacts suffered by residents

Source: Own Author

All respondents stated that they considered that the construction of the University City was not a good investment of public money. As soon as the project was presented to residents, the hope of a promising future arose, but after the work came to a halt this hope was dashed, and investments could not return to the population. However, as Figure 3 shows, most believe that the resumption of the work would benefit the community in some way, and that perhaps the population could in the future enjoy this public good.



Graph 4: Percentage of respondents who would or would not like the University City works to be resumed.

Source: Own Authorship (2019)

#### ***4.3 Provisions to optimize public works management***

The Executive Branch has adopted effective ways to improve management in public works. There are innovative measures, namely: the Growth Acceleration Program (PAC), instituted by Decree nº 6.025 of January 2007; the Differential Public Procurement Regime (RDC) launched by Law nº. 12.462 / 2011; and the Public Procurement and Procurement Law, introduced by Law nº 8.666 of June 21, 1993.

The Growth Acceleration Program (PAC) was instituted by Decree nº 6.025, on January 22, 2007, having as one of its objectives to optimize the way public expenditure is managed. PAC has become one of the main forms of encouraging economic development and improving the quality of life of the Brazilian population. Thus, it was conceived in order to establish the accelerated and sustainable development of the country, encouraging the resumption of major infrastructure works, aiming at social progress.

Decree nº 6.025 establishes five axes of measures: investment in infrastructure; institutional and economic measures to encourage credit and financing; tax administration; more attractive investment environment; long-term fiscal measures [9].

Another innovative measure that aims to improve management in public works was the Differentiated Public Procurement Regime established by Law nº 12.462, of August 4, 2011. According to Brazil (2011) [10], in art. 1 of Law nº 12.462 / 2011 the Differential Public Procurement Scheme (DRC) would apply exclusively to the bids and contracts required to undertake the undertakings for the 2016 Olympic and Paralympic Games, the 2013 FIFA Confederations Cup and the FIFA World Cup 2014, in addition to infrastructure works and hiring of services for airports in the distant capitals up to 350 km from the 2014 World Cup host cities, being restricted, in the case of public works included in the matrix of responsibility celebrated between the Union, the States, the Federal District and the Municipalities.

However, approximately one year after its publication, the Law dealing with the DRC has undergone substantial changes in its scope, as it now encompasses "the actions that are part of the Growth

Acceleration Program (PAC)” [11], “the bids and contracts required to carry out engineering works and services within the public education systems” [12], as well as “engineering works and services within the Single Education System”. Health-SUS [13]. Thus, “the RDC has, at least normatively, the nature of perennial bidding rules” [14].

Law nº 8.666 / 1993 is also a measure to improve management in public works, with the purpose of repressing illegality at each stage of a work designed by the Public Administration, providing guarantees regarding delivery, quality and efficiency. of the project, stipulating for this the rules that must be followed by the administrative contracts pertinent to works, services (including advertising), purchase leases and disposals within the Union, the States, the Federal District and the Municipalities [15].

The public administration has the bidding as a formal administrative process in which it calls, through the requirements defined in the public notice, companies that are interested in submitting proposals to perform the rendering of services to the public agency [16].

The purpose of a bid is to find an advantageous proposal for the Public Administration, so that there is state development, always ensuring equal opportunities for interested parties and allowing participation during the event [17].

#### ***4.4 Compact Effluent Treatment Station (ECTEs) as an alternative to mitigate the socioeconomic impact that affects the Lago do Teste community.***

It is a complex matter to select the type of effluent treatment that is most appropriate for a region, because the lack of this service encompasses several problems. Thus, in locations devoid of an Effluent Treatment Station (ETE) designed by the Executive Power, the population is obliged to build individualized systems, such as tanks or septic tanks, which in many cases are inefficient in providing a quality final effluent for disposal in nature [18].

Compact Wastewater Treatment Plants (ECTEs) are presented as an alternative for the implementation of a system that serves small communities, such as the Novo Teste Bela Vista Community.

The main advantages of this system are: compactness (strength); low cost of construction, operation and maintenance; simplicity of operation beyond low construction cost; does not consume much energy; and finally, it has no significant negative impact on the environment in which it will be [19]. Figure 1 shows in a schematic way the steps of an ECTE.

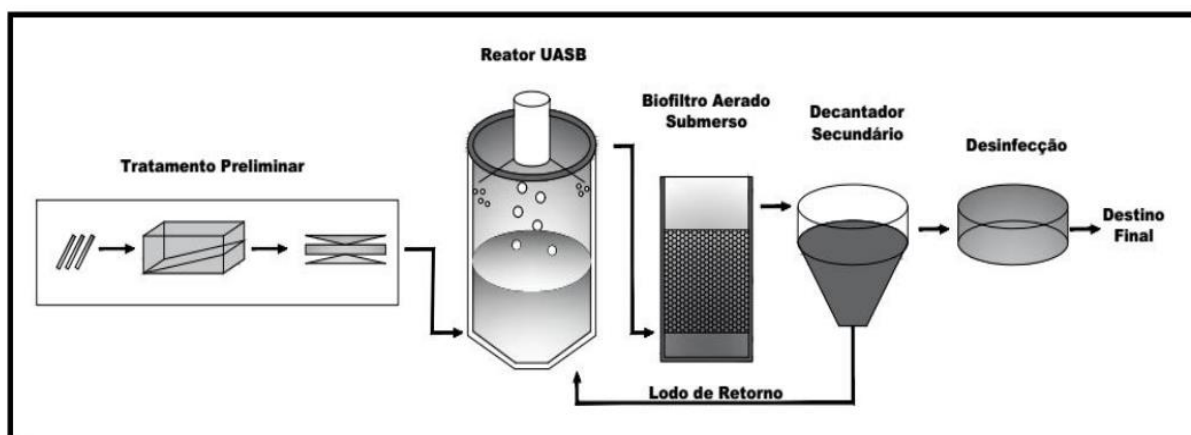


Figure 1: Graphic scheme of an ECTE

Source: [20]

In the initial phase there is a preliminary treatment, where the larger solids will be removed by grating and the sand that will be removed in the desarenator through the sedimentation of the grains. In the second phase, the removal of the organic matter that is smaller scale occurs by the UASB (Upflow Anaerobic Sludge Blanket) reactor and BAS (Submerged Aerated Biofilter). Then the effluent goes to the secondary decanter so that suspended solids that still remain in the liquid settle to the bottom [21].

The final process is disinfection to remove pathogenic organisms from the effluent. It can be done with the use of calcium hydroxide (hydrated lime) that raises the pH of the material and reduces odors and degrades part of the organic matter [22].

## 5. Final Considerations

The development of the present study allowed an analysis of the socioeconomic impacts caused by the work stoppage of the University City of Amazonas State University focusing on the Nossa Senhora de Nazaré Community of Lago do Teste, meeting the suggested objectives.

Much of their area was expropriated because of the construction, shortly after the strike, residents reported increased crime in the region, but these complaints diminished as police became more present. The need to install a sewage treatment plant that will serve the entire community, as well as the installation of an accessibility system and a leisure space for the students of the only school that serves the site, was investigated. There is also difficulty in accessing public transportation, as the community is not served by bus lines. Regarding health, the monthly care to residents has a good rating compared to what they had in the old community.

Compliance with legal standards such as the principle of efficiency, Decree No. 6,025 establishing the PAC, Law No. 12,462 / 2011 dealing with the DRC, and Law 8,666 / 1993 providing for public procurement and procurement, can prevent a work from being paralyzed.

Finally, it was observed that a Compact Effluent Treatment Station would be a way to mitigate one of the socioeconomic impacts that affect the residents of the Lago do Teste community.

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# **Quantification of CO<sub>2</sub> Emissions by Top-down Method of Manaus Public and Private Transport Fleet**

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## **Abstract**

*Air pollutants emitted by motor vehicles make a major contribution to air pollution in large urban centers, accounting for about 75% of emissions. The estimation of GHG emissions by the “Top-down” method used in the National Energy Balance - BEN, provides for the conversion of all fuel consumption measures to a common unit. Thus, the study aimed to guide the monitoring and monitoring of the concentrations of pollutant gases emitted by diesel combustion vehicles, comparing CO<sub>2</sub> emissions in 2018, in two public and private transport fleets in the city of Manaus. - AM Based on the application of the Top-Down methodology generating the data in the comparative table of public and private transport companies, it is evident that CO<sub>2</sub> emissions for both fleets present a high air pollution index suggesting the adaptation of the vehicle fleet. by adopting similar fuel with lower pollutant content. The data obtained in the study show that fuels with low emission factors should be used in urban public transport vehicles.*

**Keywords:** Pollutants; Diesel; Carbon dioxide.

## **1. Introduction**

Over time, due to the significant increase in the population living in urban areas, there has been a greater demand for transport and quantity of goods transported, sharply aggravating emissions of pollutant gases emitted by motor vehicles, changing the air characteristics (MANZOLI, 2009).

In view of the debate on global warming and climate change, it is necessary to analyze the causes and propose improvements to avoid the possibility of disastrous consequences for humanity in the future.

Air pollutants emitted by motor vehicles make a major contribution to air pollution in large urban centers, accounting for about 75% of emissions (INEA, 2009).

With regard to air quality, National Environmental Council Resolution (CONAMA) No. 3 of June 28, 1990, determines air quality standards and concentrations of air pollutants that, if exceeded, may affect the health, safety and well-being of the population, as well as causing damage to flora and fauna, materials and the environment in general (BRAZIL, 1990).

Vehicle sources produce emissions from the combustion of different types of fuel, including direct greenhouse gases (GHG) such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), as well as other pollutants such as carbon monoxide (CO), non-methane hydrocarbons (NMHC), sulfur oxides (SO<sub>x</sub>), particulate matter (MP) and nitrogen oxides (NO<sub>x</sub>) which cause or contribute to air pollution being indirect precursors of the greenhouse effect (IPCC, 2006).

In this sense, the Resolution 251/99 of the National Environment Council (CONAMA), concerned with global warming, establishes some criteria, procedures and maximum opacity limits for exhaust emission to assess the state and maintenance of motor vehicles, in national territory, to be used for the Inspection and Maintenance Programs of Vehicles in Use (MMA, 2014).

Inventory of air pollutant emissions is a strategic instrument for the management of the atmospheric resource and reflects the intensity with which different users use this common environmental resource. The inventory identifies the emitters of air pollutants, characterizing the pollutants emitted, the periodicity of the emission and their location. Both fixed and mobile sources, which need to be continuously inventoried in order to direct preventive or corrective measures that ensure the improvement and maintenance of air quality (LYRA, 2006).

To assess the effects on air quality according to an emission source, an emission inventory is required. Inventories catalog and quantify all necessary information about the relevant air pollutants. For this reason, they are essential for understanding local and global air quality (PARRISH, 2006).

Inventories are used as a subsidy for the application of mathematical models of atmospheric pollutant dispersion. They assist in the interpretation of data and provide information for the application of related impact mitigation policies and actions (BUTLER, 2007).

Specifically from vehicle emission inventories, answers are obtained on the amount of pollutants that have been emitted by motor vehicles and what is the contribution of each of the categories of vehicles evaluated (XIE; CAI, 2007).

The estimate of GHG emissions by the "Top-down" method recommended by the Ministry of Mines and Energy - MME, in 1999, in the National Energy Balance - BEN, provides for the conversion of all fuel consumption measures to a common unit.

As a result of the growth of the automobile sector, the amount of road vehicles on the city streets has polluted the air through the burning of fuels in their engines, and depending on the level of concentration, the environment cannot tolerate and dissipate this pollution.

## 2. Materials and Method

The adopted methodology will be based on the methods for the elaboration of vehicle emission inventories used by the Environmental Protection Agency (EPA) and the 1st National Inventory of Atmospheric Emissions by Road Motor Vehicles (BRASIL, 2011).

In the first stage, the number of vehicles circulating by both public and private fleets was surveyed, as well as the monthly and annual consumption respectively, with the calculation of the emission rate according to the year of consumption. These data were obtained from companies under the confidentiality of names.

Estimated rates of CO<sub>2</sub> GHG emissions will be calculated by the top-down method using the following equations:

$$CC = AC \times F_{conv} \times 45.2 \times 10^{-3} \times F_{corr} \text{ (Eq. 1)}$$

Where:

tEP (Brazil) =  $45.2 \times 10^{-3}$  TJ (tera-joule =  $10^{12}$  J);

CC = energy consumption in TJ;

AC = fuel consumption (m<sup>3</sup>, l, kg);

F<sub>conv</sub> = conversion factor of the physical unit of measurement of the amount of fuel to tEP based on the fuel's higher calorific value (PCS) (values may vary from year to year according to the annual BEN publication. 2000 of the F<sub>conv</sub> are: gasoline (0.771 tEP / m<sup>3</sup>), anhydrous alcohol (0.520 tEP / m<sup>3</sup>), hydrated alcohol (0.496 tEP / m<sup>3</sup>), diesel (0.848 tEP / m<sup>3</sup>), dry natural gas (0.857 tEP / 103m<sup>3</sup>);

F<sub>corr</sub> = PCS correction factor for PCI (lower calorific value), where in BEN the energy content is based on PCS, but for the IPCC, the conversion to common energy unit is given by multiplying the consumption of PCI. For solid and liquid fuels o F<sub>corr</sub> = 0.95 and gaseous fuels o F<sub>corr</sub> = 0.90 (MCT).

To assess the carbon emitted from fuel combustion, equation 1 will give rise to equation 2, which requires energy consumption to be estimated.

$$EC = CC \times F_{emiss} \times 10^{-3} \text{ (Eq. 2)}$$

Where:

EC = Carbon Content expressed in Giga gram of Carbon (1 GgC = 1,000 tons of Carbon);

CC = energy consumption in TJ;

F<sub>emiss</sub> = Carbon emission factor per tonne of carbon per tert-joule (tC / TJ). The IPCC 1996 and MCT 1999 values of the F<sub>emiss</sub> are: gasoline (18.9 tC / TJ); anhydrous alcohol (14.81 tC / TJ); hydrated alcohol (14.81 tC / TJ); diesel (20.2 tC / TJ); dry natural gas (15.3 tC / TJ);  $10^{-3} = \text{tC} / \text{GgC}$ .

To mark equation 3 the expressed carbon content is required. Thus, according to the MME (1999), CO<sub>2</sub> emissions can be calculated as a function of their molecular weights, where 44 t CO<sub>2</sub> corresponds to 12 t C or 1 t CO<sub>2</sub> = 0.2727 t C.

$$ECO_2 = EC \times 44/12 \text{ (Eq. 3)}$$

Where:

$ECO_2$  = CO<sub>2</sub> emission;

EC = emission of C.

Emission factors should be corrected, since a car with older technology has higher pollutant emission rates compared to a zero kilometer vehicle (TEIXEIRA, 2008).

Corrected emission factors for used vehicles are obtained by the product of vehicle emission factors in the year in question by a deterioration factor. Total annual emission rates will be calculated for the carbon monoxide (CO) pollutant.

### 3. Results and Discussion

The increasing concentration of gases in the atmosphere and the consequent climate change have mobilized governments to take measures to estimate anthropogenic CO<sub>2</sub> emissions.

Numerous public policies have been implemented in recent years that have created direct impacts on vehicle pollutant emission levels. These measures focus in general on the setting of automotive vehicle emission ceilings and fuel improvement measures (CARVALHO, 2011).

Due to the potential difference of gases in relation to their contribution to global warming, their CO<sub>2</sub> equivalence measurement was determined. It is used to buy the emissions of various Greenhouse Gases (GHG), based on the amount of carbon dioxide (CO<sub>2</sub>) that would have the same global warming potential as the Global Warming Potential (GWP). a certain period of time, estimating and quantifying how much of the environmental impact was generated by the same amount of a different gas species (SEIFFERT, 2009).

Burning fossil fuels is the world's leading cause of carbon dioxide (CO<sub>2</sub>) emissions, and is the main greenhouse gas. According to Mattos (2011), in a large city, among all sectors that consume fossil fuels, the road transport sector is the largest consumer.

The first international agreement on climate change was signed on March 21, 1994 by 182 countries, including Brazil. This agreement aimed to stabilize the concentration of gases associated with global warming, including carbon dioxide (CO<sub>2</sub>), but this agreement did not specify the concentration limit (SILVA; DIAS, 2012).

The data collected from the Public (articulated and urban) and private (micro and van) Transport Fleet differ in their number of cars and models. Presenting the operating fleet of 382 vehicles (mandatory), including 38 spare vehicles, totaling a total fleet of 420 vehicles, which consumes fossil fuel of diesel type (Table 1).

Table 1. Description of measurements taken of liters of diesel spent in 2018.

YEAR 2018	Diesel Consumption Quantity (l)
January	1.215.870
February	1.250.000

March	1.368.000
April	1.369.200
May	1.370.320
June	1.368.900
July	1.299,850
August	1.276.900
September	1.367.230
October	1.287.500
November	1.370.000
December	1.299.871
<b>Total</b>	<b>15.914.451</b>

Source: Adapted from the report on vehicle fleets analyzed (2018).

The public transport sector has a significant share in both GHG and pollutant emissions that contribute to global warming and to the damage caused to the population's health.

GHGs come from mobile combustion in the sector's vehicles, which accounts for about 30% of the world's commercial energy consumption and 60% of total world oil consumption (IEA, 2009). In Brazil, diesel consumption in 2009 accounted for 53% of the sector's total CO<sub>2</sub> emissions (BRAZIL, 2012).

Diesel oil is a petroleum-derived fuel consisting primarily of hydrocarbons. Besides presenting carbon and hydrogen, they also present sulfur and nitrogen, being formulated through the mixture as kerosene, gas oils, heavy naphtha, light diesel, heavy diesel, etc., coming from the various crude oil processing stages (CNT, 2012).

The importance of fuel quality is a fundamental factor for emission control and, consequently, for the proper functioning of the engines. Under optimum conditions, all carbon from diesel fuel would burn into carbon dioxide (FERNANDES, 2011).

As a result of the growth of the automobile sector, the amount of road vehicles on the city streets has polluted the air through the burning of fuels in their engines, and depending on the level of concentration, the environment cannot tolerate and dissipate this pollution.

The private transport company has the operating fleet of 300 vehicles, which also consumes diesel-type fossil fuel (Table 2).

Table 2. Description of the amount of fuel spent (l) by the private transport fleet in 2018.

YEAR 2018	Amount of fuel spent (l)
January	265.632

February	253.583
March	253.909
April	252.265
May	251.764
June	247.897
July	253.895
August	256.371
September	256.829
October	254.139
November	255.159
December	257.487
<b>TOTAL</b>	<b>3.049.921</b>

Source: Adapted from the report on the analyzed transport fleets (2018).

Although the car, compared to the use of buses and bicycles, is a more comfortable and convenient means of transportation, it nevertheless has negative impacts on the urban community.

According to Carvalho (2011), bus systems, which account for more than 60% of urban commuting and more than 95% of commuting, are responsible for only 7% of total carbon dioxide emissions. Automobiles and light commercial vehicles, with less than 30% of total travel, contribute half of the emissions of this pollutant.

In diesel engines, known as compression-ignition engines, where air enters the cylinder through the intake manifold, this air is compressed at high temperatures and pressure.

According Fontana (2009), when in contact with air at high temperatures, the fuel vaporizes quickly and when mixed with air, cause spontaneous chemical reactions resulting in the phenomenon known as spontaneous ignition or self-ignition.

Thus understanding the process of gas emission based on predictive models becomes necessary for the knowledge of different methodologies (Table 3).

Table 3 - Comparison of CO<sub>2</sub> emissions by public and private transport companies in 2018.

Year 2018	CO <sub>2</sub> emission (t)	CO <sub>2</sub> emission (t)
	(Public transportation)	(Private Transportation)
January	3.279.220	716.410
February	3.371.200	683.910
March	3.689.400	684.790
April	3.692.730	680.360



May	3.695.800	679.010
June	3.691.900	668.580
July	3.505.700	684.750
August	3.443.800	691.430
September	3.387.400	692.680
October	3.472.400	685.410
November	3.694.900	688.160
December	3.505.800	694.440
<b>Total</b>	<b>42.430.250</b>	<b>8.249.930</b>

Source: Own Authorship (2019).

Top Down is a practical method for obtaining the values that are closest to the reality of carbon dioxide (CO<sub>2</sub>) emissions and is even adopted by the Brazilian government for the preparation of the national inventory of polluting gases.

Fuel category is not distinguished by category (sector), only the total CO<sub>2</sub> obtained through the consumption of a certain volume is estimated (MATTOS, 2011).

The use of fuels that are viable to use the fleet is recommended. The Top Down method was developed by the Intergovernmental Panel on Climate Change (IPCC, 2006), a body linked to the United Nations (UN).

Based on the application of the Top-Down methodology in the comparison of public and private transport companies, it is evident that CO<sub>2</sub> emissions for both fleets present a high air pollution index, suggesting the adaptation of the vehicle fleet by the adoption of fuel. similar with lower pollutant emission.

#### 4. Conclusion

The data obtained in the study prove that the use of low emission factor fuels should be used in urban public transport vehicles, favoring environmental and financial gains.

It can be said that the quantities of GHG emitted by road transport (public and private) are high due to the high motorization index and the growing exponential evolution of the vehicle fleet.

Inventorying GHG emissions from these activities provides tools for understanding the evolution of the greenhouse effect. CO<sub>2</sub> has been continuously added to the atmosphere at high concentrations, which may be the subject of further studies to monitor the rise in temperature.

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# **The Importance of (ECI / EIA) applied to substations and the 500kv Transmission Line Manaus – Boa Vista and the Socio-Environmental Changes of the Waimiri Atroari Indigenous Lands**

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## **Abstract**

*The purpose of this study was to present the importance of the Environmental Impact Study as a way to mitigate the ecological relations and social and environmental viability of the 500kV Manaus - Boa Vista Transmission Line (LT) Transmission Line and Associated Substations, which complied with the Annex Terms of Reference. III-B of Interministerial Ordinance No. 419, of October 26, 2011, as directed by FUNAI. Thus, the project contemplates the expansion of the Transmission System belonging to the basic network of the National Interconnected System - SIN, seeking to interconnect the capital of Boa Vista / RR to the SIN. Exploratory research through documentary and bibliographic survey was used to understand the land use in the stretch of BR-174, cutting the Waimiri Atroari Indigenous Lands. An analysis was made of the analysis based on social and environmental changes based on maps prepared by the ECI / EIA as a land use analysis, as well as the mitigation of possible impacts to be mitigated by a previous survey proposed by the Environmental Protection Laws. Non-indigenous land occupation policies arise from the need for economic and social growth. For the indigenous, this interference process*

*alters the territorial history and the emotional bonds. Therefore, this forced contact with the non-Indian, generated a series of impacts on the life of the indigenous community, having changed the way of life the local vegetation, the occupation and use of the land, interfering in the ECI / EIA knowledge and understanding of this enterprise. . Thus, understanding these relationships becomes of paramount importance because it is not just a technological advance or the suppression of a local need, bringing transformative consequences to a nation of indigenous people.*

**Keywords:** Environmental Impacts, Amazon, Indigenous Land.

## 1. INTRODUCTION

This study presents an analysis of the importance of Environmental Impact Studies as a way of mitigating implications on the ecological relations and social and environmental viability of an enterprise along the BR-174 that comprise the Waimiri Atroari Indigenous Lands, whose demarcation was approved by Decree No. 97,837, of June 16, 1989.

In this sense, understanding the use of natural resources, as well as occupation and use of land, as well as their supervision, require almost uninterrupted monitoring, so that there are no major losses. According to CONAMA Resolution No. 460/2013, in its art. 3 ° which states that "soil protection must be carried out in a preventive manner, in order to ensure the maintenance of its functionality or, in a corrective manner, aiming to restore quality or recover in a manner compatible with the intended uses".

In this context, there are management laws and guidelines that ensure the effective management and monitoring of these areas, given their particularities. Over time, several characteristics have been added to the protection of the environment, and have broken down into several categories to meet different goals. This trend of category unfolding has been sanctioned at international meetings, and made effective in national laws and policies to accompany the large enterprises to be realized.

In support of this follow-up, this study is based on the EIA Indigenous Component (ECI) Study Report of the 500kV Manaus - Boa Vista Transmission Line (LT) and Associated Substations that complied with Annex III-B of the Ordinance Interministerial No. 419, of October 26, 2011, as directed by FUNAI (BVSA, 2014), as it has become of great importance to obtain information on changes submitted to the consolidation of this venture. Therefore, by analyzing such projections based on local surveys, it will be possible to understand the social and environmental changes in IT.

The need for knowledge of land use activities associated with rural activities, together with the importance of economic growth, brings a careful view of the environment, which proposes an approach through the use of remote sensing, aiming to reduce the major impacts caused (PINTO et al. 2017). Thus, this study is also based on the analysis of maps generated specifically by the ECI located along the BR-174, given that technological advances have brought better conditions for the monitoring of large areas through satellite images.

Thus, remote sensing is a tool that occupies a wide space of possibilities with magnificence of action, favoring the development of several terrestrial-environmental monitoring satellites, thus allowing, at a global, regional or local scale, the choice of the methodology for collecting data. adequate (quantitative and qualitative) data on various environmental situations (MASCARENHAS; FERREIRA; FERREIRA,

2009).

Therefore, it is verified that these environmental analysis techniques have become an increasingly common practice among the various research areas. In the case of land use and vegetation cover, they contribute significantly to the efficiency and reliability of analyzes involving the processes of environmental change, as well as various other factors that may cause changes in these conditions, but without forgetting the field truth (Rosendo, 2005).

Soil is one of the most important natural resources of the planet, so its use must be adequate, the use of these essential techniques for the elaboration of maps that overlap the land use, allowing the understanding of the patterns of space organization, for a possible planning. , since knowledge is seen as a use that can cause impacts on the environment (DE PAULA; CABRAL, 2012).

Thus, in the construction of this research, the survey of the spatial characteristics of the area corresponding to the study was approached, using as main source, the Waimiri Atroari IT ECI Report of the Manaus-Boa Vista Transmission Line and Associated Substations. Starting his narrative through the descriptive process of the construction of BR-174; the spatial analysis using the maps generated by the ECI / EIA and evaluation of the possible changes and mitigations of the social and environmental problems generated by the enterprise when being consolidated in an area related to Indigenous Lands.

## **2. Material and Method**

### **2.1 Study area**

The study covers the stretch of BR-174, which corresponds to the Waimiri Atroari Indigenous Lands (TI), whose demarcation was approved by Decree No. 97,837, of June 16, 1989, with a total area of 2,585,911 ha. the States of Roraima / Amazonas, cut by the BR-174, in the 121 km stretch (Lat: -1.257796 °, - 0.2226420 °; Lon: -60.407078 °, - 60.691821 °).

The highway crosses the Waimiri-Atroari IT, which inhabits a rainforest region of the northern Amazon, located in northern Amazonas and southern Roraima (VIDAL et al. 2018). It is a one-way highway with construction started in 1970 (RODRIGUES, 2011) (figure 01).

Figure 01 - Illustration of the study area named “Waimiri Atroari Indigenous Land”



Source: Funai / BBC News Brazil.

The 121.8 km crossing in the Waimiri Atroari Indigenous Land (TI) is planned considering 48.0 km in the part belonging to Presidente Figueiredo / AM and 73.8 km in the part belonging to Rorainópolis / RR. (ECI / EIA, 2013).

From exploratory research through documentary and bibliographic survey we sought to understand the occupation and use of land in the stretch of BR-174 that crosses the Waimiri-Atroari Indigenous Lands. Subsequently, we approached the case study of the enterprise composed by the 500kV Manaus - Boa Vista Transmission Line (LT) and Associated Substations (BVSA, 2014), which made a cut of the analysis based on social and environmental changes based on the choice of elaborated maps. ECI / EIA as a form of land use analysis, as well as future impacts to be mitigated by the survey proposed by the Environmental

## 2.2 Protection Laws.

Therefore, the study area of the LT Corridor within TI also developed by means of photointerpretation mapping over rectified orthophoto mosaic obtained in September 2013 for this purpose, using geoprocessing techniques, using Arcgis 10.1 software.

In this sense, the result of the comparative understanding of Line's proposal with the Environmental Protection Laws and the Indigenous Statute resulted in the analysis of the possible changes and mitigations of the social and environmental problems to be generated by the enterprise when it is consolidated in an

### 2.3 Indigenous Lands -related area.

For the analysis of this study and its respective results, the time series of the ECI / EIA Report of the Waimiri-Atroari IT-related areas along BR-174 (Table 1) were used.

Table 1: Description of maps used for composition and analysis

MAP	YEAR	EXCERPT FROM BR-174	ANALYZE
<b>Fishing &amp; Straw Harvesting Activities</b>	2013	km 218 to 221	Subsistence activity: food and crafts.
<b>Mowing and collecting buriti</b>	2013	km 236 to 239	Subsistence activity: food.
<b>Ecological walkways</b>	2013	km 271 to 274	Wildlife Passage
<b>Xeri Village</b>	2013	km 277 to 281	Subsistence Activity: Housing and Socialization

Source: ECI / EIA, 2013.

### 3. Results and Discussion

The characterization of the project comprised of the 500kV Manaus - Boa Vista Transmission Line (LT) and Associated Substations complied with the Terms of Reference of Annex III-B of Inter-ministry Ordinance No. 419, of October 26, 2011, as directed by FUNAI. This project contemplates expansion of the Transmission System belonging to the basic network of the National Interconnected System - SIN and is part of the Growth Acceleration Program - PAC 2, coordinated by the Federal Government.

The 500 kV Manaus - Boa Vista and Associated Substations LT is a project formulated within a context of regional development, since its main objective is to link the capital of Roraima, Boa Vista, to SIN, until then an isolated system. (ECI / EIA, 2013).

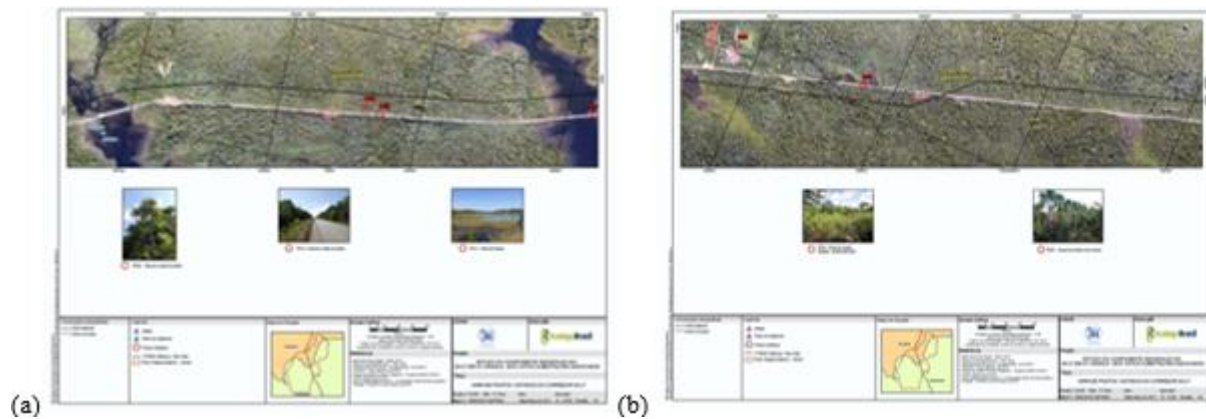
To consolidate the ECI / EIA, work groups were organized, with interdisciplinary professionals coordinated by an anthropologist, to meet Funai's term of reference, where the methodology was based on Waimiri Atroari's own forms of social and political organization, contemplating his emotional and social perceptions. practices with the territory they inhabit, identifying the natural resources and their uses, as well as the places of territorial domain that demarcate the group's ethnic identity.

Faced with so many nuances and possibilities, the study presented here was based on analyzing the alterations of subsistence activity, as well as the collective activities of indigenous people, since human beings need these two premises for their healthy performance in living and living together. Therefore, four maps of the ECI / EIA study were chosen to describe the changes in these aforementioned fields.

Figures 02 (a) and 02 (b) show the maps that we call subsistence activities characterized by the development of straw collection practices for the construction of malocas, handicrafts and utensils. It is possible to identify fishing, mowing and collecting activities. Buriti



Figure 02 - Subsistence activity location maps (a) buriti collection; fishing (b) mowing; Buriti collection.



Source: ECI / EIA, 2013.

According to the ECI / EIA, during field activities the Waimiri Atroari demonstrated that the suppression of vegetation, due to the aspects characterized by its territoriality, is one of the main points of concern and fear.

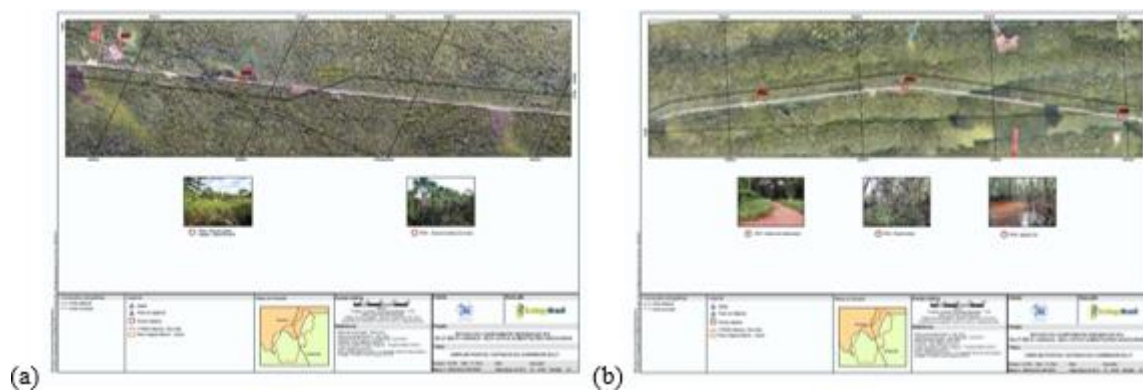
It is observed that the highlighted points are located near BR, which already configures a consolidation of past changes with the construction of the road. Virtually the entire region of the route is used for hunting, fishing and gathering forest products for handicrafts, constructions, medicinal uses. As well, the whole area is full of meanings of what it is to be and live like a Waimiri Atroari (ECI / EIA, 2013).

Regarding the history of the BR-174 and the Indigenous Peoples, this highway that would link Roraima to the rest of Brazil would shorten distances and facilitate the settlement of new residents, but it also brought with it a number of problems with the locals. Waimiri Atroari (MONTEIRO; DA SILVA, 2018). Also according to the authors cited, this undertaking involved the work of the military and civilians, and one of the obstacles was the clashes with the indigenous people who, as a result of the idea of progress at any cost, thus accounted for in 1971, two thousand dead Indians.

Still according to Monteiro; Da Silva (2018), General Enio dos Santos Pinheiro, Army Director of Works and Cooperation, added: "They were sacrificed but were sacrificed for the progress of our country." Therefore, this forced contact with the non-Indian, generated a series of impacts on the life of the indigenous community, being in the altered way of life, as in the local vegetation, through the occupation and use of the soil already mentioned.

Maps 03 (a) and 03 (b) present in a specific and specific way the socio-cultural activities of the indigenous people, who, already adapted to the changes promoted by the road, still manifest their fragmentation of the distinct use of the territory.

Figure 03 - Location maps: (a) passage of wild animals; (b) collective activities; Xeri village.



It is observed that when removing a forest, the animal species are reduced, and beyond this understanding, the indigenous understand in their perception that by restricting and changing the environment is moving with the spirits, with the body, with ethos, with practice, with the indigenous way of life (ECI / EIA, 2013).

Therefore, it is not a purely natural fact, but essentially a socioecological and cultural construction. Thus, the territory is emotionally significant, since in the Indian's view "every plant species that is extracted, each spirit-creature that is killed is a memory that is lost" (ECI / EIA, 2013).

Vidal et al. (2018) state that in the years 1972 to 1977, a "pacification" and relocation operation of the Waimiri Atroari was organized by the National Indian Foundation (FUNAI). The population was clustered in villages and later numerous transfers were ordered by the Waimiri Atroari Attraction Front (FUWA) in the 1980s (VIDAL, 2018).

#### 4. Conclusion

Non-indigenous land occupation policies arise from the need for economic growth and are a constant in our economic and social form. For the Indians, this process of interference greatly alters the emotional territorial history of their different life forms.

At present the relationship between the enterprises and the Traditional Peoples has been altered by the consolidation of Environmental Protection Laws, which we can mention: Law No. 6.938 / 1981 (PNMA, 2019), which recommends and obliges the Prior Study of Environmental Impacts in any undertaking that may cause some kind of social and environmental damage, as is the case of Tucuruí, as is also known. Law No. 6,001 / 1973, which deals with the Indian Statute (2019), has the purpose of preserving its integrated culture, progressively and harmoniously the national communion.

In this sense, the ECI / EIA's knowledge and understanding of this venture is of utmost importance to society as a whole, as it is not just a technological advance or the suppression of a local need, but beyond the vision of solving a regional problem. since it brings transformative consequences to a nation of indigenous people, who guard and safeguard a different way of life from the current capitalist societies.

For ECI / EIA, Waimiri Atroari leaders want "before visitors enter their territory to knock on their door asking for permission to talk" proposing a joint decision for their future projects.

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# **Strategic Planning Applied to Small Businesses: A Case Study in Maués - Amazonas**

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## **Abstract**

*This paper aims to present the application of strategic planning for small companies and the tools that help their development in the context of production engineering. Since strategic planning and tools such as SWOT analysis, GUT matrix, brainstorming and 5W2H are of great importance in the business environment, especially in the current economic situation, where companies need to have a differential to stay in a highly competitive market. competitive. This makes the use of methods and tools indispensable, as it is through them that the company can clearly and objectively gain insight into its strengths, weaknesses, opportunities and threats, as well as develop an action plan to defined strategies ensuring greater productivity.*

**Keywords:** strategic planning, small business, action plan, production engineering.

## **1. Introduction**

Today, competition between companies continues to grow, which is due to the need to survive in a highly competitive market that seeks total quality. This search leads them to undertake strategic planning that will help them find better ways to overcome competition and other ways of growth.

[10] define strategic planning as an ongoing and systematic process that concerns defining where you want to go. Even highlighting the importance and benefits of strategic planning for decision making in industries, there is a follow-up where this analysis tool is little used: that of small companies [3].

According to [5], small businesses collaborate with the economy, as they offer many job opportunities,

stimulate competitiveness and because they are small they can be more efficient as they do not tend to follow complex and bureaucratic processes.

Small and even medium-sized companies present certain difficulties during the development of strategic planning, some authors like [9], attribute these difficulties to certain peculiarities such as their size, structure, culture and resource constraints. Given this, there is a need to use some tools that can help you decide the best development alternative for such a company.

This paper presents the application of strategic planning for small companies together with the help of tools such as SWOT analysis, GUT matrix, brainstorming and 5W2H, within the context of production engineering. It aims to develop strategic planning for a small business, following the adapted proposal of [13] apud [10], in order to reduce costs, improve productivity and greater efficiency in decision making.

## **2. Theoretical Reference**

### **2.1. Strategic planning**

For [10], strategy is a global model of decisions and actions that place organizations / companies in their environment in order to achieve their long-term goals. For [15], the strategy concerns top management's plans to achieve results consistent with the mission and objectives set for a given organization. [2] state that "a company's strategy is defined as its theory of how to gain competitive advantage," after all, a good strategy is one that actually results in such advantages.

In fact, good strategic planning results in several advantages over the competitor because it enables a detailed analysis of the internal and external environment. According to [4], strategic planning is an administrative process that allows a methodological basis to decide the best path the company should follow, considering the internal and external conditions of the given company to act in an innovative and differentiated manner.

It can be said that small businesses somehow develop some of the stages of strategic planning, such as setting goals, diagnostics to achieve set goals, how to take action against competitors and continue with their place in the market, [1].

### **2.2. Guiding principles (vision, mission and values)**

Mission, vision and values are considered the foundation for defining direction for a company, but they must become strategic goals and guidelines.

For [14], corporate mission and vision are the foundations on which the company is being formed, ie the reason for existing. Vision is what allows the company a consistent sense and direction for the future. This is where the company aims to reach. For this, the objectives and goals must be flexible to achieve the vision, which must have the participation of all teams and levels of the company.

A company's mission must be discussed with employees at all levels, and then written down. All members must have the same understanding of the meaning and purpose of the company, [8]. He also states that values are guides for decision making and conduct of the company during the fulfillment of the mission and in the pursuit of vision.

### **2.3. SWOT Analysis**

There are several definitions of SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix, one of which is that it is a tool often used in the planning of strategic actions, where it analyzes the internal (strengths and weaknesses) and external environment (opportunities and threats) of the company. The result of this analysis is called the strategic stance, [8].

Following this line of thought [12], he states that the most important part of the analysis of the internal and external environment is the joining of the two and that their goal is to bring together all the items considered as company strengths and relate them to opportunities, weaknesses. and threats.

### **2.4. GUT matrix**

According to [6], the GUT matrix is an efficient simple tool, which aims to help managers prioritize existing problems. The letters G, U and T are initials that represent gravity, urgency and tendency. [10] state that for each strategy that has been defined, the factors must be given a rating and the higher the rating, the higher the level of G, U and T.

### **2.5. Brainstorming**

According to [7], brainstorming is a collective process in which people express ideas freely, without criticism and in the shortest possible time. Brainstorming is considered one of the tools that generate ideas most in teams, because one of its principles is the non-judgment of ideas, as absurd as they may appear.

There is a variation of brainstorming, brainwrinting. This tool is known to be closed brainstorming, the difference is that instead of ideas being presented verbally, they are written, [6].

### **2.6. 5W2H**

According to [7], 5W2H is a tool used especially in the elaboration of action plans, as well as in the mapping and standardization of processes. It is a management tool that has the intuition to easily understand what needs to be done, such as deadlines, methods, goals, etc. Given this, [4] defined 5W2H as a form for execution and control of tasks, where it is defined who will perform and how the work in question will be performed, as well as department, reason and deadline for completion at all costs involved.

It was named because it represents the initials of the English words what, who, when, where, why, how and how much it costs).

## **3. Methodology and Tools**

The choice of this area of study was through visit and research in the city of Maués - AM, where it was found that most small companies do not carry out a strategic planning. Through informal interviews with the owners, it was possible to notice that most of them perform some strategic planning steps, even informally. Among these small businesses was the company studied in this article.

The proposed solution for this small company is the development and application of strategic planning,

using auxiliary tools such as SWOT analysis, GUT matrix, brainstorming and 5W2H. Data collection was done by applying questionnaires to customers and employees, as well as an interview with the company owner.

The customer questionnaire was applied for three days in October 2019. The questionnaire structure was based on eight marking questions, where they could mark more than one option and had a space for suggestions, criticism and praise. In total there were thirty questionnaires answered, this limited number of answers was due to refusal of some clients claiming lack of time to answer. Another questionnaire was applied to all employees, ie 5 people. They answered the structured questionnaire with eight scoring questions, where they could mark more than one option and there was room for suggestions, criticism and praise. In the interview with the owner was established a questionnaire with fourteen open questions, lasting 30 minutes. Secondary data obtained from informal conversations with the owner's customers, competitors and family members were also used.

## 4. Application of Study

### 4.1. Company presentation

The company Delicias da Sonha has been in the salty and food market for 5 years and is located at Rua Deputado João Verçosa, 435 - Bairro: center in the city of Maués. Through an informal interview with the owner, it was concluded that strategic planning was never undertaken for her small business for the following reasons: lack of knowledge to carry out strategic planning, lack of time and resources.

### 4.2. Strategic Planning Preparation Steps

The strategic planning of this small company will be elaborated according to the steps in figure 1 below.

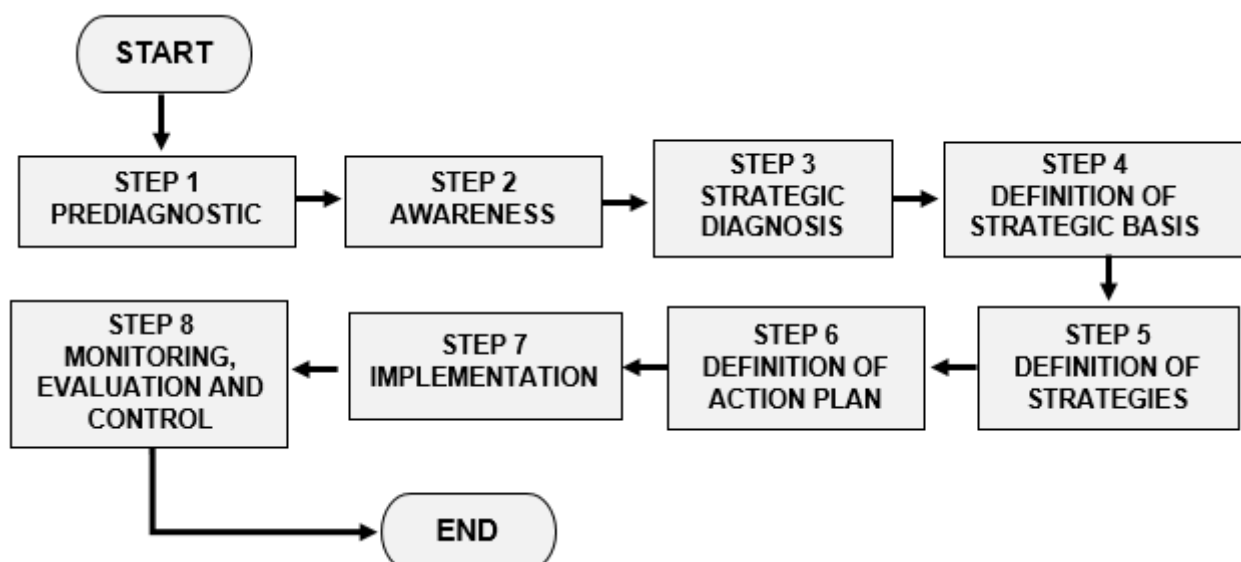


Figure 1 - Flowchart of the strategic planning development process.

Source: Author

Since steps 7 and 8 are part of the results and discussions topic.

### STEP 1 - Pre-Diagnosis

The pre-diagnosis is the stage in which the company needs planning, who could develop and what the expectations related to the result. This information can be obtained through informal conversations / interviews with the contributors and owner, for example what was done in this case. After this initial assessment it was possible to conclude, according to the information obtained, that the company needs strategic planning, because it is going through a period of financial difficulties and the reason is not known.

Asked what expectations related to the result of strategic planning, they answered that they expect financial difficulties to improve, stimulate the production process, stimulate employees and help overcome the competition.

### STEP 2 - Awareness

As the need to develop strategic planning for the company was identified, this second step is fundamental. In a meeting with all members of the company, was explained about the objectives of strategic planning and consequently the importance of the actions that were to come that would cause some changes.

### STEP 3 - Strategic Diagnosis

At this stage, the strategic diagnosis was developed. It is a detailed diagnosis of the actual situation the company is in, taking into consideration the internal and external environment. But first it is necessary to tabulate data in the application of the questionnaires to customers and employees.

With the data obtained from the application of the questionnaire to employees, it was possible to assemble table 1 below. It shows the aspects to improve according to the opinion of the five employees.

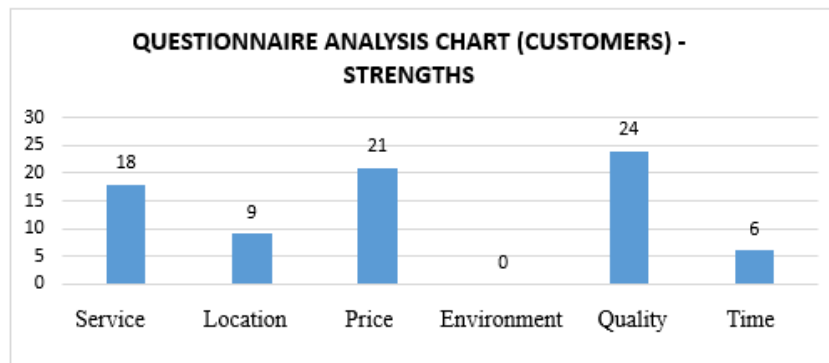
Table 1 - Aspects to be improved from the employees' point of view.

ASPECTS TO IMPROVE	AMOUNT OF EMPLOYEES
Physical facilities	2
Kitchen (equipment and utensils)	1
Management	0
Marketing / Advertising	2

Source: Author

With the data obtained from the application of the questionnaire to the customer, it was possible to assemble the analysis chart 1 below regarding the company's strengths in the opinion of the customers who answered the questionnaire.

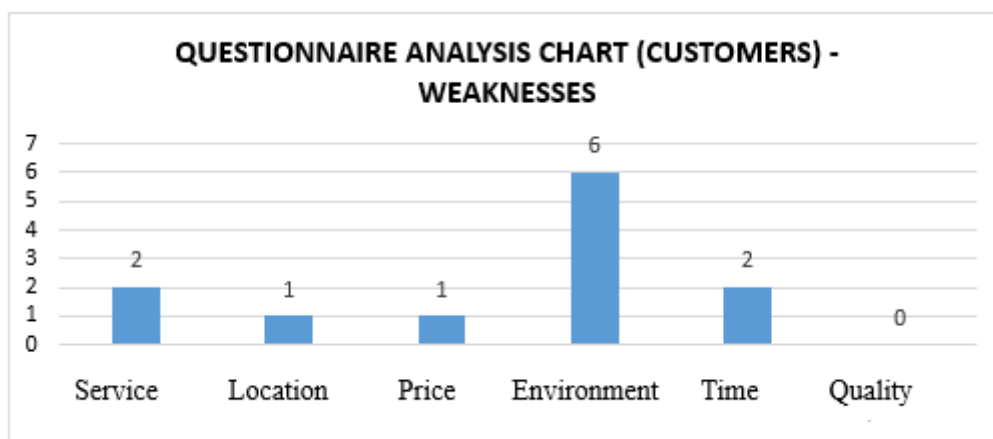




Graph 1 - Customer questionnaire analysis graph about the company's strengths.

Source: Author

Analysis chart 2 below refers to the company's weak ready-made according to customers.



Graph 2 - Customer questionnaire analysis graph about the company's weaknesses.

Source: Author

To evaluate the internal and external environment, we use the SWOT matrix tool. Also known as the FOFA (Strengths, Opportunities, Weaknesses, Threats) matrix, it is of the utmost importance that the business owner be honest in using this matrix for analysis, as this is the only way to eliminate or minimize weaknesses, devise strategies to address threats and take advantage of them. the opportunities. Data from the SWOT matrix, presented in table 2, were obtained through questionnaires applied to customers and employees, as well as the interview with the owner.

Table 2 - SWOT matrix applied to the company Delicias da Sonha

SWOT MOTHER			
Internal (Company)		External (environment)	
Strong point: (Strengths)	<ul style="list-style-type: none"> <li>- Employees committed;</li> <li>- product quality;</li> <li>- customer loyalty;</li> <li>- Market time;</li> <li>- Price;</li> <li>- Location;</li> <li>- Good service.</li> </ul>	Opportunities: (Opportunities)	<ul style="list-style-type: none"> <li>- Higher demand in the term</li> <li>- Bigger demand at the holidays</li> <li>- Maximization of marketing through social networks</li> </ul>
Weak point:	- Marketing;	Threats:	- fierce competition;

(Weakness)	<ul style="list-style-type: none"> <li>- undefined goals;</li> <li>- restricted view;</li> <li>- Management failures.</li> <li>- Physical Facilities</li> </ul>	(Threats)	<ul style="list-style-type: none"> <li>- High value of taxes;</li> <li>- High value of materials.</li> </ul>
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Source: Author

#### STEP 4 - Defining the strategic foundation

At this stage the company's strategic objectives, mission, vision, values were developed. The definition of these items, shown in table 3, came from a meeting with the owner and all employees of the company, where a brainstorming was performed.

This meeting discussed the company's strengths and weaknesses and the forward thinking of both the owner and employees.

Table 3 - Definition of the mission, vision and values of the company Delias da Sonha

<b>Mission:</b>	<b>Our mission is to satisfy our customers by offering them quality products and good service in a clean and pleasant environment.</b>
<b>Eyesight:</b>	To be a reference in the salty industry in the city of Maués, always aiming at the total quality of the products offered.
<b>Values:</b>	Respect and ethics between customers and employees, excellence in service and commitment to the quality of products offered, these values will always be priorities for our company, becoming a differential in the market.

Source: Author

#### STEP 5 - Strategy Definition

At this stage of strategic planning, this is where we define strategies for mitigating or eliminating threats, seizing opportunities, and improving weaknesses detected in SWOT analysis.

Together with the owner, some strategies were developed thinking about the continuous improvement of the company. These strategies will be presented below in table 4.

Table 4 - Definition of the strategies to be implemented.

STRATEGIES PLAN TO BE IMPLEMENTED	
SITUATION	STRATEGY
<b>Lack of marketing</b>	Creation of dynamic page on social networks (facebook and instagram) where daily updates will be made, disclosure of information about the company.
<b>Undefined goals</b>	Set business goals, mission, vision and values.
<b>Management failures</b>	Management training on production management and control, strategic planning.
<b>Physical facilities</b>	Adjustment of layout of physical facilities and making some improvements.
<b>Higher demand in the school term</b>	Own physical facilities by the end of 2020.
<b>Bigger demand at the holidays</b>	Increase production by 20%.
<b>Fierce Competition</b>	Do a factor analysis to find out what the actual production capacity is for December 23rd, December 24th and December 30.31.
<b>High value of materials</b>	Do market research to know the company's differential and invest in it.

Source: Author

After defining the strategies, the GUT matrix was used in order to prioritize situations that in the SWOT analysis were detected as weaknesses and threats that require immediate attention. Below, in table 5, you can see application of this tool.

Table 5 - Application of the GUT matrix.

<b>SITUATION</b>	<b>MATRIZ GUT</b>			
	<b>GRAVITY</b>	<b>URGENCY</b>	<b>TOTAL</b>	<b>TREND</b>
<b>Lack of marketing</b>	3	3	1	9
<b>Undefined goals</b>	4	5	3	60
<b>Management failures</b>	5	5	3	75
<b>Physical facilities</b>	2	2	2	8
<b>Fierce Competition</b>	2	2	3	12
<b>High value of materials</b>	3	4	3	36

Source: Author

#### STEP 6 - Definition of the action plan

After applying the GUT matrix, it was possible to know the order of priorities of the situations to be solved. From then on, the action plan was developed for the situations in question, as shown in table 6.

Table 6 - Plan of action.

	<b>ACTION PLAN</b>		
	<b>SITUATION 1</b>	<b>SITUATION 2</b>	<b>SITUATION 3</b>
<b>WHAT?</b>	Management failures	Undefined goals	High value of materials
<b>WHY?</b>	To improve the management of the company.	Because this problem prevents the company from setting goals and achieving them.	Because it is causing problems in the financial area.
<b>WHERE?</b>	In the management sector.	In the management sector.	In the management sector.
<b>WHEN?</b>	10/19/19 to 10/20/19	10/12/19	10/22/19 to 10/23/19
<b>WHO?</b>	Owner	Management and employees	Owner
<b>HOW?</b>	Doing training on the use of techniques and tools that help improve management.	Establishing appropriate mission, vision, values and strategic objectives.	Survey of suppliers in the city of Maués for price comparison of inputs and check prices more affordable.
<b>HOW MUCH?</b>	\$ 0	\$ 0	\$ 0
<b>WHAT?</b>	Competition Analysis	Improve marketing	Improvement of physical facilities
<b>WHY?</b>	To benchmark	To improve advertising and win customers	Because it is causing production delays and job dissatisfaction for employees.
<b>WHERE?</b>	In other eateries of the city of Maués	On the social networks	In the kitchen
<b>WHEN?</b>	10/25/19	10/31/19	From the 24/10/19
<b>WHO?</b>	Management	Management	Management
<b>HOW?</b>	Surveying the competition and benchmarking.	Creating pages on instagram, facebook and doing daily publications.	Buying appropriate utensils and equipment (if necessary), standardizing production, minimizing risks, improving lighting, conducting safety training at work.

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<b>HOW MUCH?</b>	\$ 0	Promote the cafeteria through radio and flyers.	The owner declined to declare.
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Source: Author

## 5. Results and Discussions

According to the initial flowchart, step 7 is the implementation of strategic planning.

Regarding management failures, training was conducted with the business owner on the use of techniques and tools that help control management, especially financial, which resulted in a 20% reduction in monthly costs. This cost reduction was also influenced by the survey and analysis of suppliers, which allowed the owner to purchase inputs with lower prices.

To improve the company's marketing and attract new customers, a survey of the competition was conducted in the city of Maués-AM for benchmarking, as a result made it possible to know that the company's differential is credibility, quality of products offered and focus on customer satisfaction. and thus invest in these aspects. Subsequently, the company profile was created on the social networks instagram and facebook, as well as the company's disclosure on the radio.

Regarding the undefined objectives, as presented in step 4, the mission, vision and values of the company that were disclosed to employees and customers in social networks were defined.

Thinking about job satisfaction for employees and improving production, training was given on workplace safety and risk minimization. A layout adjustment has also been made in the kitchen to allow production standardization and lamp changes to make the room brighter.

Given these improvements, it was possible to see positive results only a few days after the implementation of the action plan. Finally, step 8 is monitoring, evaluation and control. This process will be done by the owner, who received training on strategic diagnosis.

## 6. Final Considerations

This work aimed to develop strategic planning, with the aid of tools such as: SWOT analysis, GUT matrix, brainstorming and 5W2H, within the context of production engineering and apply in a small company.

This research enabled a greater understanding of strategic planning and the benefits it has for business competitiveness, while presenting the main limitations in small businesses.

Most small business owners are unaware or reluctant to adopt this tool. Largely because they feel they lack the knowledge to carry out strategic planning or because they find the process complex and expensive, which is exactly what happened in the situation studied in this article. However, as presented in this article, you can adapt it to the reality of small businesses so that you can maximize profits and enable it to survive in such a competitive market, as some small businesses close before a year is up. Market

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# **Implementation of a Solar Power System Using Frequency Converter for Water Collection Optimization in the Altamira Community of Japurá - Amazonas**

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## **Abstract**

*Solar panels are renewable sources of energy, which over the last two decades have been widely used for electricity generation, and Brazil is beginning to move towards the implementation of alternative renewable energy sources as its energy matrix, especially solar photovoltaic. The residential photovoltaic system provides local generation and consumption, helps reduce grid load, increases system reliability, reduces transmission and distribution losses, lowers energy costs and reduces environmental impact. This paper discusses the use of solar energy applied for pumping water with two proposals, most economically viable and able to serve a community with 123 inhabitants, who live in that difficult-to-light region. With this we will apply two proposals of a photovoltaic kit for water abstraction that*

*presents the economical dimensioning of its implantation, proving to be a viable system for the riverside communities with difficult access to water.*

**Keywords:** Energy Efficiency, Water Capture, Photovoltaic.

## 1. Introduction

With the creation of solar panels in the nineteenth century (MACHADO; MIRANDA, 2014), there was an evolution in the electricity sector, based on concern for the preservation of the environment, as well as seeking other renewable sources for electricity generation in the world.

The main sources of energy in the world are coal, gas, water (hydroelectric), uranium and petroleum, which are causing environmental impacts, beginning in the Industrial Revolution, when humanity began to use fossil fuels more intensively to move their machines. Since then, greenhouse gas (GHG) emissions have optimized climate change, which in turn tends to increase the average temperature of the planet (MME, 2017).

Thus, in recent years there have been major discussions about global warming, where in 2018 there was a meeting of 30,000 delegates from 197 countries, with the mission of creating an action plan to implement the Paris agreement, the United Nations Conference on climate change COP-24 (UN, 2018).

According to BBC NEWS BRASIL (2018), for the past 22 years, 2018 has been the fourth warmest year since 1880, if this trend continues, temperatures could rise by 3 to 5 degrees by 2100.

Thus, there are different studies that present various sources of renewable energy to combat global warming, seeking to replace harmful or harmful matrices, such as hydroelectric and thermal, from current modules such as wind, solar and biofuel.

In Brazil, these sources have been increasing their availability as the country has been modernizing, and as the energy sector is developing. However, most of the energy production still comes from hydroelectric plants, which accounts for 63.7% (energy available for consumption in Brazil), thermal 27.2%, wind 8.1% and solar 1%. According to ANEEL (2018), solar energy use has grown to 1,602 MW, previously generating only 1,365 MW of energy nationwide (ANNEEL, 2017).

However, Brazil, despite having favorable conditions for photovoltaic energy, still presents itself as a little explored resource. In recent years, the solar energy model has assumed and demonstrates the predominant and revolutionary role in the evolution of the energy sector in our country, mainly, following the regulation of the National Electric Energy Agency (ANNEEL, 2017).

In the Amazon there is the Balbina Hydroelectric Power Plant, built on the Uatumã River, between 1985 and 1989, where energy production totaled 250 MW, with five 50 MW capacity generators. In 2017 a floating solar plant was built in the Balbina hydroelectric lake, with a capacity of generating 5 MW that should supply 9,500 families (MME, 2017).

According to Eletrobrás energy distribution of Amazonas (2015), in 2003 the light for all program was launched, benefiting more than 104 thousand households, with approximately 509 thousand people, where only a small part of the population was not served with this program. light for all, given the allocation of this population to protected areas, and it is necessary to propose and develop actions that bring income and economic diversity to these communities.

The lack of electricity in a society results in the existence of social asymmetries in the conditions and quality of life, such as: the permanence of poverty, the lack of opportunity for growth, the migratory flow to large cities and the disbelief of this society. future, where urban lifestyles are actually adopted as a possible way of life, with numerous environmental losses (ICMBio, 2017).

Some regions face difficulties to capture water, due to the isolation of some communities or because they have high slopes, making it difficult to access electricity and water, causing these populations to develop their domestic activities on the banks of the rivers.

The discussion of this study shows the electric power generation for the motor pump, which captures water, from these populations living in isolated communities with difficult access to electricity. Thus, it is glimpsed from the technological innovation to capture water from a certain region seeking to understand the terrain, climate, fauna, flora, proximity to rivers, ease of access, solar incidence, humidity and other environmental conditions aiming the development of the project.

Thus, this study aims to analyze the economic mode of electricity generation, with the implementation of a photovoltaic kit, which will capture water, aiming at the fulfillment of technological innovation, seeking to bring improvement in quality of life, with regard to electricity generation for the community of Altamira, Japurá-AM, having as a subsidy the demonstration of the costs to change the power generation model.

## 2. Material and Method

### 2.1 Study area

The project proposal was made for the Altamira community in the municipality of Japurá-AM, located on the right bank of the Japurá river (Figure 1). According to the IBGE (2017), this municipality was created by State Law No. 96 of December 19, 1955, with territory of 55.827,207 km<sup>2</sup>. The present population of 7,326 inhabited by the latest IBGE census (2010), with a demographic density of 0.13 inhab / km<sup>2</sup>, and its coordinates are in latitude 1 ° 52'45.39 "S, and longitude 66 ° 59'46.28" W.

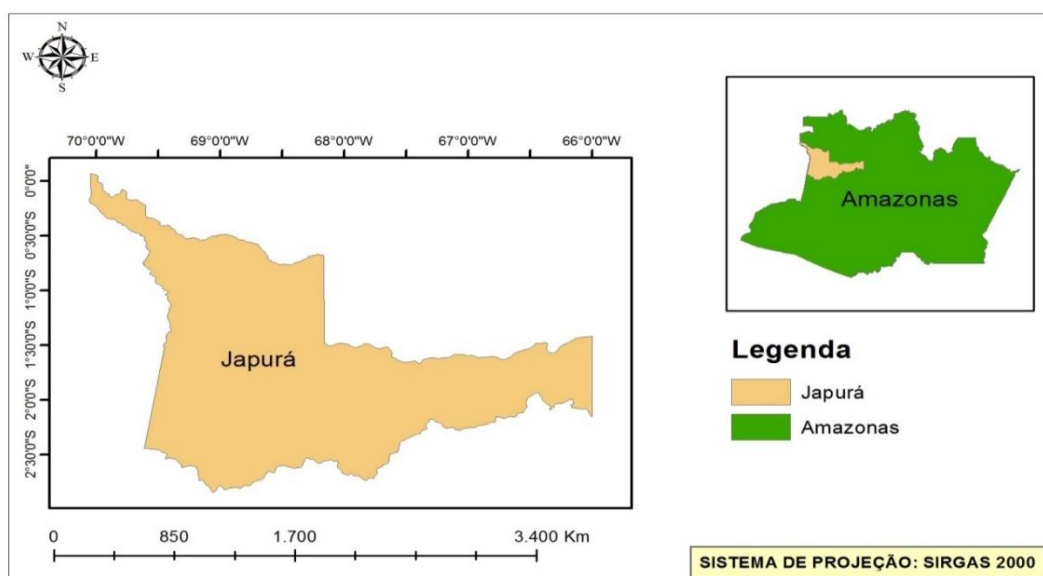




Figure 1: Map of the municipality of Japurá-AM.

Source: Own authorship (2019), marked by IBGE (2010).

The municipality of Japurá is bathed by the river of the same name, where are 43 riverside communities, where 41 communities are dependent on the energy produced from the diesel engine, which only work four hours a day (between 18:00 - 22:00h).

Therefore, the need for a pilot project to be implemented in the community, given the existence of 123 residents, without access to electricity, with income from the management of pirarucu, by RDS Altamira. To improve community water abstraction, a photovoltaic kit was proposed to eradicate the still existing electrical exclusion in this area, proposing an economic model, reducing the use of fossil fuel and advancing the use of renewable energy generation.

Two types of photovoltaic kit were proposed to the community, the first consisting of materials such as: solar plate, solar inverter, water pump, sensor float; and the second, by a solar plate and 12 V dc Shurflo 8000 motor pump. Thus, it was divided in two steps to demonstrate the most advantageous type from the economic question.

### 3. Case Study Application

#### 3.1. First Proposal of Inverter Photovoltaic Kit

According to Oliveira; Lira; Moraes (2018), photovoltaic solar energy can be applied to telecommunication equipment, irrigation, home supply etc. The materials to be used and the procedures required for research development are:

The. Solar plate; The solar plate is a device that converts solar radiation into electricity, which will be used for the generation of electricity; B. Solar inverter; Irrigasol solar inverter, used in variable speed drive with state-of-the-art technology for three-phase induction motors using photovoltaic or wind solar energy. It can be used in water pumping, ventilation and cooling systems with Maximum Power Point Tracking (MPPT) technology for maximum power point tracking, extracting maximum system performance and can convert panel power to 127 V, for pump motor operation; ç. Water pump; In this module I use 1 CV system, serving to supply the water tank of 5,000 liters, suitable for large flows and small manometric heights, and may be submersible or surface; d. Sensor float; used to drive the pump motor for when the water tank is full or dry;

With this the system was designed to drive a 1 hp pump motor. This sizing of the system began with solar radiation, based on the need to use the site metric Solari index.

In addition, from the metric Solari we used the latitude and longitude of the Altamira community to know the solar radiation index. To obtain the time of solar radiation in this region, information was taken from the Ministry of Mines and Energy (MME, 2019) by adding the latitude and longitude coordinates that provided a table with Average Daily Capacity in h / day (Figure 2).

Cálculo no Plano Inclinado																
<b>Estação:</b> Japura <b>Município:</b> Japura, AM - BRASIL <b>Latitude:</b> 1,801° S <b>Longitude:</b> 66,549° O <b>Distância do ponto de ref.</b> ( 1,7825° S; 66,5475° O ) :2,1 km																
#	Ângulo	Inclinação	Irradiação solar diária média mensal [kWh/m².dia]													
			Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez	Média	Delta
☑	Plano Horizontal	0° N	4,58	4,77	4,61	4,33	3,97	4,17	4,22	4,82	5,07	5,01	4,87	4,58	4,58	1,10
☑	Ângulo igual a latitude	2° N	4,53	4,74	4,61	4,36	4,02	4,22	4,27	4,86	5,08	4,98	4,82	4,52	4,58	1,07
☑	Maior média anual	1° N	4,55	4,75	4,61	4,35	4,00	4,20	4,25	4,84	5,08	4,99	4,85	4,55	4,58	1,08
☑	Maior mínimo mensal	12° N	4,21	4,51	4,52	4,42	4,18	4,47	4,49	5,00	5,06	4,78	4,50	4,17	4,52	,89

According to Daniel (2010), to do the sizing we have to follow the following steps.

$$Pb = T \times C \text{ (Eq. 1)}$$

C = electric current.

$$GEb = Pb \times t \quad (\text{Eq. 2})$$

T = pump operating time.

$$E_p = P_p \times I_s \quad (\text{Eq. 3})$$

$P_p$  = solar panel power;

$I_s$  = time of solar radiation in the inclined plane.

### **3.1.4 Step 4 - Number of solar plates**

To know the number of solar plates, it was based on the power generated from the solar panel ( $E_p$ ) and the result of the water pump equation 4.

$$N = E_b / E_p \quad (\text{Eq. 4})$$

$N$  = number of solar plates.

$E_b$  = water pump power generation;

$E_p$  = energy generated by the solar panel throughout the day.

### **3.1.5 Step 5 - Number of solar plates**

According to the number of solar plates, which can be connected in parallel, the supply of generated power need ( $E_g$ ) to drive the pump during the water tank supply is obtained by equation 5.

$$E_g = E_p \times n \quad (\text{Eq. 5})$$

$E_g$  = energy generated during the day for pump motor operation.

$E_p$  = energy generated by the solar panel throughout the day;

$N$  = number of solar plates.

### **3.1.6 Step 6 - The return on investment**

From this, the return on investment made in the equipment was based on the Payback equation 6.

$$T \text{ (years)} = \frac{C_t}{C_d \times (365 \text{ day / year} / 7 \text{ days of the week})} \quad (\text{Eq. 6})$$

$T \text{ (years)}$  = return on investment time;

$C_t$  = total investment cost;

$C_d$  = total cost of diesel spent per week;

This calculation will show the return on investment of this system, used to replace the fuel that was used to start the light motor and drive the pump motor.

## **3. 2 Second Proposal of the Non Inverter Photovoltaic Kit**

According to the manufacturer, the inverterless system, created by Solenerg Engineering Company, is a system specially designed for pumping water from wells, lakes and rivers. The characteristic of this type of system is that it does not need storage of the electric energy produced by the solar panels, since the pumped water can be stored in reservoir.

This system consists of only the following materials: solar plate and Shurflo 8000 pump, which fill a 500l water tank. For this system, indicated, it was made sizing, using the same formulas of the first proposal, based on the characteristic of the pump motor and also on the amount of water needed to pump.

## **4. Results and Discussion**

### **4.1 First Proposal of Inverter Photovoltaic Kit**

In the first proposal of the photovoltaic solar kit was made the sizing using the driver and according to data from the metric Solari in the region of Altamira-AM, a daily average of 4.58 h / day was observed. For this, the step by step for application follows.

#### **4.1.1 Step 1 - First Proposal - dimensioning of the pump**

The driver promotes the conversion of direct current energy from photovoltaic modules to three-phase alternating current energy, where the rated current output is 14 A, depending on the motor pump electrical current. The design of the water pump was made with reference to the completely empty water tank, being necessary to pump 5000 l of water / day, based on these technical specifications of the motor pump in voltage of 127 V and current of 14 A, has up .

$$P_b = 127 \text{ V} \times 14 \text{ A} = 1,778 \text{ W}$$

#### **4.1.2 Step 2 - First Proposal - How much energy will be used**

The panels that were used are of JINKO POLI 330w brand, for the sizing of the solar plates, being necessary to calculate the power of the water pump ( $E_b$ ) during the operation period of 3:30 h / day. .

$$G E_b = 1,778 \text{ W} \times 3.30 \text{ h / day} = 5,867.4 \text{ Wh / day}$$

#### **4.1.3 Step 3 - First Proposal - calculate the energy generated from a solar panel**

The energy generated from a solar panel, multiplied by the power of the solar panel and the solar irradiation time according to the data obtained by the cresesb (2019) of 4.58 h / day of solar irradiation, using the solar panel power of 330W.

$$E_p = 330 \text{ W} \times 4.58 \text{ h / day} = 1,511.4 \text{ Wh / day.}$$

#### **4.1.4 Step 4 - First Proposal - Number of solar plates**

Regarding the number of solar plates, the generated power of the solar panel ( $E_p$ ) and the operating time of the water pump ( $E_b$ ) were calculated, obtaining the result of 4 solar plates.

$$N = \frac{5,867.4 \text{ Wh / day}}{1,511.4 \text{ Wh / day}} = 3.88 \cong 4 \text{ solar plates}$$

#### **4.1.5 Step 5 - First Proposal - Number of solar plates**

From these four solar panels connected in parallel, to reach the pump drive for 3h30min, and supply the 5000 l water tank, culminating in the energy generated has:

$$E_s = 1,511.4 \text{ wh / day} \times 4 = 6,045.6 \text{ Wh / day}$$

Having a ready-sized system, a battery is needed for energy storage, as there is no pre-analysis included to choose the replacement of the system, which uses battery, a driver was used to convert the energy and automatically start the pump. In this case it will not be used on the battery to store energy.

#### **4.1.6 Step 6 - First Proposal - The return on investment**

With the value of the investment made, the return on investment of this system is calculated by replacing the fuel.

The value of the photovoltaic kit of the first proposal costs around R \$ 6,912.40, being spent four (4) liters of diesel during 3: 30h, where the value of diesel is R \$ 4,50, since the pump Water was turned on every three days. Therefore, during the operation of the water pump was spent around 4l diesel / day, multiplying by the value of diesel \$ 4.50 l. totaling \$ 18 / day and \$ 54 / week.

$$T \text{ (years)} = \frac{6,912.40 \text{ R \$}}{\$ 54 \times 52.14 \text{ week / year}} = 2.45 \cong 3 \text{ years}$$

#### **4.2 Second Proposal of Non Inverter Photovoltaic Kit**

With this basic system the inverter was not used, different from the previous one. According to Pereira (2010), this system is basically made up of only the solar panel and the Shurflo 8000 pump, which is designed to be connected directly to the solar panel without any other components between the panel and the pump.

##### **4.2.1 Step 1 - Second Proposal - dimensioning of the pump**

The pump sizing to 500 l water tank capacity, being used daily, has a voltage of 12 V and current of 10 A

$$P_b = 12 \text{ V} \times 10 \text{ A} = 120 \text{ W}$$

##### **4.2.2 Step 2 - Second Proposal - How much energy will be used**

By sizing the solar plate, the power output of the water pump ( $E_b$ ) was calculated during the operating period of 4:58 h / day.

$$E_b = 120 \text{ W} \times 4.58 \text{ h / day} = 549.6 \text{ Wh / day}$$

##### **4.2.3 Step 3 - Second Proposal - calculate the energy generated from a solar panel**

Calculating the energy generated from a solar panel, the solar panel power was multiplied by the solar irradiation time of 4.58 h / day of solar radiation, from the solar panel power of 155 W.

$$E_p = 155 \text{ W} \times 4.58 \text{ h / day} = 709.90 \text{ Wh / day.}$$

##### **4.2.4 Step 4 - Second Proposal - Number of solar plates**

The number of solar panels were scaled based on the generated solar panel power ( $E_p$ ) and the water pump operating time ( $E_b$ ):

$$N = \frac{549.60 \text{ Wh / day}}{709.90 \text{ Wh / day}} = 0.77 \cong 1 \text{ solar panel}$$

##### **4.2.5 Step 5 - Second Proposal - Number of solar plates**

With an arrangement of a solar plate connected to direct current, supplying the energy requirement to drive the pump for 4h58min and supplying the 500 l water tank, with a solar plate we have:

$$E_s = 709.90 \text{ Wh / day} \times 1 = 709.90 \text{ Wh / day}$$

##### **4.2.6 Step 6 - Second Proposal - The return on investment**

The value of the first proposal photovoltaic kit costs around R \$ 826.99, and it was spent 1 liters of diesel

for 40 min, since the value of diesel is R \$ 4.50. Since the water pump is activated every three days, then during the operation of the water pump it costs around 11 diesel / day multiplies R \$ 4,50, totaling R \$ 4,50 and three days of the week the expense reaches R \$ 13.50 / week.

$$T \text{ (years)} = \frac{867.55 \text{ R \$}}{\$ 13.50 \times 52.14 \text{ week / year}} = 1.23 \cong 1 \text{ year and 3 months}$$

### 4.3 Project Return on Investment

The results obtained in this dimensioning show the total equipment used in a photovoltaic kit to drive the pump motor.

In a water pumping system, the average cost is \$ 7,000, and can pump approximately 5,200 l of water / day to a community, reducing the time spent by residents who needed to get canned water for their consumption, transport water for a rural family that consumes about 6 hours of work between collection and transport in bucket, a work typically done by women and children (OLIVEIRA, 2010).

With the sizing made of the first proposal, the results were obtained, and it was used in a Payback table. In the first item, there is the diesel expense in one year, in the second item there is the initial investment value of the first one (Table 1).

Table 1: One-year diesel and investment spending of the first proposal.

Item	Description	Spent
1º	Diesel in a year	R\$ 2.815,56
2º	Initial value of investment	R\$ 6.912,40

Source: Own authorship (2019).

Table 1 shows that in one year 40.73% of diesel is spent, compared to the initial investment value of the first proposal. Thus, in the other proposition there is no use of fuel (Table 2).

Table 2: Return on investment time and possible spending on diesel.

TRI	0 year	1 year	2 year	3 year	4 year	5 year
Initial value of investment	-R\$ 6.912,40	-R\$ 4.096,84	-R\$ 1.281,28	R\$ 1.534,28	R\$ 4.349,84	R\$ 7.165,40
Diesel spend	-R\$ 2.815,56	-R\$ 5.631,12	-R\$ 8.446,68	-R\$ 11.262,24	-R\$ 14.077,80	-R\$ 16.893,36

Source: Own authorship (2019).

Table 2 shows the return on investment given in the third year, with 22.20% of its initial investment. In five years, he has 103.66% profit and 3.66% more than the initial value used in the project.

It can also be observed that after three years the percentage of profit with the use of the photovoltaic kit is achieved, compared to the use of the diesel engine there is a big difference in fuel expenditure, which in three years would be spent 734.04% a more compared to using the photovoltaic kit, which would already have a return on investment of 22.20%.

According to Valverde (2017), the Payback determines the time required for the invested capital to be recovered. Discounting the investment, the profits will be obtained over the investment period until the

capital invested is completed and the time taken for this process is accounted for. The lower the payback, the more interesting the investment becomes.

In proposal two, a design was made without the use of the inverter, using the same Payback calculation as in the first proposal (Table 3).

Table 3: Diesel spend in one year and investment expenditure of the first proposal.

Item	Description	Spent
1°	Diesel in a year	R\$ 703,89
2°	Initial value of investment	R\$ 867,55

Source: Own authorship (2019).

Table 3 shows that in a year 81.13% of diesel is spent, almost the same as the initial investment value of the second proposal, adding the return on initial investment (Table 4).

Table 4: Two-year return on investment

TRI	0 year	1 year	2 year	3 year	4 year	5 year
Initial value of investment	-R\$ 867,55	-R\$ 163,66	R\$ 540,23	R\$ 1.244,12	R\$ 1.948,01	R\$ 2.651,90
Diesel spend	-R\$ 703,89	-R\$ 1.407,78	-R\$ 2.111,67	-R\$ 2.815,56	-R\$ 3.519,45	-R\$ 4.223,34

Source: Own authorship (2019).

Table 4 shows the two-year return on investment, with 62.27% of your initial return on investment. In five years, there is a 305.68% return on investment and 243.41% more than the initial value of the investment. If in two years you continue to use the diesel engine, the expense will reach up to 390.88% more, compared to the initial value of the investment.

Compared to the two systems it can be said that both have their advantages and disadvantages, in the first proposal there is a system that can fill a reservoir of 5000 l, whereas the second proposal can only supply a reservoir of 500 l where in this view The most advantageous is the first proposal, given the service to the whole community.

In the community there are 30 residences, and the second proposal can serve only one residence, having this condition as a disadvantage.

In terms of return on initial investment compared to both systems, the second proposal is the most unfeasible, due to the short term return on investment, with a positive balance of 62.27% of your initial investment and in the first proposal your return. It is long-term according to the Payback calculation, with this return in three years and may have 22.20% of the initial investment.

In this case the community requested the photovoltaic kit which is to serve all homes in the community. Therefore, even though a high initial value of equipment expenses to attend all the homes presents better results. This would have to multiply the initial value of the photovoltaic kit (VIKF) by the total community residences, so one has:  $VIKF = 867.55 \times 30 = \$ 26,026.50$  apparently a high expense when compared to the first proposal. However, from figure 3, there is the comparison of the best proposal.

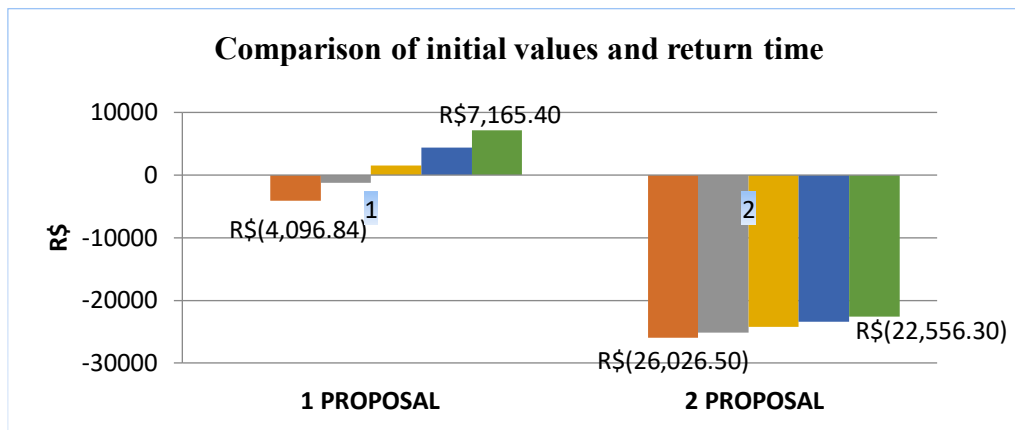


Figure 3: Comparison of initial values and return time

Source: Own authorship (2019).

We can see that the first proposal has a low initial value and a quick return on investment compared to the second proposal, which even with a high investment value, has a long term return.

That is why it is taken as an indication of the first proposal, to serve the whole community, with low investment cost and a quick return on investment made in the photovoltaic kit.

## 5. Conclusion

This work demonstrated the results of two proposals for a photovoltaic water supply kit in the region of difficult access to water, seeking to replace the use of diesel engine, bringing savings to the residents of the community, which has a large fuel expense. given the high value of this material.

Using Payback to calculate the two proposals of the photovoltaic kit both are viable, each with its advantages, in the first proposal it was found that it has a high value, but can meet the whole community and its return time is soon. However, due to the high volume of water that this equipment can pump to be stored, there is a great advantage related to another proposal that serves only one residence.

The second proposal is economically less infeasible due to its short-term payback time, showing an economical kit, but only serves a residence with the 500 l reservoir.

With this was made another comparison of the two proposals, which would be to serve the whole community, having the best efficiency the first proposal, which ensures the sustainability of the system.

This project is an excellent alternative to the community water supply problem, showing economic, ecological and social viability.

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## **Evaluation of environmental changes as a function of climatic variables from 2008 to 2018 in the city of Manaus - Amazonas**

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### **Abstract**

*El Niño intensifies the temperature increase in the Amazon region, causing heat and extreme drought in much of the Amazon, in Manaus the process of urbanization intensifies the temperature increase of the city. This study aims to perform an analysis of climatological variables of the city of Manaus-AM, from January 2008 to December 2018, through the maximum and minimum temperature, precipitation and relative humidity in order to show the increase in temperature through statistical analysis showing the temperature. year of greatest impact. According to the results obtained, in 2008 Manaus recorded the lowest minimum temperature in the period being 23.4 ° C, characterizing the minimum maximum temperature with 32 ° C, it is noted that due to the presence of the negative phase of ENSO ( La Niña) in 2008 the precipitation level in the region was high, contributing to the low temperatures and the relative air humidity averaged 87%, and the highest annual average of the maximum and minimum temperature in the study period occurred in 2015. , being 33.5 ° C and 25.7 ° C, due to the positive phase of ENSO (El Niño), temperatures in the capital were high, with little precipitation during the year directly impacting the relative humidity (75%). . Therefore, the positive / negative ENSO anomalies had a major influence on the climatic variables in the year 2008 and 2015, characterizing low temperatures in 2008 and high temperatures in 2015.*

**Keywords:** Climate phenomena, El Niño, Amazon.

## **1. Introduction**

Population growth has led to urban sprawl, resulting in changes in natural features, such as deforestation for land use, especially in Permanent Preservation Areas (APPS), through disorderly man-made pavements and constructions, resulting in large quantities. heat-retaining materials, incurring factors that act or optimize climate change (GARTLAND, 2011).

According to Ferreira; Coelho (2015), deforestation and disordered land occupation cause loss of biodiversity, causing environmental damage. In Brazil, this loss results in 22% of Greenhouse Gas (GHG) emissions. Allied to this, the transformation of forest into pasture directly influences evapotranspiration, especially in periods of drought, decreasing the amount of water in the atmosphere, causing a decrease in rainfall in the Amazon and, when presenting climatic phenomena, results in other Brazilian states (NOBRE, 2014). In addition, the National Policy on Climate Change - PNMC, instituted by Law No. 12,187 of 2009, was one of the series of actions that Brazil had to take to adapt to climate change (ARAÚJO, 2017).

According to Leal et al. (2014), the horizontal surface coatings in urban centers contribute to the temperature increase, causing heat islands through heat retention, being higher in regions with hot and humid climate. These impermeable surfaces not only contribute to the increase in temperature, but, according to TUCCI (2016), poor urban drainage contributes to flooding, causing water to run superficially and according to the study by SILVA et al. (2019), the altered hydrological cycle, causing this runoff to generate more flooding due to improperly accumulating waste in the soil.

The expansion of urban centers uses pavements with materials that retain a large amount of heat, with the temperature rising which, depending on the shape, becomes heat islands. The disordered growth of the city of Manaus-AM is mainly through the invasions that expand in the city limits, having as main focus the east zone and areas adjacent to the AM-010 and BR-174 highways, where the urbanization process increases the temperature of cities due to heat retention, as the structure of large urban centers when compared to vegetated areas, impacts on temperature, causing numerous problems in human and environmental health.

From the Industrial Revolution it is remarkable that the population in the big cities increased significantly in search of better living conditions. From the rural exodus, there were a total of 27 million people from 1960 to 1980, migrating from rural to urban areas (BRITO; HORTA; AMARAL, 2018). This process of these was due to the fact that technology in agriculture, given by the replacement of human labor by machines, generating economic, social and environmental problems (BAENINGER, 2016). From the 1960s, Manaus received a significant amount of people provided by the implementation of Manaus Weak Zone, receiving approximately 100 thousand people (ARAÚJO, 2017)

The large migration of people leads directly to the deficiency of basic sanitation and decent housing to serve everyone (SILVA, 2016), these in turn seek spaces and illegally expand their areas, deforesting and causing siltation of soil and springs. With the lack of information at the time, there was the use of materials in road construction and other enterprises to serve the population, which retained heat,

generating optimized heat areas, therefore by these materials (GARTLAND, 2011).

Therefore, one of the main villains in temperature rise is the materials used in buildings, dark materials, which absorb more heat from the sun, failing to dissipate heat through evapotranspiration and the absence of moisture, which according to Gartland (2011). ) indicates that impermeable sun-heated surfaces may have temperatures between 27 and 50 ° C, while the presence of natural vegetation would reduce to 21.1°C.

In the centers of large cities there are several factors that contribute significantly to heat islands (MONTEIRO et al. 2014). With the removal of vegetation cover to meet the need for rural exodus one of the main reasons observed should be the construction of houses, buildings and streets, containing materials such as asphalt and concrete making the environment warmer (FERNANDES, 2015).

The combination of these two factors, expansion and removal of vegetation cover, can be characterized as the main causes of temperature increase in cities, causing soil sealing and consequently higher temperatures (CORRÊA, 2016).

Greenhouse Gases (GHGs) are the main causes of temperature increases in cities, and according to the National Plan on Climate Change (PNMC, 2008) in developed countries one of the main gases emitted is CO<sub>2</sub> in the atmosphere which, in 2016 reached 403.3 ppm (WMO, 2017). This amount comes from the burning of fossil fuels to serve the population through electricity, also considering the existing industrialization process such as the production of cement and waste incineration.

In Brazil, the main sector that emits CO<sub>2</sub> is agriculture, via land and forest use change (75%); Other factors such as industry and transportation total 9% of emissions each and fugitive emissions (1%) (PNMC, 2019). Manaus has a large number of motor vehicles burning fossil fuels (CO<sub>2</sub>) constantly, this “population” according to the IBGE (2018) was 718,205 vehicles, tending to be larger over time, since the transportation offered to quality, encourages the purchase of own vehicles to meet their mobility, generating more and more CO<sub>2</sub> in the city.

As the climate of the city of Manaus is hot and humid (FERREIRA; SOUZA; ASSIS, 2014), the burning of forests in the Amazon has direct application in increasing the temperature and decreasing rainfall in the region, given its carbon stock, where when If trees are cut down, all carbon that has been absorbed will be released, considerably increasing the influence on the greenhouse effect (NOBRE, 2014).

Climatic phenomena are natural processes that are becoming increasingly intensive due to direct damage caused by man, tending to become severe events that cause severe degradation. Some acquaintances, others not so much, depending on the event can occur a great flood or drought (DA SILVA DIAS, 2014).

El niño intensifies the rise in temperature in the Amazon region by warming the tropical Pacific ocean, causing extreme heat and drought in much of the Amazon (JIMÉNEZ-MUNOZ et al. 2016). In addition to the increase in temperature, this phenomenon decreases the rainfall regime in the region, affecting the hydrological regime (SOUSA et al. 2015).

Considering the way cities expand, characterized by the lack of planning, this study aims to perform an analysis of climatological variables of the city of Manaus-AM, from January 2008 to December 2018, with the purpose of showing via Statistical analyzes increase in temperature and relate to urban sprawl, demonstrating the year of greatest impact.

## 2. Material and Method

### 2.1 Study area

The city of Manaus, located in the state of Amazonas (Figure 1), located on the left bank of the Rio Negro, has its climate classification, according to Köppen (1948) as humid tropical climate or equatorial climate, characterizing the average temperature of the region in 18 ° C.



Figure 1 - Location of the city of Manaus - AM

Source: Own authorship, 2019.

According to the Brazilian Institute of Geography and Statistics (IBGE, 2010) the municipality's territorial extension is 11,401 km<sup>2</sup>, with an exponential increase in population (Figure 2).

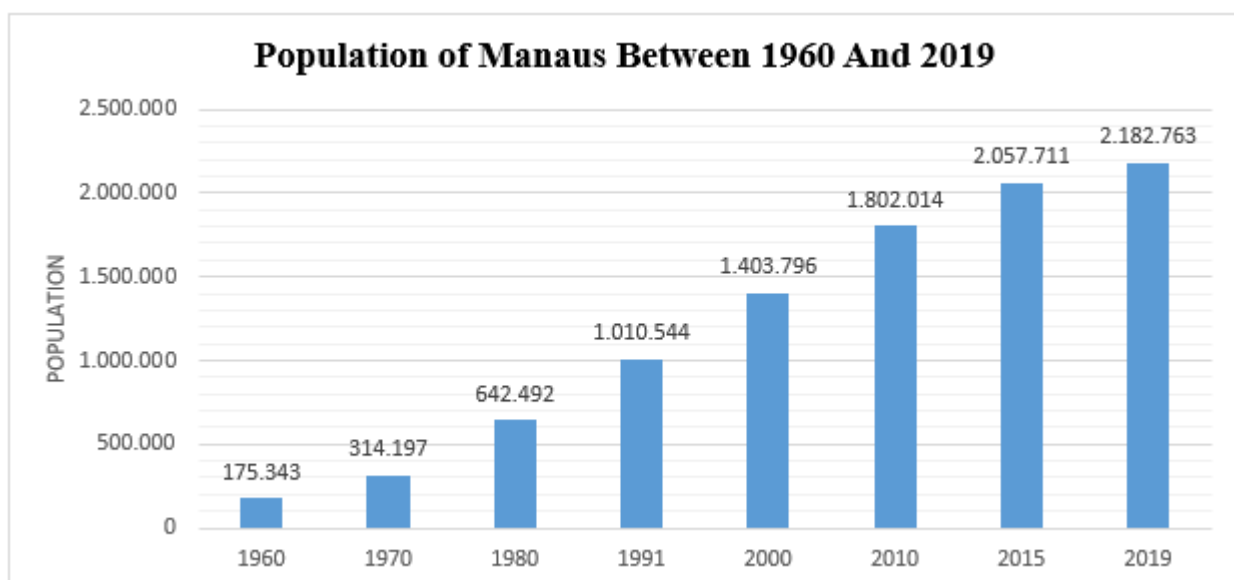


Figure 2 - Population of Manaus between 1960 and 2019.

Source: Own authorship, 2019.

## 2.2 Data collect

The collected data were: maximum and minimum temperature, precipitation and relative humidity of the station available on the website of the National Institute of Meteorology (INMET), located at Rua Recife, 1041 - Adrianópolis, Manaus - AM, using database of the years. from 2008 to 2018.

To guide and relate these measures evaluated in the city of Manaus over the period of 11 years (2008-2018) Anova was used by the Systat 13.1 program, for the variables collected on the INMET website.

## 3. Results and Discussion

According to data from the National Institute for Space Research - INPE, in 2008, the deforestation area in the Amazon was 604 km<sup>2</sup>, and in 2018 with an area of 1045 km<sup>2</sup>. This loss of vegetation cover is associated with illegal logging, illegal mining, removal of forest for grazing and, in the city of Manaus, there is the invasion of green areas to build communities illegally, in addition to urbanization through roads, construction of buildings and expansion of Manaus Free Zone, which contribute to the emergence of heat islands.

Corroborating with the study of Dos Reis; Guimarães (2017), when extreme weather events occur in the Amazon region, temperature rates tend to be higher with the presence of the ENSO (El Niño) positive phase and rainfall increases with the presence of the negative (La Niña) phase causing environmental, social and economic disasters due to flooding.

The average annual temperature of Manaus in 2015 was around 29.6 ° C, with average monthly temperature in March around 28.2 ° C and September 32.3 ° C, with the average variation between maximum and minimum, respectively. , 33.5 ° C and 25.7 ° C (INMET, 2019).

Figure 3 shows the annual average of the maximum and minimum temperature in the study period, where the highest and minimum values occurred in 2015, with 33.5 ° C and 25.7 ° C, and in 2008 with 23.4 ° C. minimum and maximum 32 ° C (La Niña). From 2008 to 2010 there was a rise in temperature in the capital, from 32 ° C to 33 ° C, remaining at an average of 32.6 ° C in the years 2011 to 2014, and in 2015 reaching the highest rate observed in the years collected. due to the presence of extreme weather event. In the years 2016 to 2018 the maximum temperature returned to average of 32.6 ° C. Pearson SYX correlation 69%, considering a moderate correlation.

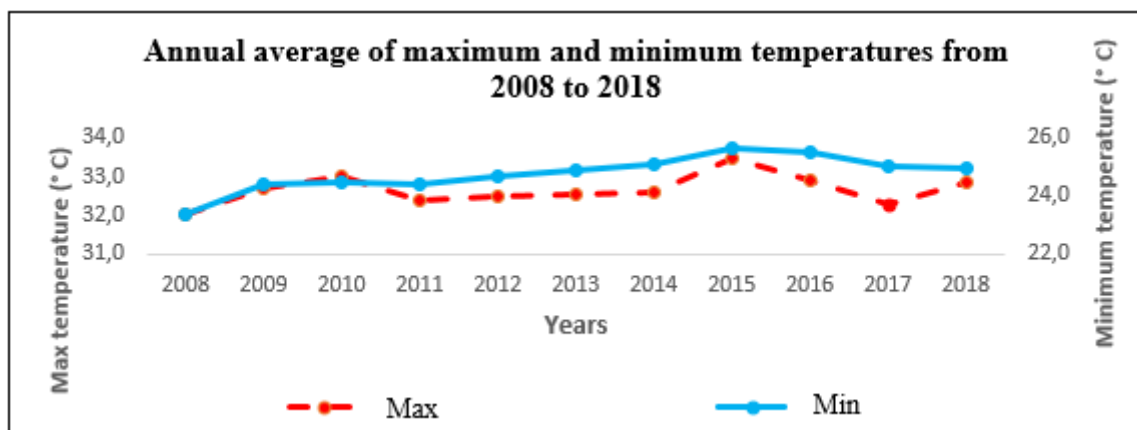


Figure 3 - Annual average of maximum and minimum temperatures from 2008 to 2018.

Source: Own authorship, 2019.

According to Figure 4, the highest rainfall occurred in 2008, with the presence of La Niña and in 2015 the lowest rate due to the presence of El Niño. Thus, the lack of cloudiness provides direct radiation, and there is no filter to disperse the radiation, where according to Cirino, Vitorino; from Holland (2019), corroborate Costa's study; Mattos (1998) who obtained the lowest temperature values in the rainy season and the highest in the dry season. Moreover, it presents a statistically significant difference between the years ( $F = 0.774$ ;  $P = 0.653$ ).

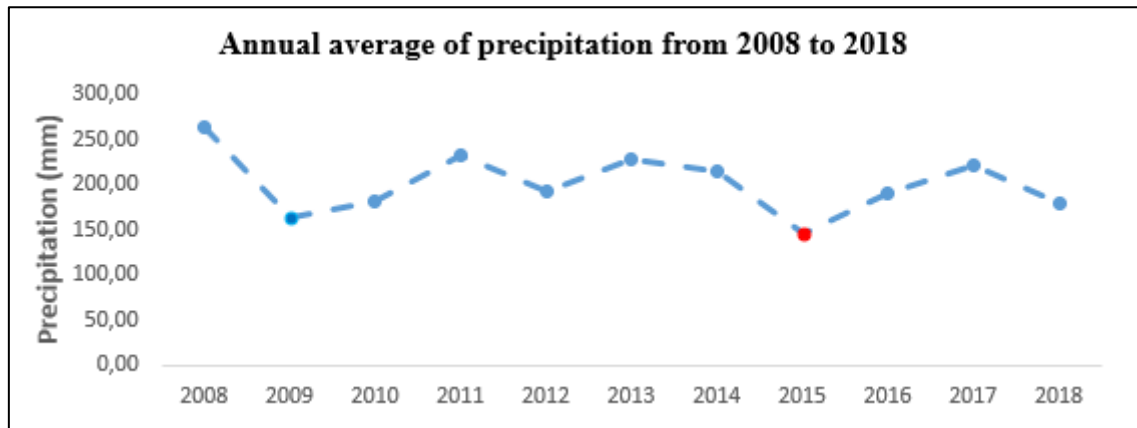


Figure 4 - Annual average of precipitation from 2008 to 2018.

Source: Own authorship, 2019.

The average relative humidity (%) for Manaus was 79%, with the highest rate of water in the atmosphere in 2008 and in 2015 and 2016 the lowest RH (%) for the capital (Figure 5 ), providing a hot and dry climate, which can lead to urban and rural fires, as well as damage to human health. These results corroborate the study by Monteiro et al (2014) that obtained in September 2012 an average of 72%, and 87% in March 2013. Finding values for  $F = 3,451$  and  $P = 0,001$ , highly significant.

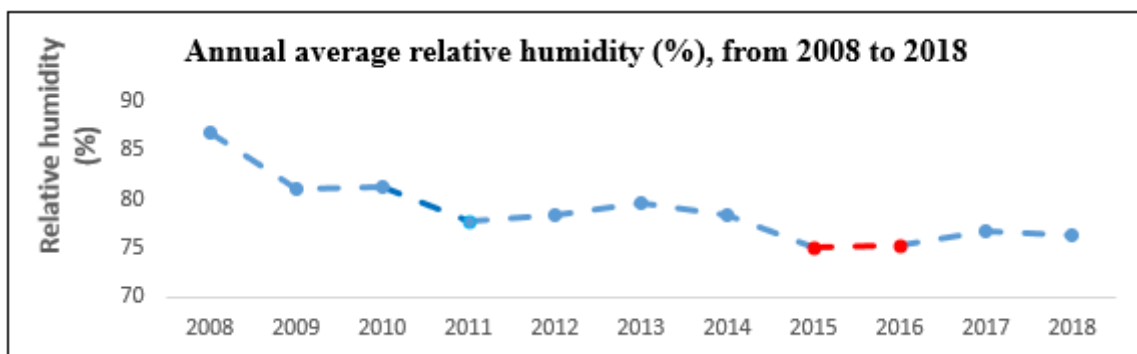


Figure 5 - Annual average relative humidity (%), from 2008 to 2018.

Source: Own authorship, 2019.

In 2015, given the presence of the El Niño climate event, high temperatures and low rainfall were obtained, which is characteristic of the phenomenon. However one must take into account the intensity of the event, which in fact has indicated sudden changes in the environment. Thus, Figure 6 shows that the maximum temperatures were lower from January to June, while the maximum minimum temperature values occurred from August to December. Years of extreme drought caused by climatological

phenomena should consider little variation of minimum and maximum temperature in the dry season, explained exactly by the condition of temperature rise, optimized by the phenomenon.

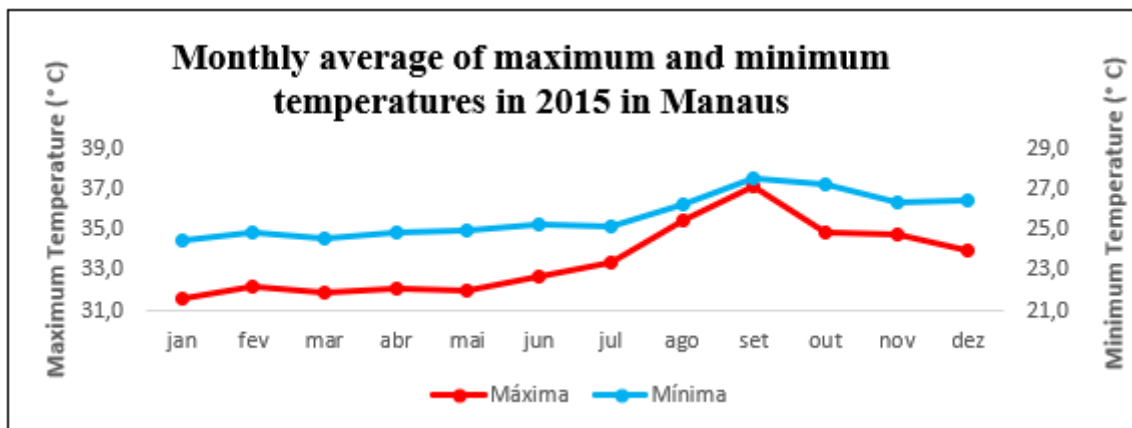


Figure 6 - Monthly average of maximum and minimum temperatures in 2015 in Manaus.

Source: Own authorship, 2019.

Thus, from the observations described by the collected data, it is noted the direct interference of / on temperature. The annual average rainfall in 2015 (Figure 7) was 144.6 (mm). From July to October, the region had rainfall below the average than in the other months, which is very similar in the Amazon region. However, once again it is worth mentioning the intensity caused by the climate phenomenon. In this period, the highest values for maximum temperature and lowest values for minimum temperature were obtained. The presence of the positive ENSO phase kept temperatures high in December due to lack of precipitation in the region (Figure 7).

In agreement with the study by Monteiro et al (2014), Manaus, presents only two seasons, the Amazonian winter between the months of November to June (rainy season) and the summer of July to October (dry season). Rainfall data show that in March there was the highest rainfall, which may be considered as the coldest month and in August with the lowest levels being the hottest (Figure 7).

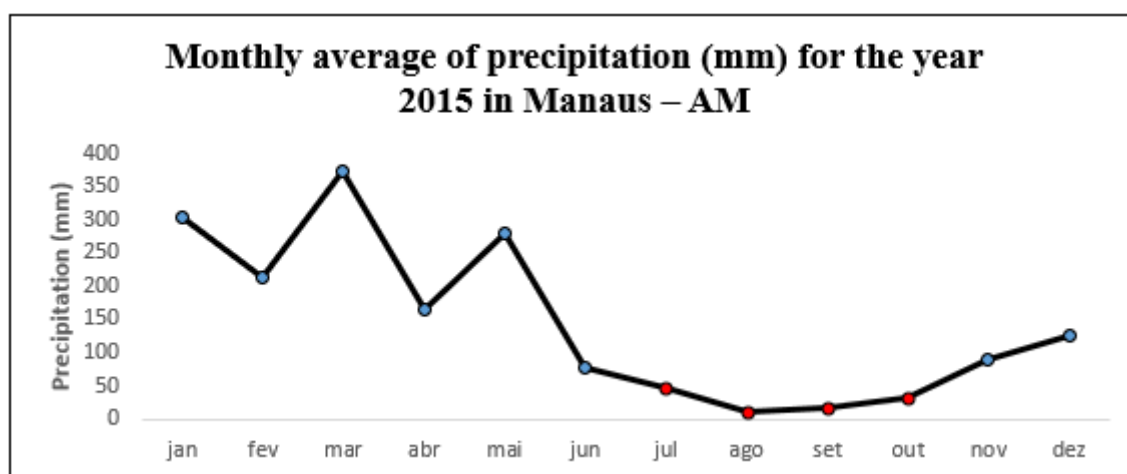


Figure 7 - Monthly average of precipitation (mm) for the year 2015 in Manaus – AM.

Source: Own authorship, 2019.



The low humidity presented in 2015 and 2016 shown in figure 8, is justified by El-Niño that decreases the precipitation rate, raises temperatures and leaves the dry climate in the Amazon region. In 2015, the months with the lowest rate were September and October, with an average of 63%. In March the relative humidity had its highest rate, reaching 85% (Figure 8). Correlating Relative Humidity (%) with Precipitation (mm) is a moderate to strong correlation of 0.731, indicating that the lower the precipitation, the lower the relative humidity.

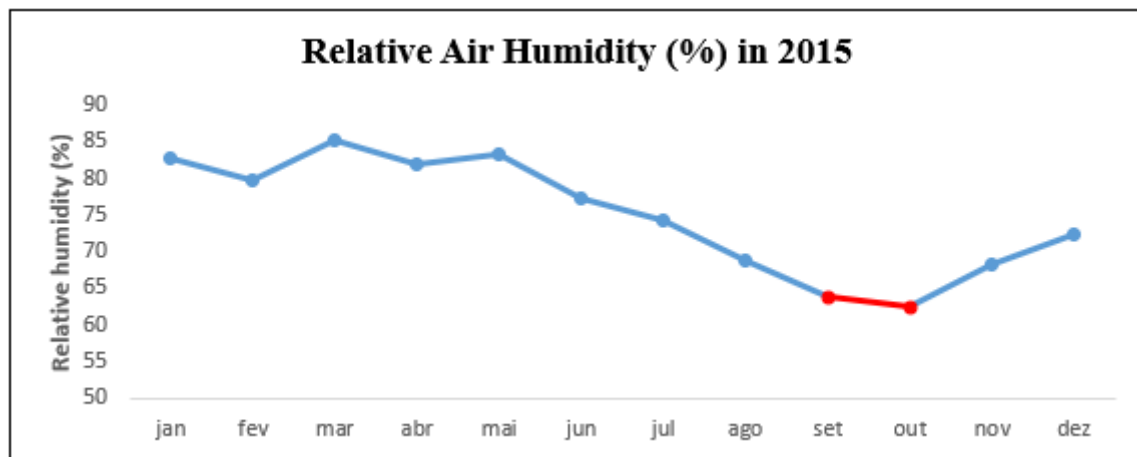


Figure 8 - Relative Air Humidity (%) in 2015.

Source: Own authorship, 2019.

#### 4. Conclusion

The presence of positive and negative ENSO (El Niño-Southern Oscillation) anomalies influenced the climatological variables in the years 2008 and 2015 in the city of Manaus - AM. In 2008, the presence of La Niña caused low temperatures, high precipitation and relative humidity. In 2015, the capital of Amazonas suffered from high temperatures, reduced rainfall, low relative humidity and a long period of drought, characterized by the presence of the extreme El Niño weather event, which may have been prolonged during the year. Following.

Climatic phenomena have been gaining momentum with environmental changes, however it is necessary to understand the whole process, the monitoring of predictive variables and the intensity with which these events have been occurring over time, as a way to find minimization / mitigation processes, for protection, conservation and sustainability response.

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# **Application of queuing theory to a financial institution in the public service sector in the city of Manaus**

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## **Abstract**

*This paper aims to apply queuing theory to a banking service system. Financial institutions are known to attract large audiences on a daily basis, generating long and lengthy queues. Based on empirical knowledge, it is common to use seasonality to explain the increase and decrease in the flow of people in the agencies, either because it is the payment week of a wallet, the workers' lunchtime. This paper aims to apply the theory in a system, with the objective of increasing the company's competitiveness, so that it is remembered as the customer's first choice.*

**Keywords:** Service; Queue Theory; Decision Making; Banking.

## **1. Introduction**

Queue theory is a well-known subject, but this study aims to broaden knowledge by explaining how and why queues are created. In addition to applying such knowledge in a banking sector in order to reduce the formation of large queues.

Much of a bank's ways of making money depend on the client who goes to the agency, whether it's loans, checking, financing, and so on. That is, customer dissatisfaction may lead them to seek out the competitor directly affecting profit. Therefore, good queue management is required in order to build customer loyalty.

According to [1], the idleness of the attendants or the very large number of customers always waiting for

attendance can mean the inadequate system sizing.

Every year there is a significant increase in the opening of current accounts, according to [2], in 2017 there was a 171% increase in the opening of digital accounts compared to 2016, large parts of transactions can be executed by Internet banking, but there are still situations where the customer needs to look for a branch, which means a significant increase in account holders going to banks.

To develop the work, a bank branch of Manaus was chosen to analyze a service sector seeking to identify the main causes of the cluster. Subsequently, propose improvements to meet customer expectations, as well as use efficient service as a competitive factor for the company.

## 2. THEORETICAL REVIEW

This topic will cover the bibliographic material that underlies the research, its relationship to operational research, and the use of queuing theory. Thus, the theoretical foundation focuses on providing the scientific information necessary for a good understanding of queuing theory and where it fits within the study.

### 2.1. Queue Theory

According to [3], queue management may be related to manufacturing, however, rather than product inventory, it is a customer inventory that seeks to reduce its total cost by assessing the balance between maintenance and procurement costs. [6], the realization of the balance between costs as expressed in a U curve, relating the increase in operating capacity with the reduction in the number of customers waiting in queues.

For [4] queues are inevitable and often impossible to program. Each company should put queues under control as they follow. The layout may change, the number of attendants may increase or decrease, among other factors contributing to queue management.

According to [13], even with their distinctions, four elements can be considered common during queuing, which are: queued customers, priority rule utilization, customer generating input population in potential, service facilities, which may be the means, structure and persons necessary to perform the service.

The author [5] describes a queue as a state of clients waiting for service. These queues can be defined as finite or infinite:

According to [6] some of the queue structure models are:

- With a single channel and single phase: there is a queue and a server between the arrival and departure period;

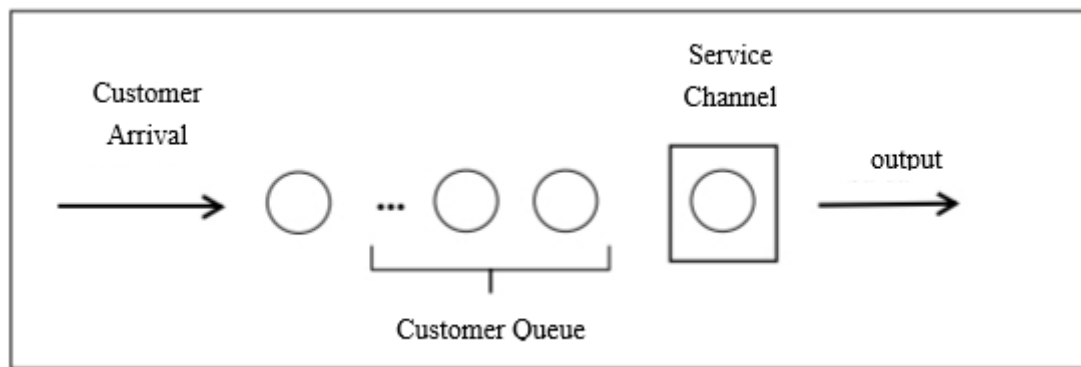


Figure 1: Single Queue and Single Channel System

Source: Adapted from [1]

With single channel and multiple phases: where the individual expects to be served by one server and later served by another;

Multiple Channels and Single Phase: A queue that provides access to different servers;

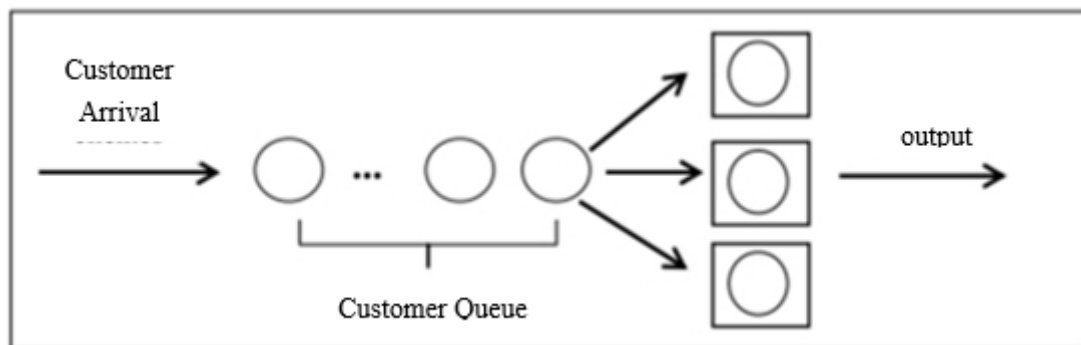


Figure 2: Model with one row and multiple channels.

Source: Adapted from [1]

- Multiple channels and multiple phases: a single queue and more than one answering channel, later passed to other channels;
- Mixed: Multiple queues for single channels and alternate path structure.

The queue model with infinite population and multiple service channel is one with more than one attendant and with discipline of PEPS service, where the values of  $\lambda$  and  $\mu$  will not always be constant. According to [5], the M / M / k model is based on the hypothesis that all times between calls are distributed identically following an exponential distribution according to another exponential distribution and that the number of attendants is k (any integer). positive). Thus, using the nomenclature of [12], we have the following equations:

Table 1: List of Equations

Indicators	Equations
Sector occupancy rate Eq. 1	$\rho = \lambda / c * \mu \rightarrow \rho = 0,257$
Fraction of time a server is empty Eq. 2 and 3	$P_0 = \frac{1}{\sum_{i=0}^{s-1} \frac{(s\rho)^i}{i!} + \frac{(s\rho)^s}{s!(1-\rho)}} =$ $P_j = \frac{(s\rho)^j P_0}{j!} =$

Expected number of customers at the bank and likelihood that attendants or one of the service channels will be busy Eq. 4

$$P(J \geq s) = \frac{(s\rho)^s p_0}{s!(1-\rho)}$$

The average number of clients in the queue and system Eq. 5 and 6

$$L_q = \frac{P(J \geq s) \rho}{(1-\rho)} = L = L_q + \frac{\lambda}{\mu}$$

The average wait time of a customer in bank Eq. 7

$$W = \frac{L}{\lambda}$$

Source: Author

For the system to be considered stable it is necessary that:

$$\rho = \frac{\lambda}{K\mu} < 1 \quad (\text{Eq. 7})$$

Where  $\lambda$  is the average arrival rate of customers;  $\mu$ : is the rate of service of a single channel, in this case, it assumes that all  $\mu$  are equal;  $\rho$ : is the system utilization factor;  $K$ : is the number of service channels.

## 2.2. Decision making

The decision-making process is common in every individual's daily life, and this also applies to managers whose goal of their choice is to solve a present problem or situation. According to [8], one way to understand how institutions work is to focus on their hierarchical flow, work materials, information and decision-making processes.

For [9], the process of reaching a decision is affected by elements such as the nature of the problem, its organizational context, the basic characteristics of decision makers, and the cognitive limitations of human beings. In order to make a good decision one must keep in mind all the viable options to the problem in question, using analysis procedures as a decision support system.

According to [10], there are some steps that must be put into practice that configure the role of decision maker, which are:

- Identify the problem: Problems are not always clear and well defined. At this stage it is important to identify which systems interact with the system where the problem in question occurs. It is very important to have a multidisciplinary team so that the problem can be seen from different points to have the best solution.
- Formulate objectives: Here you define the objectives to be achieved by solving the problem. These may be quantitative objectives, which involve profits and costs, as qualitative which in turn may refer to customer satisfaction. In some situations there may be a conflict between them.
- Analyze limitations: after defining the objectives it should be pointed out which limitations will be applied to the proposed solutions. These restrictions may relate to budget, deadlines, demand, technologies, and other points.
- Evaluate alternatives: With the alternatives in hand, the decision maker will choose the best solution to apply, he should use tools and procedures to support his decision. In this process the person responsible may use a quantitative or qualitative approach. The qualitative approach applies to common everyday problems that have little impact on this treatment should take into account the experience of past

situations. Since the quantitative approach is more used in less frequent, more complex problems, here it is recommended to use scientific optics and available to obtain the best solution.

### 3. Methodology

The survey was conducted at a bank branch located in the city of Manaus. The agency sectors can be divided into four groups, management sector, cash sector, miscellaneous service sector, and legal sector. The chosen object of study of this work was the service sector diverse because it is the biggest bottleneck of the company. This sector serves credit, account, and other faster customer support services. The site consists of four terminals, three of them for employees to perform the service and the fourth for an independent broker. That is, for answering by password, it is considered three terminals.

Data collection was performed in the defined sector, at first the researcher did not intervene in the activities in order to analyze and identify possible problems in the care system. The collection took place through tables where the employee wrote down the customer's password number, the time of entry, the time it was answered and finally the service time.

The article had outlined the results of sizing calculations and service performance measurements.

### 4. Application of Study

The sector studied has the highest concentration of agency staff, being affected by seasonality in various periods, several factors that contribute to this were observed, namely: trade lunch time, INSS retirees pay week, and pay periods of monthly bills.

Data were collected between April and June 2019, from 9:00 am to 3:00 pm. The data were organized in Excel spreadsheet, for later calculations.

Thus, the time used for answering is 6 hours and the number of 3 answering channels without limit of attendance capacity and PEPS type order.

Bank arrival rate ( $\lambda$ ): 13.80 calls / hour

Call rate ( $\mu$ ): 18.23 calls / hour

The data collected can be seen in the table below.

Table 2: Data from consultations collected between April and June 2019

Service Day	Number of calls	Service Time (h)
1	102	5,35
2	90	4,37
3	57	3,4
4	99	5,45
5	72	4,48
<b>Total</b>	420	23,05

Source: Author

### 5. Results and Discussions



In the city where this study was conducted, there are laws in place [11] that set the time the consumer can spend waiting for care, 15 minutes on normal flow days; 20 minutes on eve or after holidays and 25 minutes on paydays from public servants. According to the calculations and data collected, it is possible to observe how the customer flow happened during the monitored period. Below in table 3 are the results obtained:

Table 3: Results obtained through the calculation of the collected data.

VARIÁVEL	VALUE (APPROXIMATE)
Customer Arrival Rate ( $\lambda$ )	13.80 clients / hour
Service Rate ( $\mu$ )	18.23 calls / hour
Fraction of time a server is empty (probability) ( $P_0$ )	45%
Customer Waiting Probability ( $P_j$ )	34%
Queued Customer Probability ( $P(J \geq S)$ )	9%
Average Number of Customers Queued ( $L_q$ )	0.03 client / hour
Average number of clients in the system ( $L$ )	0.79 customer / hour
Average customer wait time ( $W$ )	0.057 hour or 3.42 minutes

Source: Author

From the results obtained it can be observed that the average time that a customer waits in line is 3.189 minutes which is at acceptable levels of the company regarding the waiting time for customer service. It can also be noted that despite the continuous flow of customer arrivals at the company this does not prevent customer service and waiting times from remaining within acceptable business and customer satisfactory standards.

Looking at the tables, it can be seen that the total number of clients were served before 1/3 of the maximum waiting time, leaving employees with idle time in about 45% of their work routine.

As previously mentioned, the analyzed sector has three attendants to the public. A new analysis was made this time removing one of the attendants, relocating it to another sector. With this we get the results represented in the table below:

Table 4: Results considering the removal of one of the attendants

VARIABLE	VALUE (APPROXIMATE)
Customer Arrival Rate ( $\lambda$ )	14 clients / hour
Service Rate ( $\mu$ )	13.48 calls / hour
Fraction of time a server is empty (probability) ( $P_0$ )	32%
Customer Waiting Probability ( $P_j$ )	32%
Queued Client Probability ( $P(J \geq S)$ )	34%
Expected Average Number of Customers Awaiting Service ( $L_q$ )	0.35 customer
Average number of clients in the system ( $L$ )	1.39 customer
Average customer wait time ( $W$ )	0.099 hour or 5.95 minutes

Source: Author

According to the results obtained, reducing the number of attendants, the customer's waiting time was from 0.057 hours or 3.42 minutes to 0.099 hours or 5.95 minutes, which remains slack within the required standard. By reducing to two attendants the system remained stable, which allowed the manager to allocate his employees more efficiently, allowing him to solve pending activities due to lack of manpower. In addition to reducing the cost with staff, because previously there was the idea of hiring another professional to support the activities as mentioned above. That is, the changes meet the needs of clients and the institution.

## 6. Final Considerations

Queue theory allows you to analyze the efficiency of a system. Through it one can analyze the management of the customer and the service. By gathering information, it is possible to improve the functioning of the process. This is why it is very useful to apply it to a bank service system.

With the results obtained, it was found that there is the possibility of optimizing the analyzed care process. To study the system, a sample of attendances was collected using as one of the methods the timing of the time that the customer spent in the system. Aiming to collect data to optimize the provision of services to customers, as well as assist in the decision making of managers.

In the first data collection it was found that the customer's waiting time was within the standard required by municipal laws. As it was identified that employees were about 45% of their work routine idle. For this reason, to reduce this time it is indicated to change the system from three channels to two channels. Such modification obeys the client's needs, as the waiting time remains below the limit, besides offering the manager options to optimize processes in other sectors of the institution.

If they chose to remove two of the three employees, the waiting time would remain within the limit, but it is not advisable due to unforeseen issues that could lead to industry congestion and customer overload, which would have consequences for the institution and would cause dissatisfaction. of the customer.

Service is an important factor for the customer when deciding which banking institution to choose. Which makes it a competitive factor to provide fast and efficient service. These improvement actions combined with entrepreneurial skills are important steps to ensure the success of the venture.

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## **Degrees of Risk of Environmental Impacts Arising from Irregular Occupations in the Northern Zone of Manaus - Amazonas**

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### **Abstract**

*The disordered urban growth in the city of Manaus has had serious consequences for the environment in recent years, especially towards the northern part of the city. It is extremely important to verify the environmental impacts caused by this situation, in order to define the priority areas for planning and recovery actions of the areas. Sixteen areas were identified during the study, which were divided into four quadrants to define their risk levels. The risk levels were I - low, II - medium, III - high and IV - very high. The first criterion for dividing the areas in the quadrants was to identify similar characteristics between them and the second, the proximity of the areas, considering, therefore, the size of the area, as well as the loss of vegetation cover, the state of the soil and the existence and quality of the areas. water resources near the occupied areas. It was found that the presence of streams is a decisive factor to increase the environmental risk of a occupied area, in which anthropic actions intensify natural processes. Another factor considered is related to the degree of erosive processes, therefore, the occurrence of gullies and ravines accounted for the increased risk. After accounting for recorded impacts, quadrant B, located in the Cidade de Deus neighborhood, has a high environmental risk, while quadrants C and D have medium risk. These three quadrants have streams in their areas, however, quadrant A, which has no water body, has a low degree of risk, although three of its four areas have gullies. From this analysis, it is possible to define mitigation and impact containment measures, allowing natural resources to be preserved for the well-being of everyone today and for years to come.*

**Keywords:** Urban growth; Risk areas; Environmental variables

## **1. Introduction**

Manaus is considered a city with good rates of job opportunities, services, income and education compared to other municipalities in the state of Amazonas, presenting the best HDI in the state, generating great population attraction [1].

Population growth linked to the disorderly occupation rate over the years has generated a number of environmental problems, causing the urban area to grow in the countryside, replacing native vegetation with buildings and paving.

The city was not prepared to meet the population's demand for basic infrastructure such as sanitation and housing, increasing the population in peripheral areas [1].

Some of the most common problems triggered by this situation, inferring from numerous social, economic and environmental problems, are deficiencies in basic sanitation; lack of proper water and sewage treatment; and low frequency solid waste collection, factors that increase the likelihood that people living in these areas will suffer from the environmental impacts often caused by them [2]

In the last decades, the urban growth of the city has turned mainly to the north zone, being Cidade Nova, created in 1981, one of the first neighborhoods in this region through projects of construction of housing estates by the Government of the State of Amazonas, through of the Housing Superintendence - SUHAB [3].

After the creation of the first stage, others emerged as sets and neighborhoods, starting from the same. In 2010, the subdivision of the neighborhood, given by Municipal Law No. 1,401, of January 14, made the Nova Cidade, Cidade de Deus and Novo Aleixo neighborhoods official. Currently, these neighborhoods comprise 19.3% of the municipality's population, showing the importance of the region [4].

Among the neighborhoods mentioned, Cidade Nova and Cidade de Deus have, respectively, the Sumauma State Park and the Adolpho Ducke Forest Reserve, which are conservation units that are strongly affected by urban sprawl, a fact that can be viewed with the help of remote sensing tools. besides verified in person.

Using geotechnologies is an efficient way to locate areas without having to go on site, saving time and resources. In addition, environmental management, monitoring and inspection processes have used geoprocessing tools as a way to obtain data faster, more accurately and predict scenarios for decision making, as well as assist in solving social and environmental problems that directly affect the environment. welfare and safety of the population [5].

In addition to geotechnologies, it is important to use conventional methods where field truth is required, such as some forms of environmental impact assessment: Ad Hoc, Checklist, Interaction Matrix, Interaction Networks, Overlay Maps, Simulation Models [6 ]. To be more effective in studying areas, two or more methods need to complement each other, depending on the resources, time, and staff available.

In areas that are irregularly occupied close to urban buffer zones, such as forest fragments (which protect the soil) and also to watercourses, the Checklist is of great value in identifying the environmental impacts directly observed on the physical environment, vegetation cover. and water resources, thus identifying the degree of environmental risk in each location.

CONAMA Resolution No. 01/1986 [7], which deals with the basic criteria and general guidelines for

environmental impact assessment, is that any change in the physical, chemical or biological properties of the environment caused by anthropic action is found. or natural, which affect the health, safety, well-being of the population; economic and social activities; the biota; the aesthetic and sanitary conditions of the environment; the quality of environmental resources.

Environmental impact is defined by the likelihood of the occurrence and the consequences caused, varying in its form, magnitude, location, specific characteristics and reversibility of the impact caused [8].

Therefore, the objective of the present study is to identify the environmental impacts intensified by anthropic actions in the Cidade de Deus and Cidade Nova neighborhoods, with the purpose of dividing the areas into quadrants and defining their risk levels directly affected by urban growth and occupations. irregular in the last ten years. The risk degrees of the impacts caused by this situation will be compared at grade I (low), II (moderate), III (medium) and IV (high).

## 2. Materials and Method

### 2.1 Study area

In the urban area of Manaus / AM ( $-03^{\circ} 01' 47.73''$  S and  $-59^{\circ} 58' 07.19''$  O), the study areas, located in Cidade Nova and Cidade de Deus neighborhoods, have irregular occupation. over the last ten years and generate environmental impact on areas considered at risk. The coordinates of the analyzed areas, located via Google Earth and transformed to decimal coordinates, are recorded in table 01.

Table 01. Decimal coordinates of the evaluated areas.

AREA	LAT	LONG	AREA	LAT	LONG	AREA	LAT	LONG	AREA	LAT	LONG
01	-3,0176	-59,9597	05	-3,0099	-59,9516	09	-3,0274	-59,9557	13	-3,0225	-59,9698
02	-3,0126	-59,9619	06	-3,0095	-59,9516	10	-3,0125	-59,9686	14	-3,0247	-59,9654
03	-3,0106	-59,9565	07	-3,0222	-59,9507	11	-3,0159	-59,9672	15	-3,0437	-59,9777
04	-3,0104	-59,9557	08	-3,0303	-59,9506	12	-3,0210	-59,9641	16	-3,0451	-59,9830

Source: Own authorship (2019).

### 2.2 Data Collection

The research is characterized as descriptive-qualitative, being raised in the field in order to verify the set of situations of the areas covered in this study. Along with this process, the causes and consequences of environmental impacts were discussed. The tools used to obtain the data were Google Earth Pro; ArcGIS 10.4; Microsoft Excel 2013 and the Checklist method for environmental impact assessment, in which the collected data were determinant for the characterization and classification of the degrees of risk and type of impact on the environment.

Google Earth Pro has been used to identify areas of irregular occupation that have emerged over the past ten years, targeting those with remnants of vegetation, water bodies and steep slopes in their vicinity. Geographic coordinates were collected using this software and later added to a Microsoft Excel 2013 spreadsheet to convert them to decimal coordinates. After the insertion of decimal coordinates of the areas in the Excel table, the work of creating shapefiles in ArcGIS 10.4 began.

Subsequently, the area was divided into four quadrants in ArcGIS 10.3 and the number of four areas in

each was accounted for. From this, there was a field survey, in which each area was visited and the components found from the environmental impact analysis method through the checklist were observed, which used to identify and enumerate the environmental impacts, and with bibliographic basis, the risk levels of the quadrants in the neighborhood area were defined.

It was verified the existence of irregular occupations and the impact on the soil caused by natural actions intensified by the anthropic. The process also used the ArcGIS and Google Earth tools to measure irregularly occupied land, which is fundamental to stipulate the price of land, multiplying by the value of the m<sup>2</sup>, thus defining how much the government responsible for land has lost economically in recent years.

### 2.3 Criteria for establishing risk grades

The first criterion established depended on the slope and the distance where the occupied areas are positioned. The areas, when visited, had the slope estimated macroscopically and images were recorded to prove it. The length was defined using the Google Earth geoprocessing tool.

It is known that the population itself creates new risks beyond the occupation and suppression of the vegetal area, such as effluent discharge in irregular places, solid waste, among those that were identified during the on-site visit. The model described in Table 02 was used as a basis to identify the environmental impacts encountered at the sites during field visits.

Table 02. Model for establishing risk factors in study area visits.

CHARACTERISTICS TO BE ANALYZED					
<b>GROUND</b>	Occurrence of steep incline (above 45 °)	Furrow (do not consider) Ravine (YES) Gully (YES)	Receiving inappropriate waste disposal	Receiving effluent discharge	
<b>WATER RESOURCES</b>	existence	Occupation distance in disagreement with Brazilian Forest Code	Waste in the watercourse	Silting Process	Eutrophication Process
<b>VEGETAL COVER</b>	Dimension of total area (above 5,000 m <sup>2</sup> )	Size of occupied area in m <sup>2</sup> (consider risk if more than 20% of lost area)			

Source: Own authorship, 2019.

A table was created to account for impacts in each quadrant. Therefore, each item per area could be worth up to four. Then, from the sum of the impacts, divided by the number of areas, it was possible to establish the degree of risk for each of them.

During the visits to the areas, it was reported which of the factors, together, occur in each one, thus defining the ones that suffer the greatest environmental impacts. Finally, each area was allocated to a quadrant next to the nearest areas, observing the risk levels of the occupied areas, being degrees I - low, II - medium, III - high and IV - very high.

Among the eleven components described in Table 02, the risk will be defined based on the number of the following aspects.

- Low risk (grade I): one to three aspects;

- Medium risk (grade II): four to six aspects;
- High risk (grade III): seven to eight aspects, and;
- Very high risk (grade IV): from nine to eleven aspects.

### 3. Results and discussion

The change in land use and occupation in the last ten years (2009-2019) in the study area is highly significant, where vegetation suppression was the aspect that suffered the most loss, an aspect analyzed through remote sensing. This is a worrying factor economically because the minimum price of these areas is high wherever it is located. The m<sup>2</sup> numbers of the areas are described in table 03.

Table 03: Lost values and areas in m<sup>2</sup> for irregular occupations.

Lost Values and Areas (m <sup>2</sup> ) for Irregular Occupations					Lost Values and Areas (m <sup>2</sup> ) for Irregular Occupations				
			Cidade Nova	Cidade de Deus			Cidade Nova	Cidade de Deus	
	Size of the area (m <sup>2</sup> )	Occupied zone	R\$ 185,57	R\$ 40,17		Size of the area (m <sup>2</sup> )	Occupied zone	R\$ 185,57	R\$ 40,17
Area 01	266.302	115.916	21.510.532,12	-	Area 09	36.398	2.263	-	90.904,71
Area 02	46.159	15.078	-	605.683,26	Area 10	9.907,28	11.103	1.838.493,95	-
Area 03	152,62	*	-	6.130,74	Area 11	45.134	1.775	329.386,75	-
Area 04	68,94	*	-	2.769,32	Area 12	28.810	10.125	1.878.896,25	-
Area 05	750,13	*	-	30.132,72	Area 13	46.577	19.659	3.248.120,63	-
Area 06	659,45	**	-	**	Area 14	24.331	9.532	1.768.853,24	-
Area 07	14.217	1.543	-	61.982,31	Area 15	181.953	***	-	-
Area 08	8.818	2.476	-	99.460,92	Area 16	55.296	4.399***	816.322,43	-

Source: Own authorship, 2019.

\* areas that do not have direct occupation over the site, \*\* area belonging to the union and with priceless rich biological and natural heritage; minimum value simulated because the area is rich in biodiversity.

All areas of this study have their uniqueness, with some features also found elsewhere. However, four strongly draw attention because it contemplates most of the aspects analyzed in the places, being them in red color (figure 01).





Figure 01: Areas analyzed.

Source: Own authorship (2019).

The quadrants, called A, B, C and D, have four areas each, encompassing similar aspects between them, which is the first criterion for subdivisions. The second criterion is the proximity between the areas. From the extent of loss of vegetation cover in the last ten years, described in table 4, it is possible to delimit the environmental impacts and risks of each quadrant.

Table 4: 2009-2019 loss of vegetation cover in the study area.

Quadrant	Quadrant Areas	Neighborhood	Neighborhood Area (m <sup>2</sup> )	Occupied zone (Last 10 years)	% loss of vegetation cover
A	3, 4, 5 e 6	Cidade de Deus	1631,14	no significant n°	0
B	2, 7, 8 e 09	Cidade de Deus	96.774	21.360	22,1
C	01, 10, 11, 13	Cidade Nova	367.920	148.453	40,3
D	12, 14, 15, 16	Cidade Nova	206.284	24.056	11,7

Source: Own authorship, 2019.

The loss of vegetation cover in quadrant C is the most significant, where 40.3% of the total area was lost to irregular occupations. There is a tendency of demographic growth in the area, where it is worrying about the preservation of the main area with remaining vegetation in the same quadrant, area 11. This one, which has steep declivity, houses a significant biodiversity, such as Sauim de coleira, an endemic and highly endangered species.

Quadrant B covers the smallest amount of occupied area in the last years, being possible to notice that the occupation does not tend to increase high, being a limited area; while quadrant A does not have significant occupancy numbers given the short perimeter compared to other areas, however, the impacts on them are of significant importance.

Quadrant D has two areas located near strategic points, such as Av. Gov. José Lindoso, access road to the International Educative Research Foundation and Publisher © 2019

south-central area. The fact that these areas are located near housing estates not derived from the famous “invasions” and with greater supervision over the sites, may interfere with not being greatly impacted.

In contrast, the remaining two areas of the quadrant - 12 and 14 - have a higher rate of irregular occupations, totaling 19,657 m<sup>2</sup>, or 81.7% of the total area occupied in the quadrant. The possibility of areas located in the peripheral zone being more prone to the appearance of irregular occupations was observed during this analysis, except for areas without more space for expansion.

Loss of vegetation cover is the primary aspect for the emergence of several other impacts, such as erosion, particle carry-over to water bodies, construction of irregular occupations that generate effluent discharge, often without basic treatment, in inappropriate places, such as soil and watercourses, as well as loss of biodiversity at the sites.

Therefore, it is important to cite the impacts caused by the situation, starting from the ground, as described in table 5, in order to define the degrees of risk of the quadrants.

Table 05: Impacts on soil by quadrant.

	Area	Approximate Tilt Angle	Erosion type	Occurrence of waste dumping	Occurrence of effluent discharge
Quadrant A	3	80°	Gullet	Not included	X
	4	80°	Gullet	X	X
	5	80°	Gullet	X	X
	6	25°	Not included	X	Not included
Quadrant B	2	12°	Groove	X	X
	7	25°	Ravine	X	X
	8	12°	Not included	X	X
	9	55°	Not included	Not included	X
Quadrant C	1	80°	Gullet	X	X
	10	65°	Gullet	Not included	X
	11	52,5°	Not included	X	X
	13	35°	Groove	Not included	X
Quadrant D	12	23°	Groove	Not included	X
	14	40°	Ravine	X	X
	15	30°	Groove	X	Not included
	16	40°	Not included	X	X

Source: Own authorship, 2019.

From the data analyzed, it is observed in quadrant 01, the occurrence of high slope relief and gullies identified in 75% of the areas. In them, where the dystrophic yellow latosol was located, the effluent from the houses near the top, directly above the ground, was also observed.

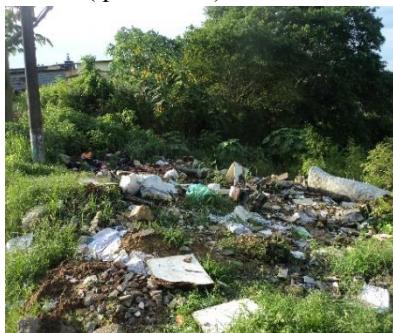
In the areas 04 and 05 of the referred quadrant, it was possible to notice that effluent discharge occurs directly on the soil, resulting in the vegetation growth (figures 03 and 04). At the same time, in area 06 - edge of the Adolpho Ducke reserve - there is the occurrence of an addicted dumpster, in which the odor and occurrence of vector proliferation are high. Waste was carried to the base of the vegetation after torrential rain.

**Figure 02: Area 03****Figure 03: Area 04****Figure 04: Area 05****Figure 05: Area 06.**

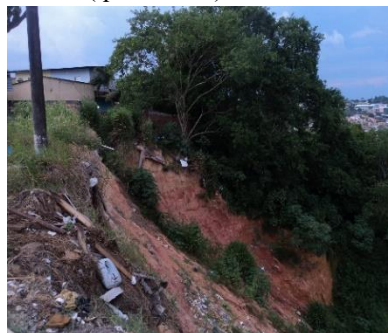
Source: Own authorship, 2019.

The region's soil situation is of concern, as erosion is in a difficult phase to contain. There are few areas in the early-middle phase of increasing erosion dimensions, such as furrows and ravines, which can still be contained.

Quadrant C, which has the second highest rate of gullet occurrences, differs from quadrant A because it has a total of occupied areas 7 times larger. In addition, it has the highest land use index in the last ten years, in which 40.35% of the vegetation cover has been lost. Allied to factors that occur after occupation, such as improper dumping of solid waste and effluents, this aspect promotes an increase in the percentage of soil losses, favorable to the increase of the size of erosion areas, as in area 01 (figures 06 and 07 ).

**Figure 06:** situation of area 01 (quadrant C) in 2017.

Source: Own Author

**Figure 07:** situation of area 01 (quadrant C) in 2019.

Source: Own Author

**Figure 08:** Area 09, Quadrant B

Source: Own Author

It is important to emphasize that the areas of quadrants A and C are close, making it possible to state that the coverage area of both quadrants has the most marked relief of the study. Therefore, the area tends to the appearance of erosions that, if not contained, evolve to larger dimensions, reaching the gully level.

As for the erosion ratio in the soil, quadrant D does not stand out, since it has a vegetation cover, still conserved in the last ten years; Areas 12 and 14 have lost a significant number of vegetation cover, however, their relief is not greatly accentuated.

In quadrant B, which has only one area without vegetation cover and ravine type erosion, it was possible to observe an area unique to the others in this work. It was observed the occupation of the base of a steep slope, of approximately 55 °. The area, which is the division of a collective garage and the Cidade de Deus neighborhood, has native vegetation - sustaining the slope - at the same time as the occupation, also receives effluent discharge without any treatment, resulting in destabilization of the slope. (figure 08).

Impacts on the ground are easily observed in the occurrence of irregular occupations, because of this, they are the first to be noticed. Another type of worrying impact is on water resources. In this case, in urban areas. Among the 16 study areas, 07 areas with impacts on the watercourses were analyzed, as detailed in table 6.

Table 06: Situation of streams observed in the study areas.

Quadrant	Area	Existence of watercourse	Approximate Width	Occupation distance shorter than recommended	Waste in the stream	In the process of silting	In process of eutrophication	Untreated effluent discharge
A	3	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-
B	2	X	5 m	X	X	X	X	X
	7	X	3 m	X	X	X	X	X
	8	X	5 m	X	X	X	X	X
	9	-	-	-	-	-	-	-
C	1	X	7 m	X	X	X	X	X
	10	-	-	-	-	-	-	-
	11	-	-	-	-	-	-	-
	13	-	-	-	-	-	-	-
D	12	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-
	15	X	9 m	Not included	X	X	Not included	Not included
	16	X	5 m	Not included	X	X	Not included	Not included

Source: Own authorship, 2019.

In relation to watercourses, it was observed that in quadrant B the impacts on streams are the most significant, where they are at serious risk of not being able to resist anthropic actions if they continue to receive the current level of impacts. about them. One of the factors that warns of the resistance of streams over the years is the width of the streams, because all, in the dry season, reach less than 10 m wide.

In this quadrant, which is the most worrisome, there is also the loss of vegetation cover on the banks of water bodies for the occupation of simple and many precarious dwellings, which are flooded during torrential rain, which impairs the natural water cycle. As reported in table 03, the watercourses analyzed in quadrants B and C are silenced due to loss of vegetation cover, and it is possible to locate solid waste and tailings (figure 09), as well as the discharge of untreated effluents. due basic treatments, causing the eutrophication of water bodies near inhabited areas.

**Figure 09:** Area 01 stream margin situation (quadrant C)**Figure 10:** Excerpt from area 07 stream (quadrant B)





Source: Own authorship, 2019.

During the visits to the analyzed areas, solutions were also found for the areas. Area 11, located in quadrant 03, received a large volume of tailings and solid waste, mainly from civil construction and furniture used until early 2019 (Figure 09). In mid-June of that year, the City Hall installed prohibition signs regarding the disposal of these materials on the area, which has a high conservation index of the vegetation that protects the soil from exposure and possible erosion, as it has rugged relief. .

In addition to the plaques, ornamental plants were inserted in the area as a measure of sensitization to the residents of the region (figure 12) so that there is no disposal of tailings in this area.

**Figure 11:** Area 12, in 2017;



**Figure 12:** Area 12, after City Hall Action



Source: Own authorship, 2019.

Another example of recovery attempt was found in area 14, located in quadrant D, where ravine-type erosion that served as an open-air dumpster occurs. As in area 12, waste disposal boards and tire-wrapped ornamental plants were installed (figure 13). However, the area also received the Green Area sign (Figure 14).

**Figure 13:** Area 12 (Quadrant D) Recovered.

**Figure 14:** Green area code in area 12.





Source: Own authorship, 2019.

Differently from the areas described above, both previously receiving solid waste, recovered by awareness actions of the city hall, in area 15, there was a work of cleaning the local stream (Figures 15 and 16). The action improved the flow velocity of the stream, removing the vegetation that covered it and the solid waste suspended or trapped in the vegetation.

**Figure 15:** Stream cleaning action in area 15 (quadrant D). **Figure 16:** Amount of vegetation and waste removed from site.



Source: Own authorship, 2019.

### Degrees of risk

After analysis of the events occurring on areas of the quadrants and in accordance with the observed facts, the result of the analysis of the degree of risk is given as follows:

Table 7: degrees of risk in the quadrants.

	A	B	C	D
Area Dimensions	-	4	4	4
(above 5000 m <sup>2</sup> )	-	1	2	2
Area occupied (> 20%)	3	2	3	-

Tilt (> 45 °)	3	1	2	1
Erosion (Ravine / Gully)	3	3	2	3
Soil residues	3	4	4	3
Effluents on soil	-	3	1	2
Existence of a stream	-	3	1	-
Creek Distance-Occupied Area	-	3	1	2
Residues on the stream	-	3	1	2
Siltation in the stream	-	3	1	-
Effluent discharge directly into the stream	-	3	1	-
Eutrophic Igarapé	12	32	23	19
	<b>DIVIDE BY 4</b>			
	3	8	6	4,75

Source: Own authorship, 2019.

Through the sum of the impacts intensified by anthropic actions and the subsequent division of the numbers by the number of areas, the quadrant identified as the one that suffers the greatest environmental impacts was the B, located in the Cidade de Deus neighborhood, with high risk, having 8 aspects around all. The factor that most contributed to the result was the number of streams by area and their states, all in degeneration and close to occupations.

Quadrant A, which does not have water bodies, has the lowest risk compared to the others, reaching an average of 3 impacts, mostly related to erosions. Meanwhile, the C and D quadrants, with respectively 4.75 6, and the results were included in the average degree of risk.

Quadrant A, which has areas with more similar characteristics, showed greater homogeneity during the descriptions of environmental impacts by irregular occupations. Meanwhile, areas with significant differences in characteristics found in others in the quadrant changed the risk level of the quadrant, such as area 01, inserted in quadrant C. If the risk grades were accounted for by area, the risk degree of the area 01 would be given as 'very high', but as the other areas analyzed in the quadrant have less impacts intensified by anthropic actions, resulting in a lower degree of risk, the average of the points evaluated in the quadrants generated an average risk.

Therefore, it is possible to affirm that areas with homogeneity of characteristics result in a more accurate quadrant risk degree, in contrast to quadrants that have areas with different characteristics, resulting in a different risk degree to the reality of the areas.

#### 4. Discussion

The effects of unbridled growth, which have been highly impacting, in recent years are directed to the northern area of Manaus, where there are still several areas with vegetation cover, seen by the occupation agents as an area to explore. Often, housing in precarious and unhealthy conditions is occupied close to the streams, emphasizing how problematic territorial management, the organization of a single planning

pattern and the ordering of a metropolis such as Manaus [9].

As spaces and the natural environment are transformed by anthropic actions, there is the destruction of springs, threats to the extinction of native animal species, erosion problems, flooding and loss of vegetation cover [10].

Many of the areas covered in this study, located in occupations near watercourses and steep slopes, are considered Permanent Preservation Areas - APP [11]. This law establishes the protection of marginal areas of watercourses up to 10m wide by 30 meters of riparian forest and native vegetation on each side, in addition to considering APP slopes and part of them with slopes greater than 45 °. However, the law is not being respected, as irregular occupation was found in a shorter distance than recommended, the removal of vegetation on slopes and the non-preservation of these, where also the dumping of solid waste in inappropriate places.

The factors found in the present study resemble those found by [12] in the Gilberto Mestrinho neighborhood, such as irregular occupation of slopes, siltation of canals, suppression of vegetation cover, cuts in slope profile for terracing, housing and land use, waste disposal, poor sanitation infrastructure.

The loss of the vegetation cover of the space promotes the forest fragmentation of areas with less interest for the occupation, resulting in the isolation of species, placed in a fragile situation. The distance between fragments influences the lack of interactivity with their continuous habitat, which is detrimental to plant and animal populations with continually migrating migration and dispersal rates [13].

According to [13], one of the most common impacts on edge effects of a forest fragment occurs from the contact of two different environments, in which one suffers alteration under the influence of the other. This situation, found in area 06 (quadrant A) and areas 01 and 11 (quadrant C), reflects the impact caused by the population on forest fragments and gullies edges, which receive a large amount of solid waste, visually impacting besides providing proliferation of pathogenic vectors.

Anthropic impacts on forest fragments also occurred in the studies of [14], in which the release of fresh sewage into the woods and inadequate disposal of waste was observed. Similar to the present study, several disturbances threaten the fragile balance of the ecosystem, all related to human activities on the local environment.

The study of [15], which also identified solid waste dumping in forest edge areas and water bodies, enabled the development and attraction of pathogenic vectors, as well as obstructing galleries and decreasing oxygen in the waters, which can be found in area 16, located in quadrant D of this study.

At the same time, the commitment not allied to non-awareness of the environmental damage is one of the main factors for the incidence of solid waste in streams. Many people not only throw directly on the watercourse, but accumulate the waste in improper places, the so-called junk dumps, which during heavy rains, are carried by water to the streams [16]. In addition to wastewater in streams, Manaus water bodies also receive 89.82% of freshwater sewage discharged directly into their beds, as stated by [17].

The development of urbanization most often not only negatively impacts water bodies and vegetation cover, but also influences the development and acceleration of erosion processes, which slows down when urbanization is consolidated and receives the intervention of the government. It is stated that in many areas, the main cause of gullies is human intervention, given the ineffectiveness of government supervision to prevent urban occupation [18]. The instability of slopes, unique among the areas, is



potentiated through anthropic interventions, such as vegetation suppression, cuts, landfill, garbage disposal, risk factors that can lead to fatalities [14].

Along the eastern zone, the northern zone of Manaus has the largest amount of erosive processes in the city, in which there is the presence of high slopes, where there are several housing estates in the flat areas of the board tops, reaching the edges of the erosive areas. Erosions arise naturally or accentuated by anthropic actions. The most severe forms of erosion are ravines, which if not contained in time, evolve into gullies, both derived from the action of runoff, but gullies present a higher risk due to complexity and potential linear erosion [19].

The identification of environmental risks is preceded by something primarily impactful. Risks have different effects that a given event may cause, at one point or that may be forwarded to another [13].

Urban risks, mainly due to climate actions, such as excessive rainfall and unorganized occupations, such as streams and slopes, bring the need to establish preventive measures and mitigate environmental impacts [20].

## **5. Conclusion**

Field studies combined with the Checklist tool and the use of geoprocessing tools to perform comparisons on vegetation loss have shown that the influence of urban growth on natural area remnants such as forest fragments, water bodies and their impacts is highly worrying.

All water bodies - an essential factor for the degree of risk - are in a siltation state, as well as most receiving solid waste disposal. Quadrant B, which has in three of its four areas waterways, has the highest degree of risk. Meanwhile, areas with gullies and gullies were also highlighted during impact accounting. Quadrant A, which has three gullies - the most advanced erosion state - with steep declivity, has a low environmental risk, with an average of three impacts, due to the size of its areas, as well as the lack of water resources.

The quadrants located in the Cidade Nova neighborhood, C and D, have medium risk degrees, with great variation because their areas do not have a homogeneity of the components found in the evaluation. It can be said that if the areas were evaluated individually, some of them could fall into the high risk category. The heterogeneity of environmental characteristics had a strong influence on the quadrant as a whole. Explained by homogeneity, an essential factor in the search for results closer to the reality of the places. During the on-site visits, it was possible to observe the intervention of the city hall in the recovery of three areas, all in the Cidade Nova neighborhood, two with steep slopes, raising awareness about the reduction of solid waste disposal on their edges. The third area is the stream 15, where the cleaning occurred for better water circulation, in which excess vegetation over the stream and accumulated solid waste was removed.

The actions of the city in relation to the environment are of great value for the promotion of the well-being and sensitization of the population of the area to choose to do the right and maintain the conserved areas. However, similar work is required in all areas. The difficulty is known, but if the actions were repeated in many other areas, we would not possibly be able to see how quickly degradation reaches all natural environments still trying to exist in our urban area.

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# **Spatial variability in fertigated coffee yields and plant nutrients in soil saturation extracts**

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## **Abstract**

*The spatial distribution and levels of available plant nutrients (elements) in the soil can limit coffee yield and must be evaluated for effective crop management. Therefore, we analyzed spatial variability in yield and plant nutrients in the saturation extract of a clayey Oxisol cropped with fertigated coffee. The experiment was carried out on 14 hectares of coffee in Monte Carmelo, Minas Gerais, Brazil. Soil samples were collected (0 - 0.2m layer) at 61 regular grid points (spaced 50x50m) and used to determine*

*plant nutrients in the saturation extract. Coffee yield was also determined at these points. Descriptive statistics were calculated for each variable and geostatistics were used to build a spatial variability model representing the physical attributes of the soil. Variographic analysis was performed using semivariograms. These showed that yield and soil chemistry varied throughout the study site. Thus, the maps generated from geostatistics can be useful tools for soil management in fertigated coffee crops.*

**Keywords:** precision agriculture; *Coffea arabica* L.; geostatistics;

## 1. INTRODUCTION

Brazil is the global leader in coffee production, with 61.7 million processed bags in 2018 (CONAB, 2018). Thus, coffee is an important part of Brazilian agribusiness and the Brazilian economy. The Cerrado of Minas Gerais has the soil and climate conditions needed to produce (Ortega and Jesus, 2011), high quality coffee (Alves et al. 2011) that can achieve certification and compete in the market (Barra and Ladeira, 2016).

Various interrelationships among the physical, chemical and biological properties of the soil control processes and related aspects that vary by time and location. Thus, the fertility, structure and biological activity of the soil can be modified by any changes to the soil, which can in turn affect production processes (Stefanoski et al. 2013, Silva et al. 2015) and crop yields. Therefore, strong yields require the monitoring of soil fertility and nutrient availability and consequent soil corrections (Deus et al., 2015).

Soil solution analysis is an underutilized tool that is used to evaluate nutrient availability in the soil (Coscione et al., 2014) and show plant nutrition elements available in the soil saturation extract (Souza et al., 2015). Analysis of the soil saturation extract plays an important role in agriculture and is widely used in several countries (Riedi, 2013). In Brazil, this type of analysis has been carried out since 1973 to quantify heavy metal contamination and since 2002, the company Agrichem has employed this process to determine micronutrient availability for crops (Riedi, 2013).

In an interview, Riedi (2013) stated that, unlike normal chemical analysis, which gives a partial picture of nutrient levels, the saturation extract shows exactly what the plant can absorb from the soil. Understanding the levels of plant nutrient elements available in the soil can be useful for achieving an optimal nutritional balance for coffee. Thus, precision agriculture is important and increasingly complemented by an understanding of spatial variability in soil attributes (Zanao Junior et al., 2010, Zonta et al., 2014), which is essential for monitoring the distribution of plant nutrients.

Moreover, a better understanding of the dependence and spatial distribution of soil nutrients can be used to efficiently manage and optimize the coffee fertilization. Several studies have shown that the mapping of soil properties based on geospatial data can be used to manage spatial variability in soil nutrients. Xu et al. 2017 used remote sensing to show that the spatial resolution of orbital images directly affects the effectiveness of empirical models used to estimate potassium concentration in the soil.

Geostatistics can also be used to detect variability and spatial distribution of variables, which is useful for analyzing and describing variability in soil attributes. Recently, geostatistics has been used in several studies to evaluate soil variability but has been little used in the field of soil chemistry.

Given the spatial dependence of soil attributes, spatial interpolation (e.g. kriging) has also been widely used as a management tool for various crops. Studies on sugarcane (Li et al, 2019) and conilon coffee (Santos et al., 2015) have demonstrated that spatial interpolation via kriging can be used to estimate calcium (Ca) and magnesium (Mg) deficiencies in the soil, and may be a useful tool in the process of meeting crop nutritional requirements.

Given the importance of coffee and the lack of studies that examine the relationship between spatial variability in soil attributes and yield, studies involving soil nutritional variables are essential for precision agriculture. Thus, the objective of the present study was to analyze spatial variability in yield and available nutrients in the saturation extract of a clayey Oxisol cropped with fertigated coffee.

## 2. MATERIAL AND METHODS

The evaluations were carried out on fertigated coffee crops in a region of the Brazilian Cerrado (Monte Carmelo MG, 18° 42' 28,9" S and 47° 33' 27,0" W) with a clayey Oxisol (SANTOS et al., 2013). This coffee crop was replanted with *Coffea arabica* L. (spaced 3.8 x 0.7 m) in January 2012. In March 2015, approximately 14 ha of this plantation was mapped with a 61-point sampling (soil and plants) grid (50 x 50m) (Figure 1).

The coordinates of the grid points were determined using an L1 / L2 dual frequency Hipper Global Navigation Satellite System (GNSS) receiver. One receiver was used as a static relative positioning device and provided the basis for GNSS tracking. The resulting data were processed with Topcon Tools 8.2.3 software and using the Uberlândia MG and Rio Paranaíba MG stations of the Brazilian Continuous Monitoring Network (RBMC - Rede Brasileira de Monitoramento Contínuo).

Soil samples were collected (0 – 0.2m) at each of the grid points, which covered the varying topography of the landscape. These soil samples were used to create a paste (35% humidity) from which the saturation extract was obtained (Teixeira et al., 2017), which was then used to determine plant nutrition content via ICP-OES. In May 2015, coffee plants were harvested from each grid point to determine yield per plant (average of 5 plants per grid point). Data analysis was divided into two stages: exploratory analysis and geostatistical analysis. The exploratory analysis consisted of statistical analysis (non-spatial) and determination of spatial dependencies through experimental semivariograms (spatial). The geostatistical analysis involved fitting data to theoretical models and mapping.

Statistical analysis was performed to determine central tendencies and dispersion and histogram measurements to confirm data normality. Descriptive statistics were used to determine principal moments for each variable. These were then used to create probability distributions and examine data variability. The statistical moments included the mean, variance, coefficient of variation, asymmetry coefficient and kurtosis coefficient. Data minimums, maximums and amplitudes were also identified.

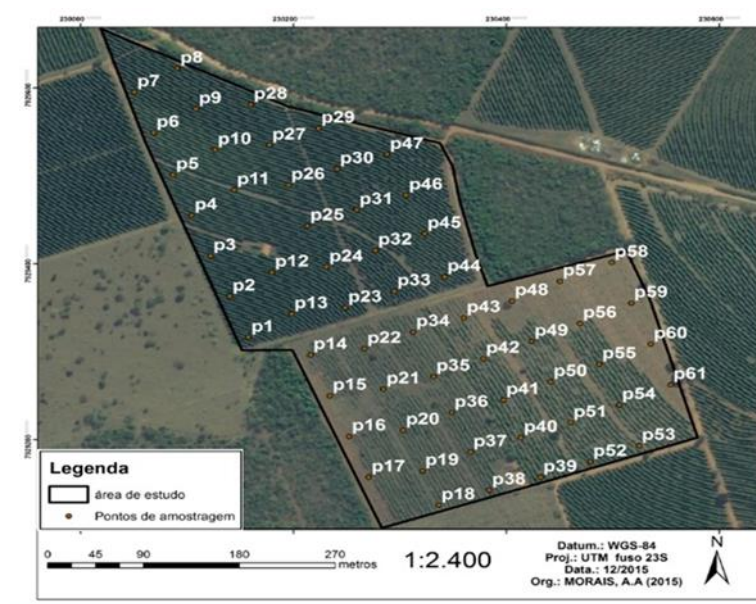


Figure 1. Layout of the study area at Fazenda Juliana, Monte Carmelo, MG, Brazil.

Geostatistics were used to build spatial variability models of soil physical attributes. Variographic analysis was performed using semivariograms. Semivariance was then graphed ( $\gamma(h)$  versus distance ( $h$ )) and used to build semivariogram models that fit the experimental data. The GS+ geostatistical software package (Robertson, 1998) was used to calculate semivariance and to select semivariogram models. After defining the models, interpolation was performed using the ordinary kriging method. Cross-semivariogram calculations were also used to determine spatial correlations between attributes.

The models were fit to the semivariograms using the Jack-knifing validation method, which analyzes the mean and variance values of the reduced errors (Souza et al., 1997), of spherical, exponential, Gaussian and linear models.

### 3. RESULTS AND DISCUSSION

The descriptive statistics and classification of the coefficient of variation (Warrick and Nielsen, 1980) as low ( $CV < 12\%$ ), medium ( $12\% < CV < 60\%$ ) or high ( $CV > 60\%$ ), showed that the pH and copper variables were low and homogenous (Table 1). However, all other CVs were classified as median. The heterogeneity of these variables may be affected by agricultural practices and soil attributes. This conclusion corroborates the results of Almeida et al. (2018) regarding the physical attributes of soil cropped with coffee.

Table 1. Descriptive statistics for: coffee yield ( $\text{kg plant}^{-1}$ ), pH, plant nutrients in the soil saturation extract ( $\text{mg L}^{-1}$  of P: phosphorus, S: sulfur, K: potassium, Ca: calcium, Mg: magnesium, B: boron, Cu: copper, Fe: iron, Mn: manganese and Zn: zinc)

Variable	Descriptive statistics						
	Mean	Mín	Max	SD	CV	As	Kurt
yield	4.75	0.36	8.94	1.95	13.73	-0.02	-0.02
pH	7.31	5.96	7.70	0.29	3.91	-0.59	7.23
P	0.22	0.10	0.55	0.09	39.46	0.16	1.79

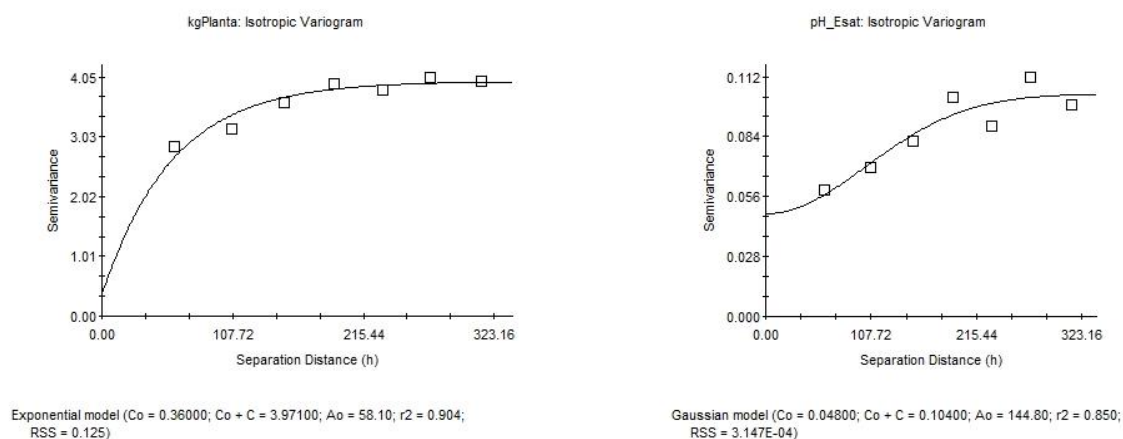
S	10.38	5.55	34.60	5.45	52.49	0.94	6.15
K	17.55	9.21	27.34	4.52	25.76	0.45	-0.51
Ca	18.24	5.37	42.62	6.57	36.03	0.91	2.11
Mg	5.79	1.01	13.73	2.63	45.39	0.69	2.18
B	0.15	0.09	0.19	0.02	14.28	-0.35	0.39
Cu	0.17	0.16	0.18	0.01	3.50	0.50	-0.11
Fe	2.23	0.14	4.39	1.25	55.97	-0.83	-0.95
Mn	0.16	0.13	0.24	0.02	14.34	0.75	1.59
Zn	0.15	0.11	0.27	0.03	19.01	0.70	8.48

\* Min: Minimum; Max: Maximum; SD: standard deviation; CV: Coefficient of variation; As: Asymmetry; Kurt: Kurtosis.

There was little variation among the mean values for most variables, as indicated by asymmetry values close to zero, except for sulfur, calcium, magnesium, iron, manganese and zinc, which had asymmetry values approaching 0.5, indicating normally distributed data (Webster, 2001).

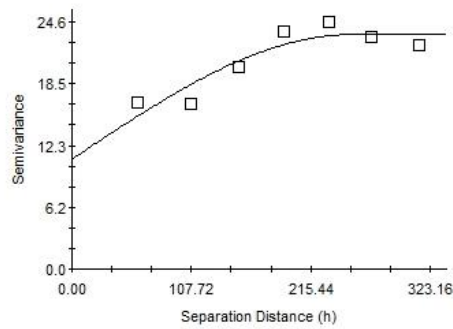
The semivariograms show that the nugget effect was greater than zero for all variables (Figure 2). This suggests that variability was not explained or that the distance between grid points and/or small variations were not detected by sampling (Lundgren et al., 2017, Pelissari et al., 2018).

The model fit to coffee yield and plant nutrients in the soil saturation extract was exponential for phosphorus and copper; however, the coefficient of determination was low for phosphorus, copper, sulfur and manganese. The spherical model was fit to potassium, sulfur, magnesium, boron, iron and manganese in the soil saturation extract. The Gaussian model was fit to pH and calcium, while only zinc was fit to the linear model. Carmo et al. (2016) and Santos et al. (2015) fit the same models to coffee yield and plant nutrients in the soil. Nevertheless, few studies have fit models to the relationship between plant nutrients in the soil saturation extract and coffee yield.



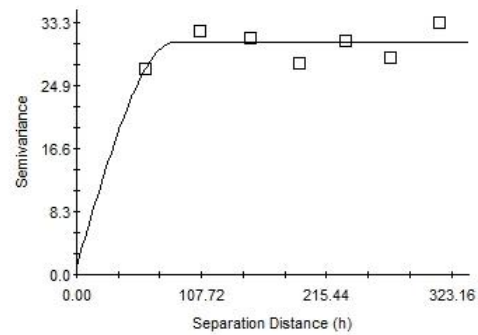


K\_Esat: Isotropic Variogram



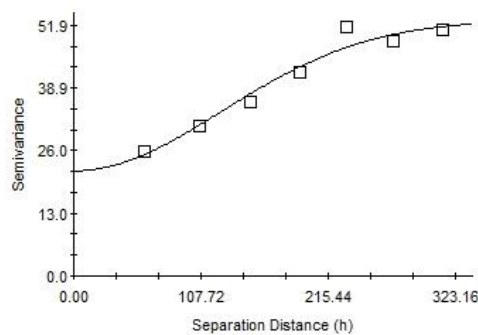
Spherical model ( $C_0 = 10.96000$ ;  $C_0 + C = 23.39000$ ;  $A_0 = 252.60$ ;  $r^2 = 0.842$ ;  $RSS = 10.7$ )

S\_Esat: Isotropic Variogram



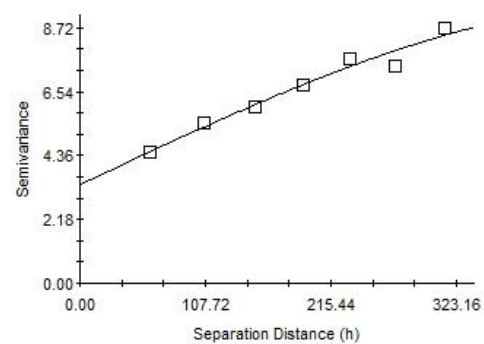
Spherical model ( $C_0 = 1.03000$ ;  $C_0 + C = 30.67000$ ;  $A_0 = 84.50$ ;  $r^2 = 0.334$ ;  $RSS = 21.1$ )

Ca\_Esat: Isotropic Variogram



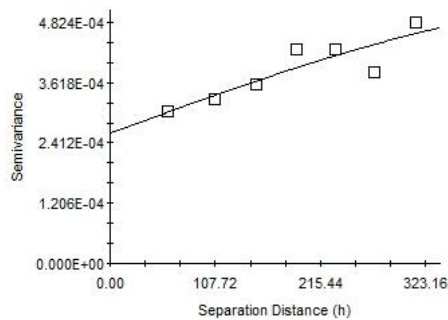
Gaussian model ( $C_0 = 21.79000$ ;  $C_0 + C = 53.06000$ ;  $A_0 = 177.30$ ;  $r^2 = 0.958$ ;  $RSS = 26.1$ )

Mg\_Esat: Isotropic Variogram



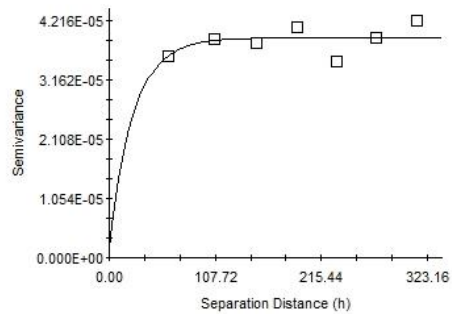
Spherical model ( $C_0 = 3.37000$ ;  $C_0 + C = 9.62100$ ;  $A_0 = 500.20$ ;  $r^2 = 0.967$ ;  $RSS = 0.415$ )

B\_Esat: Isotropic Variogram



Spherical model ( $C_0 = 0.00026$ ;  $C_0 + C = 0.00052$ ;  $A_0 = 550.50$ ;  $r^2 = 0.777$ ;  $RSS = 5.279E-09$ )

Cu\_Esat: Isotropic Variogram



Exponential model ( $C_0 = 0.00000$ ;  $C_0 + C = 0.00004$ ;  $A_0 = 24.40$ ;  $r^2 = 0.214$ ;  $RSS = 3.160E-11$ )

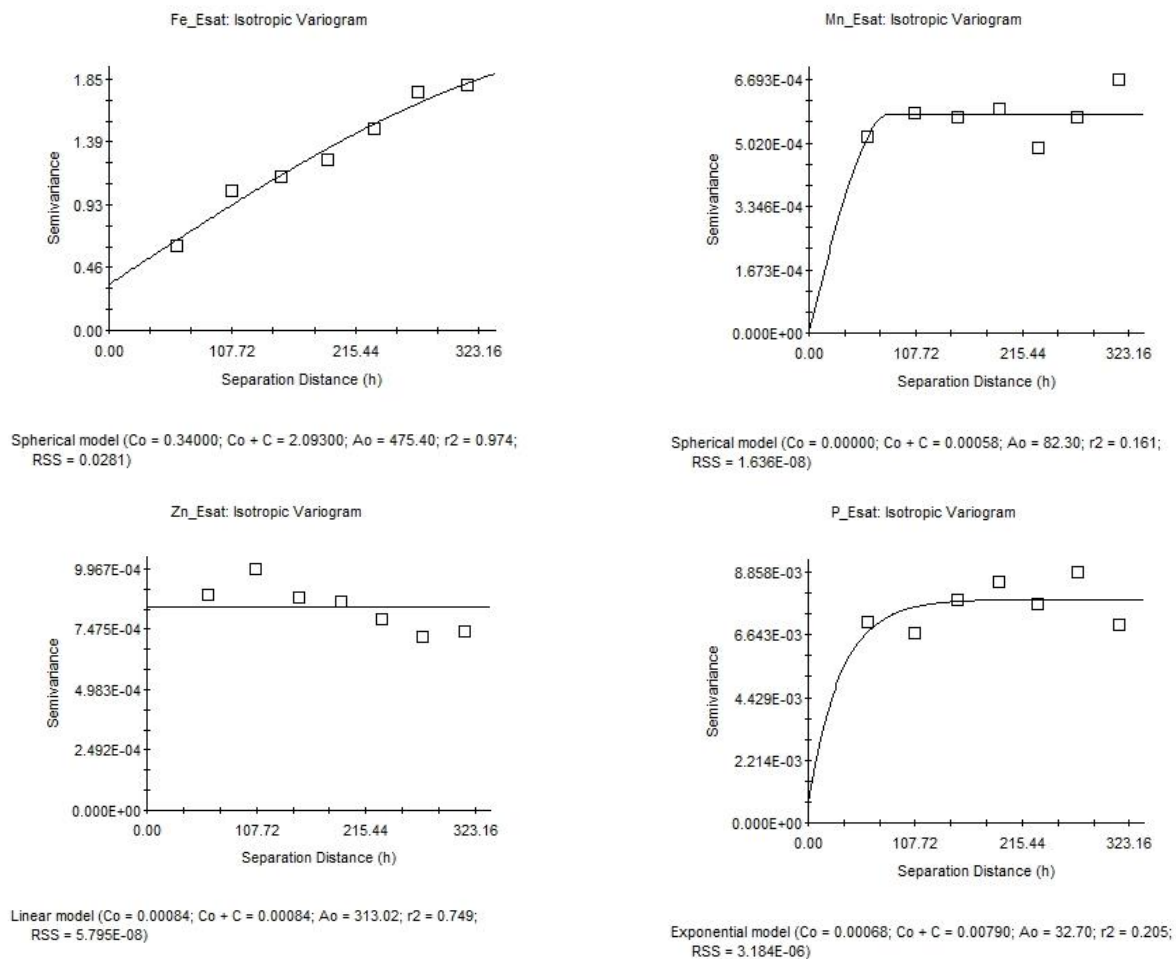


Figure 2. Semivariograms of coffee yield ( $\text{kg plant}^{-1}$ ), hydrogen potential ( $\text{pH-pH}_{\text{Esat}}$ ) and plant nutrients in the soil saturation extract ( $\text{mg L}^{-1}$  of: S: sulfur ( $\text{S}_{\text{Esat}}$ ), K: potassium ( $\text{K}_{\text{Esat}}$ ), Ca: calcium ( $\text{Ca}_{\text{Esat}}$ ), Mg: magnesium ( $\text{Mg}_{\text{Esat}}$ ), B: boron ( $\text{B}_{\text{Esat}}$ ), Cu: copper ( $\text{Cu}_{\text{Esat}}$ ), Fe: iron ( $\text{Fe}_{\text{Esat}}$ ), Mn: manganese ( $\text{Mn}_{\text{Esat}}$ ), P: phosphorus ( $\text{P}_{\text{Esat}}$ ) and Zn: zinc ( $\text{Zn}_{\text{Esat}}$ )).

Analyzing variations in plant nutrients in the soil saturation extract and coffee yield is possible with maps and semivariograms, but not via an isolated analysis of minimums, maximums and means. Therefore, geostatistics were used to show that spatial dependence existed for all variables (i.e. none of the variables were randomly distributed) (Table 2).

Table 2. Semivariogram parameters fit to coffee yield ( $\text{kg plant}^{-1}$ ), hydrogen potential (pH), plant nutrients in the soil saturation extract ( $\text{mg L}^{-1}$  of P: phosphorus, S: sulfur, K: potassium, Ca: calcium, Mg: magnesium, B: boron, Cu: copper, Fe: iron, Mn: manganese and Zn: zinc)

Attribute	Parameters <sup>1</sup>					
	Model	$C_0$	$C_0 + C_1$	$C_0 / (C_0 + C_1)^2$	$a$	$r^2$
$\text{kg Plant}^{-1}$	Exponential	0.36	3.971	9.1	58.1	0.904
pH	Gaussian	0.048	0.104	46.2	144.8	0.850
P	Exponential	0.00068	0.00791	8.6	32.7	0.205
S	Spherical	1.03	30.67	3.4	84.5	0.334
K	Spherical	10.96	23.39	46.9	252.6	0.842

Ca	Gaussian	21.79	53.06	41.1	177.3	0.958
Mg	Spherical	3.37	9.621	35.0	500.2	0.967
B	Spherical	0.00026	0.00052	50.0	550.5	0.777
Cu	Exponential	0.00001	0.00004	25.0	24.4	0.214
Fe	Spherical	0.34	2.093	16.2	475.4	0.974
Mn	Spherical	0.00001	0.00058	1.7	82.3	0.161
Zn	Linear	0.00084	0.00085	98.8	313.02	0.749

<sup>1</sup> Co: nugget effect, Co + C1: threshold, <sup>2</sup>Degree of spatial dependence (percentage) such that: <25% = strong; between 25 and 75% = moderate and > 75% = weak (Cambardella et al, 1994); a: range.

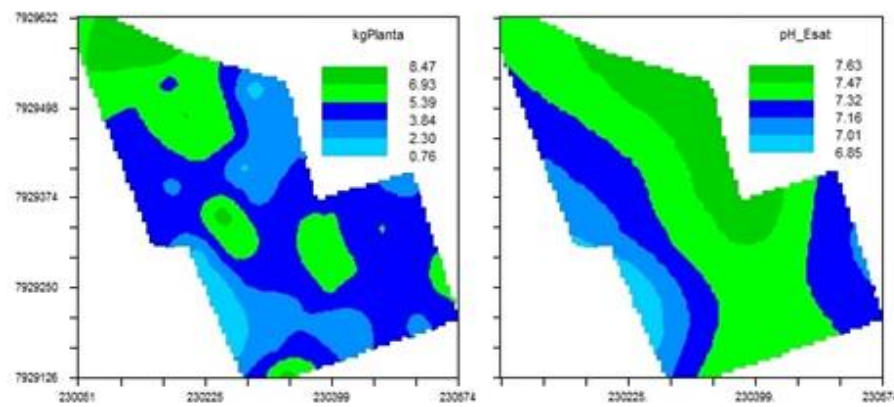
The lowest coffee yields (<2.3 kg plant<sup>-1</sup>) were found at the longitudinal extremities of the study site while the highest values were found at higher and more central longitudinal bands. Other studies have found similarly wide spatial variations in coffee yields (Ferraz et al., 2018, Ferraz et al., 2012, Jacintho et al., 2017, and Silva et al., 2008).

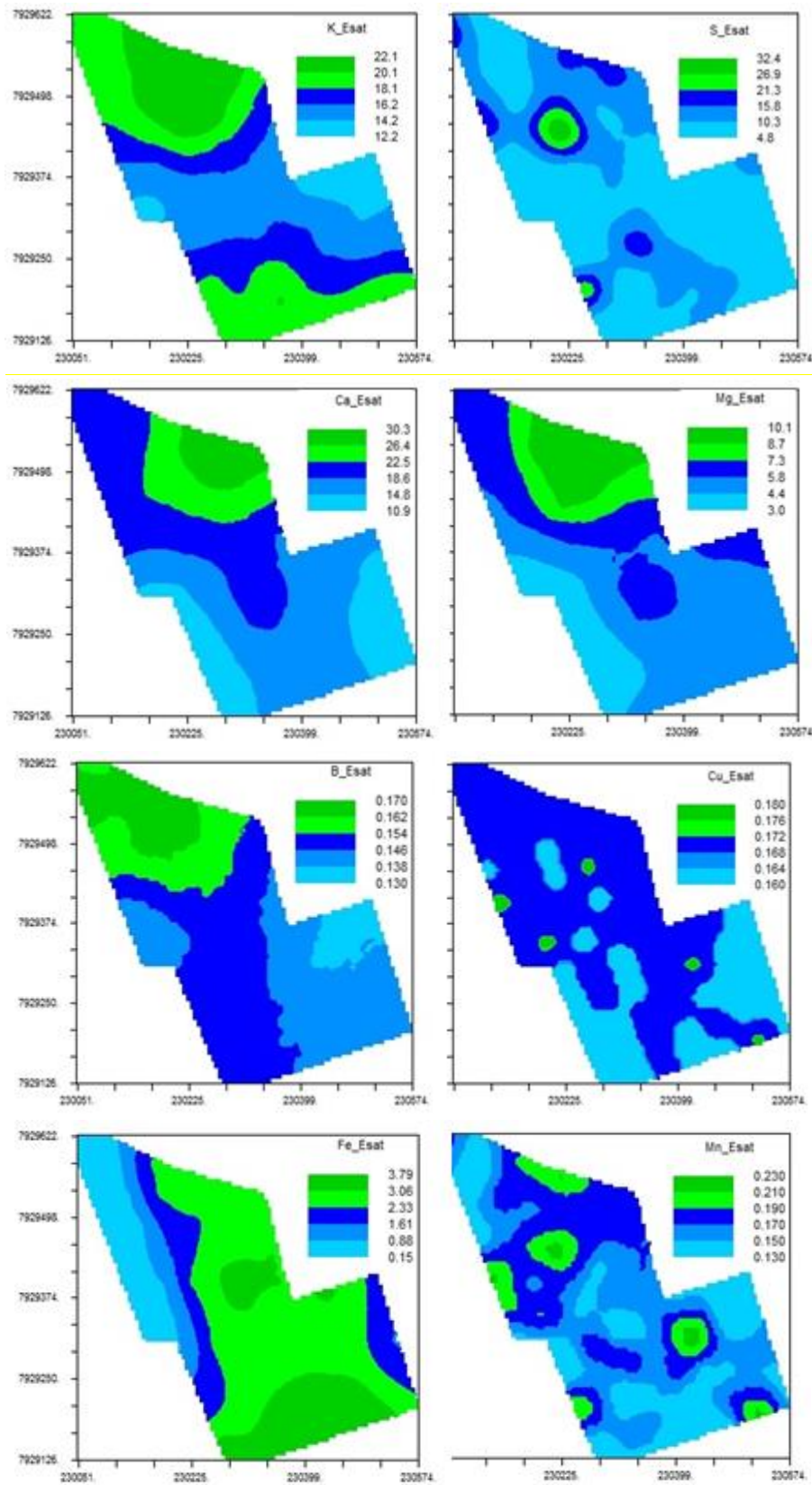
All plant nutrient levels in the soil saturation extract, except Zinc, followed the same pattern as variations in yield. Zinc levels, on the other hand, were lowest in areas with the highest coffee yields. The agricultural and environmental significance of the current study is underlined by the lack of studies on precision agriculture or management zones that examine the relationship between plant nutrition levels and the soil solution under fertigated coffee, which is in contrast to the level of attention given to soil chemical attributes (Ferraz et al., 2018, Jacintho et al., 2017, Santos et al., 2015 and Silva et al., 2008).

Based on the classification system of Cambardella et al. (1994), coffee yield showed strong or moderate spatial dependence on plant nutrients in the soil saturation extract, except for zinc which was weakly dependent. Similarly, Almeida et al. (2018) found that physical soil attributes at georeferenced points had more in common with neighboring points than with the rest of the sample space. This shows the importance of spatial evaluations for the effective management of plant nutrients in the soil solution.

The yield figure shows that yields were highest in the extreme north and two central regions of the study area. Concomitantly, the levels of pH, K and B were also highest in these areas. Calcium, magnesium and iron also peaked within these same sites, but in a more limited area.

Significantly, the dispersion patterns of yield, pH, potassium, calcium, magnesium, boron and iron were zonal (i.e. higher concentrations covering larger areas). Conversely, the dispersion patterns of the remaining attributes were marked by smaller, more scattered areas within the study area.





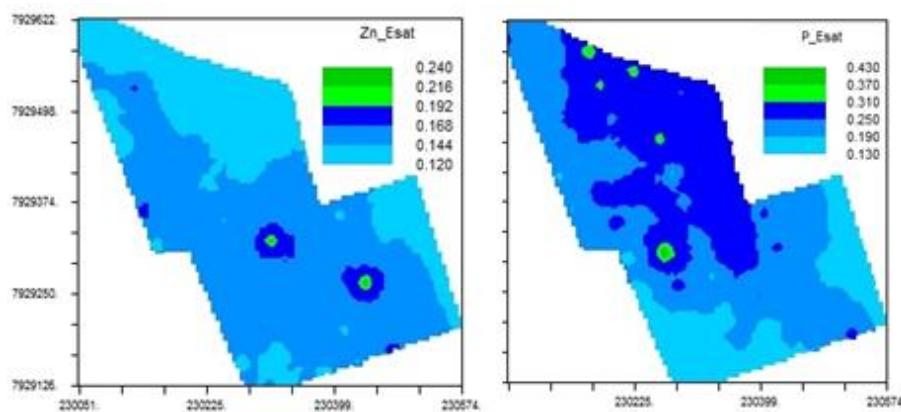


Figure 3. Spatial distribution of coffee yield ( $\text{kg plant}^{-1}$ ), hydrogen potential ( $\text{pH-pH}_{\text{Esat}}$ ) and  $\text{mg L}^{-1}$  of plant nutrients in the soil saturation extract (S: sulfur ( $\text{S}_{\text{Esat}}$ ), K: potassium ( $\text{K}_{\text{Esat}}$ ), Ca: calcium ( $\text{Ca}_{\text{Esat}}$ ), Mg: magnesium ( $\text{Mg}_{\text{Esat}}$ ), B: boron ( $\text{B}_{\text{Esat}}$ ), Cu: copper ( $\text{Cu}_{\text{Esat}}$ ), Fe: iron ( $\text{Fe}_{\text{Esat}}$ ), Mn: manganese ( $\text{Mn}_{\text{Esat}}$ ), P: phosphorus ( $\text{P}_{\text{Esat}}$ ) and Zn: zinc ( $\text{Zn}_{\text{Esat}}$ )).

In Brazil, Silva and Lima (2012) used geostatistics to examine spatial variability in coffee yields and found that yields were limited by excess nitrogen and copper. Almeida and Guimarães (2012) used geostatistics to study sustainable soil fertility management in a drip fertigated coffee crop (Araguari, Minas Gerais, Brazil), grown in a Red-Yellow Latosol, and found that pH was strongly spatially dependent and was fit to a Gaussian model. The study found similar results for macronutrients, except the sulfur variogram data, which were fit to a spherical model. Cerri (2005), evaluated and correlated physical and chemical soil attributes to yields at the São João sugar and ethanol plant (Usina São João Açúcar e Álcool) in Araras, Sao Paulo Brazil, and found that these physical and chemical properties, including copper, showed isotropic characteristics and that a spherical model provided the best fit to the semivariogram data. Valladares et al. (2009), studied the spatial variability and availability of copper and zinc in vineyard soils in the city of Jundiaí, Sao Paulo, Brazil and found strong spatial dependence and spatial dependence ratios for copper, despite great distances between sampling points. The semivariograms from this study were fit to a Gaussian model and the nugget effect was lower and closer to zero for copper than for zinc.

The study of coffee yield and plant nutrients in the saturation extract is worthwhile and has been shown as a promising method for diagnosing soil fertility, especially in citrus fertigation systems (Souza et al., 2015). Nevertheless, studies and recommendations for coffee crops are lacking. Saturation extract analysis can be used to quantify the elements available in the soil solution and identify actual plant nutrient requirements, which in turn can be used to optimize fertilizer applications (Riedi, 2013). However, this process is currently employed by only a few companies. This underutilization may be due to a lack of information on how to make decisions based on the nutrient content of the soil solution. Appropriate fertilizer and corrective recommendations lead to better crop yields. A combination of these recommendations and precision farming techniques can make agricultural and environmental sustainability possible and result in gains for crops such as fertigated coffee.

#### 4. CONCLUSIONS



We found a strong or moderate degree of spatial dependence between yield and plant nutrients in the soil saturation extract of a fertigated coffee crop. This shows that the behavior of these variables throughout the study area was not random and that geostatistics can be used to help make decisions to improve plant nutrition and soil sustainability in coffee plantations.

## 5. Acknowledgement

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# **Analysis of Labor Qualification in Civil Construction in Manaus Amazonas**

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## **Abstract**

*Civil construction is one of the fastest growing sectors in Brazil, and in the state of Amazonas is no different, however, it is observed that several problems are affected by direct formal companies and one of them is the unskilled labor, especially when it deals with masons and servants, in these terms, the study of this study and analysis of the qualification of the labor in the civil construction in the city of Manaus-Am. To achieve the research objectives, in the first moment of this study a bibliographic research was carried out, based on books, articles and magazines already published, and in the second stage field research and it is also a qualitative research. And according to the two surveys, it was found that construction in Manaus needs to look for new ways to qualify its workers, so that the sector can be producing their buildings with better quality, as well as making their deliveries on time. Regarding the proposal to qualify the workforce, the surveyed companies will study a way to perform training for their workers.*

**Keywords:** Construction; Labor; Manaus; Qualification;

## 1. Introduction

Civil construction is the industrial sector that represents a fundamental importance in the Brazilian economy. In addition to its importance related to economic and social aspects, construction has a very strong interference in nature. “It uses natural resources in a substantial way and this relates to the environment, whether in obtaining its raw material, or in the large amount of debris generated by the sector, as well as the use of urban space”. (ALMEIDA, 2019, p.35).

In studies of Silva (2015), construction companies are currently at a very fast pace of undertaking and the number of these companies has grown considerably. However, the highlight will be that company renowned for its positive results regarding the efficient application of material and financial resources, respected deadlines, quality of products delivered, skilled labor, among others.

Second Pacheco (2016, p.14), “It is known that labor problems are very common in the construction sector, acting as time constraints and influencing project performance.” In this sense, lack of manpower capacity increases rework and spread errors on the construction site, resulting in low productivity and increased deadlines for project execution.

The present study is of great relevance to professionals, as it is a topic much discussed today that also directly affects the economy as a whole in this sector. For society it is important because of the quality of work when they hire such professionals to perform small or even large works. For the academy it is necessary to bring this debate, as it refers to the quality of professionals that this sector needs to offer to its clients.

Given the above, this research aims to analyze the qualification of labor in civil construction in the city of Manaus-Am. The study will be carried out according to the methodology: firstly, a bibliographic survey will be made and then a field research, which will answer the objectives proposed in this research.

## 2. Methodology

### 2.1 Research Strategy and Classification

As a research strategy, the Case Study was adopted, analyzing two construction companies. “Case study refers to examining the real world as it exists in its natural environment” (POZZEBON e FREITAS, 1997, p.5). The research will be conducted at W3 Engenharia and Direcional Engenharia companies in Manaus-AM. The choice of work was due to the availability of access to the locus, as they are small facilities, as well as favoring the achievement of the research objective.

### 2.2 Study Population and Sample

The population consisted of 10 construction professionals (masons and housekeepers) who work in both companies. The research was conducted with a sample of subjects composed of 10 construction professionals, among them obtaining a total of 100% of the population.

Considering the analysis of technical procedures, the research developed as an empirical investigation. In the first moment through a survey of bibliographic materials and in the second moment field research, as

shown in Figure 1.



Figure 1: construction workers

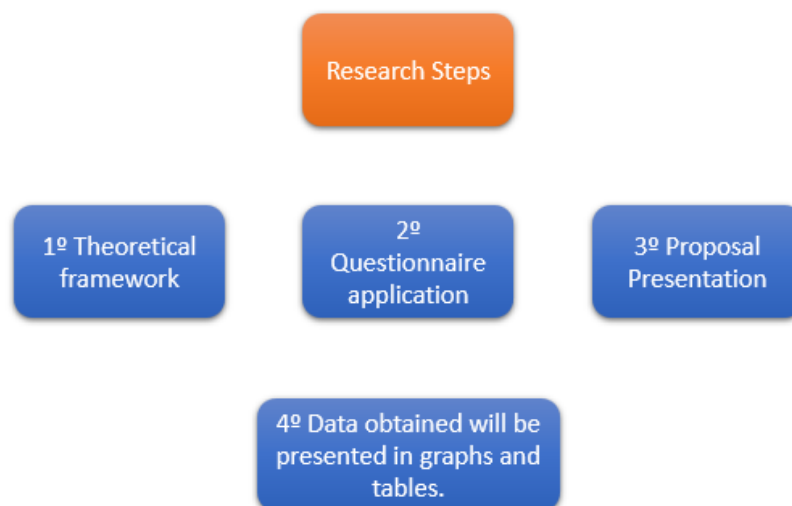
Source: Author 2019

### 2.3 Study Characterization

This research is qualitative in nature, the relevance of a qualitative approach to this research consists in the fact that it works in depth in the search for understanding a phenomenon (VÍCTORA; KNAUTH; HASSEN, 2000). As for the objective is characterized as a descriptive and exploratory study. It will have as method and technique the semi - structured interview that will use for the data analysis, the hermeneutic - dialectical method, as well as the application of a proposal for the qualification of the workforce.

### 2.4 Research Design

To reveal the construction industry: a case study on the qualification of the workforce in Manaus-AM, in the first stage, semi-structured interviews will be conducted with the professionals of the two construction companies in Manaus. In addition to the interviews, the second stage will be a survey of the problems involving unskilled labor in construction, in the third stage will be presented a proposal in companies with a view to mitigate the lack of qualification of labor in the construction sector in the city of Manaus. As the flowchart shows.



**Figure 2: Research Steps**

Source: Author 2019

The results will be presented in tables showing the qualitative data of this study. The research was developed through bibliographic studies and field research, which investigated the lack of qualification of labor in the civil construction in Manaus.

**3. Civil Construction in the Amazon State**

The construction industry sector creates jobs directly or indirectly, which favor the economy of the country. Second Leão (2016), "Civil construction is an industry sector that absorbs a significant number of workers, through direct or indirect jobs, having fundamental importance for the economy of the country."

For Carneiro et al. (2016), In the Amazon region, civil construction directly implies the use of natural resources. The region is known for its resource-rich natural wealth and, on the other, still has a very significant demand for infrastructure. This coupled with the growth of cities sets a scenario conducive to the expansion of the construction industry, as well as contributing to job creation in the Amazon.

According to Alves J. (2015, p.3), In this context of civil construction in the Amazon, the scarce and unskilled labor becomes a great torment for construction. the amount of waste and debris produced in this process.

**4. Labor in Civil Construction.**

The construction industry has had a strong growth, in this sense in the studies by Leão (2016), signaling the strong growth of the construction industry in recent years has caused a mismatch between supply and demand for skilled workers.

According to Silva (2017, p.3), "behind the responsibility given to engineers and construction managers, the important role of IES (Higher Education Institution) stands out", which prepares this professional for the job market. work in its segment, which periodically needs to evaluate the quality of this training and its adequacy to the needs of.

According to Duarte et al. (2015), the contribution to the creation of a pleasant work environment and to the physical and mental well-being of workers has become a matter of strategy for the company, as it increases the dedication, loyalty and commitment of the worker, which reflects directly in the increase of productivity and quality of service, cost reduction and improvement of financial results mainly in the civil construction, being that sometimes these professionals are exposed to the sun and the rain.

For Serrado (2017, p.13), "soon the reduced quality of labor is considered as the most important subgroup to be considered in market risk", followed by the reduced quality of construction equipment, thus realizing the importance the sector invest in the quality of the workforce and invest in its workers, as well as in their equipment, providing a favorable working environment for the development of their activities. According to Anschau (2016, p.4), in this context, "in order to obtain a good use in the qualification of workers, it is of utmost importance to know the profile of the worker to be trained", thus being able to

include in the subjects related to their current reality, achieving this will draw the attention of the worker making the course or practice to be implemented becomes something pleasurable, thus having a simultaneous engagement with the company and greater use of its activities.

## **5. Labor Profile in Civil Construction**

The profile of the workforce in Brazil is very archaic, that is, over the years little has been done so that it could have been more efficient in this segment, besides the companies themselves, when hiring their employees, require very little their qualifications.

According to Alves (2018), Brazil, when compared to other countries, the productivity of Brazilian workers' labor is significantly and historically discrepant, below average, thus it is observed the lack of concern of this sector to improve the quality of its workforce. constructions.

For Duarte et al. (2015), one of the characteristics of civil construction, is the intensive use of manpower, which uses little machinery in the execution of services. . In this sense, the workforce needs to be specialized in the execution of machinery, i.e., the profile required here is that the professional has at least one course for skills with machines aimed at construction.

According to Silva C. (2015), the Brazilian construction sector was built by hand by the hands of mostly illiterate workers without technical qualifications, now the sector pays the price of years without investments in personnel training.

For Silva (2017, p.2), "considering that the construction industry worldwide is responsible for the consumption of 50% of natural resources and 40% of energy inputs from all sources during the life cycle of buildings" . Thus, it is necessary that professionals are aware of these resources so that they can act with quality in their services.

According to Tavares (2006), in addition to the energy consumption in the useful life of buildings, the energy spent in the manufacture of building materials, in the work itself and in the deconstruction, is notorious the great responsibility that falls to these professionals. Such responsibilities could be avoided if these professionals were oriented with regard to execution and energy consumption.

For Castisiani and Castelo (2015, p.4), the construction worker, like the Brazilian worker, is on average older, works less hours per week and has more years of study. These are variations that, although timid, indicate advances.

### **5.1 Qualification of Labor in Manaus City**

In Manaus, the construction workforce needs a qualification as well as a higher education, that is, the workers in this sector are mostly poorly trained, both in teaching knowledge and in the construction sector, and This directly influences the company's productivity results.

In the studies by Almeida and Silva (2019), training becomes the key to the construction market to supply the need for skilled labor and to maintain good performance and constructive quality. Quality minimizes production costs, guarantees a high level end product mainly at construction sites in Manaus, which in recent years has grown significantly.

In the studies by Silva C. (2015), professionals are preparing more and more and business opportunities

are available to those who see ahead the advantages of implementing a Project Management culture that can contribute to the improvement. of the current framework of construction companies.

According to Almeida and Silva (2019), they indicate that they are low-educated workers, as this is a sector in which, to start working, it is not necessary to be literate or have knowledge of the profession. Even for the employer, knowledge or experience is overlooked when hiring the workman. Just start as a servant and observe how others perform the tasks, so the Manauaras develop their activities in construction, without at least a course focused on the segment.

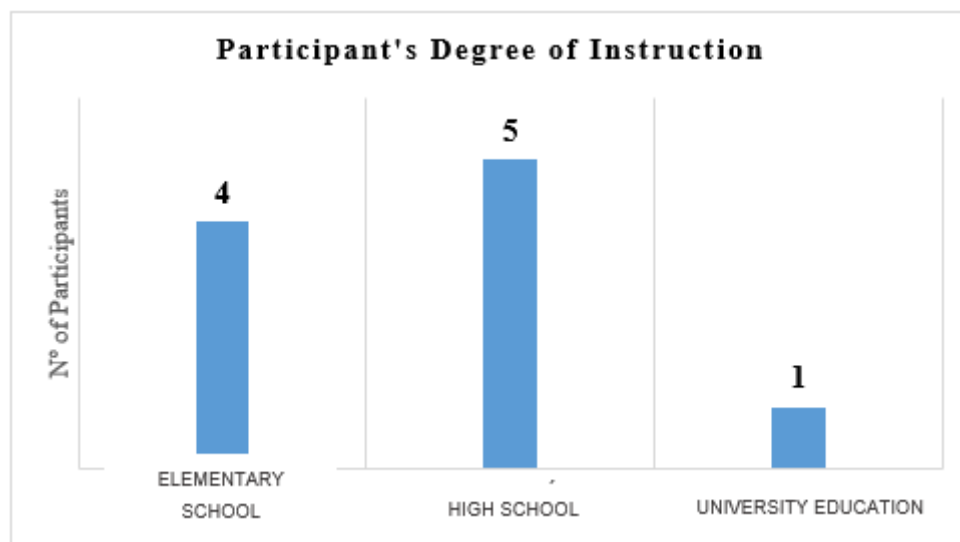
## 6. Discussion of Results and Analysis

The questionnaire was unveiled to professionals from the construction sector in Manaus and the results will be presented through graphs and speeches of the participants. The research was carried out in the following companies: W3 Engenharia and Direcional Engenharia, the components were: 05 professionals from the company W3 Engenharia and 05 from Direcional Engenharia, totaling 10 participants, 8 males and 2 females, with an average age of 29 years old.

Regarding the marital status of the participants, 5 are single, 3 married and 2 “others”. It was noticed that workers who are married have a greater responsibility for work than those who are single, because they work with commitment, due to the need for their families to support themselves.

When argued about how many salaries they receive, participants replied that they receive about 2 to 4 minimum wages and at the end of the year the tenth. In the construction industry, workers with a formal contract have their labor rights guaranteed, as in any other profession.

When asked about schooling the answer was 5 participants who answered that they have completed high school, 4 completed elementary school and 1 completed higher education as shown in Graph 1.



Graphic 1 - Degree of instruction

Source: Author (2019)

It is observed here that most professionals such as bricklayers and housekeepers have little study, some have only elementary school and a basic knowledge in the field. This reflects on the bottom line of overall business productivity.

The qualification is a requirement in contemporary times, that is, it is clear that there are few professionals seeking a study or a qualification in the construction sector, aiming for a greater gain in the accomplishment of their work. Within these contexts, Manaus construction workers are no different from other Brazilian capitals, yet express an interest in seeking more and more knowledge, but companies do not offer courses to their employees and do not dispense early when they study or perform a training elsewhere. This could avoid various inconveniences regarding unskilled labor.

When asked about working time in construction, the participants answered: 1 worker with 9 months of service, 1 worker with 4 months of service, 1 worker with 2 months of service, 1 worker with 1 year of service, 1 worker with 1 year and 5 months, 3 workers with 2 years of service, 1 worker with 4 years of service and one worker with 5 years of service, as shown in Graph 2 below:



Graphic 2 - Worker's Length of Service

Source: Author (2019)

It was noticed that only 3 professionals have more than 3 years in the company, and the others have only months of service in the company where they work.

When argued about your work schedule? All responded that they work during business hours, totaling the workload of 40 hours per week. In both companies the professionals do not work overtime, so the work is only 40 hours per week and do not perform night work.

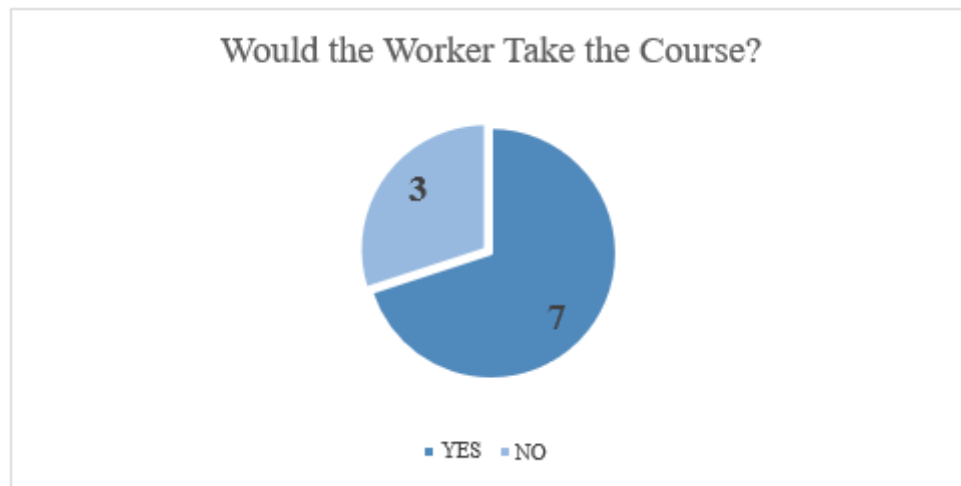
Regarding working time in the company, the answers were as follows: 5 W3 ENGENHARIA employees have between 1 years and 4 years in the company, the other 5 of the company DIRECIONAL ENGENHARIA has from 2 months to 2 years in the company.

When asked about, did you take a course to learn more about construction? All participants answered “no”. In fact, construction professionals such as bricklayers and servants learn the activity by looking at them by hand, that is, one is teaching what he knows to the other, without any teaching through courses. However, they aroused interest in participating, if the company offers a qualification course aimed at the branch.

When asked about: Does the company hire only qualified and experienced construction professionals? 1 participant answered “Yes: and 9 said “no ”.



Regarding the argument, if the company offered a labor qualification course would you attend? 7 participants answered “yes” and 3 said “no” as shown in Graph 3.



Graphic 3 - Worker's take course

Source: Author (2019)

It was observed that the professionals expressed interest in taking courses, if companies offer, in this sense, in order to improve their knowledge, as well as their qualification in the field that exercises within the company.

## 7. Conclusion

According to the bibliographical research, it was noticed that the construction industry has been successful in its growth in Brazil, however a big problem was observed with regard to skilled labor. However, several situations were presented, as one of the factors teaching, since most workers do not have even elementary school, especially when it comes to bricklayer and servant.

Regarding the salary received, construction workers are paid between 2 and 4 minimum wages, which enables a good living condition, because they can keep up with their earnings. However, he noted that most of the workers interviewed never took a course focused on construction or any other branch in this segment. But they pointed out that if they had in the company they would perform for sure.

Regarding the proposal of qualification of manpower in the company's W3 Engenharia and Direcional Engenharia, both were studying the possibility of implanting in the institution lectures and courses that allow their professionals more knowledge, as well as, more security in the accomplishment of their work. activities in the construction sector and also motivates them to finish their studies.

The study made it clear that, in order to have quality in the construction industry, it is necessary to invest in qualified labor, that is, companies must offer this training to their workers, because both the company and the professional gain when they have a job. quality, as well as ensuring safe and effective construction for society.

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# Work Safety Management for Optimization Production Process

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## Abstract

*The safety at work of employees is not always viewed with due importance. However, with the help of technology, such as E-social, the government system that organizes companies to communicate in a unified way as information for their employees, it executes with whom employers comply with strict safety standards. The main objective of this article is to demonstrate that occupational safety management improves accident rates in the company through actions on enforcement methods that are the basic causes of accidents. What's more, quality, management, costs and other values are better through behavioral changes. Within the Thematic service, we seek or develop conscientious and motivated employees, as a safe environment must be in place to support safe working employees. Therefore, after the implant or safety management system, you can reduce a satisfactory reduction of work accidents and get good results in the production process.*

**Keywords:** Safety Management, Work Accident, Accident Index, Productive Process.

## 1. Introduction

Currently, the subject of occupational safety is a theme that is widespread in all segments, even though still at different stages in each area. Regardless of the size of the organization, this issue is highlighted in the routine of any company, as social responsibility and concern for the well-being of employees and their families are much discussed today.

Brazil is no example when it comes to worker safety. Statistics from the ILO (International Labor Organization), prove this unpleasant condition that puts us among the countries that recorded accidents at

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work in the world, a position it could be even worse if all accidents were reported, meaning many accidents do not are recorded and many omitted for their seriousness, thus circumventing the true result of these statistics. ILO data report the occurrence of over 1.2 million deaths from work-related injuries worldwide. Given the above, it is necessary to prioritize actions and adopt stricter policies for the prevention of risk factors in the workplace.

## **2. Reference Theoretical**

### **2.1. Workplace Safety**

Occupational safety is a science that aims to promote the protection of workers in their workplace, aiming at reducing work accidents and occupational diseases. In Brazil, safety at work is defined by rules and laws and described as Specialized Safety Engineering and Medicine (SESMT), regulated by an ordinance of the Ministry of Labor and Employment (MTE), Regulatory Standard 4 ( NR-4), in addition to the international conventions of the International Labor Organization (ILO), ratified by Brazil.

According to this Regulatory Standard of the Ministry of Labor and Employment, must have necessarily with Occupational Safety professionals all private and public companies, public agencies of the direct and indirect, and the legislative and judicial powers, possessing employees governed by the Consolidation Labor Laws (CLT) and which fit into Annex II of NR 4, which measures the SESMT. In addition to being mandatory, Occupational Safety organizes activities, prevents accidents and shows employees the concern of the company with their health and well-being. This increases employee productivity, helps motivate and thus brings many benefits to companies. .

For organizations to be competitive, it is necessary to implement preventive measures that result in a pleasant and safe work environment for their employees.

Safety at work is a major issue, which is not applicable only to workers but also to business and society in general, as an injured worker, in addition to personal suffering, causes costs to the health system and starts to receive their rights social security, which are paid by all workers and companies (LIDA, 2005, p. 421).

### **2.2. Work Accident and Occupational Disease**

As provided in art. 19 of Law 8,213 / 91 work accident is what occurs through the exercise of work in the service of the company or the exercise of the work of the insured referred to in item VII of art. 11 of said Law, causing bodily injury or functional disturbance that causes the death or loss or reduction, permanent or temporary, of work ability. Occupational diseases are those triggered by the work activity performed by the Insured. Occupational diseases are considered as occupational accidents and are divided into occupational and occupational diseases.

In general, it can be said that accidents within an industry are mainly characterized by losses. These are not only of physical integrity, but also of materials, equipment and company image, depending on the events (SAMPALIO, 2002).

Occupational Diseases: are those arising from situations common to members of a particular professional category of workers. They are listed in Annex II of Decree 3,048 / 99 or recognized by the Social

Security;

Work Diseases: are those acquired or triggered due to special conditions under which work is performed. It is directly related to the conditions of the environment, that is, the professional activity developed is not the cause of any disease or functional disturbance, but the conditions of the environment that surrounds the insured.

### **2.3. Work Safety and Productivity**

In the past, the issue of "Safety at Work" was not much discussed or implemented in production areas, as the priority was based solely on profit and productivity. Nowadays the vision is another one, in which, besides promoting a safe work environment, is a legal obligation of the companies, it is through the investment in the people that the economic objectives are reached. Thus, safety conditions in the workplace are extremely important and directly affect both employee quality of life and productivity, and one of the main causes of loss of results in many companies is the absence of employees due to health problems. , either due to occupational disease or occupational accident. This can mean anything from a posture problem to an unsafe act or condition. In such cases, the professional may have to be absent in a crucial period or even become invalid for a long time. By investing in safety, the company also contributes to improving the quality of life of employees, which reduces the chances of them getting sick. With better health, they can keep up the pace of work over time, avoiding potential damage to their business and thus maintaining the required productivity.

Reducing the risk of accidents and health damage is also very important for your team's productivity, and being under some form of constant stress can at least take your employee's focus away from work. By removing this concern from employees, it will be easier to keep their focus on tasks. The immediate result here is the higher productivity of the group, delivering more customer value and improve your sales. In a short time, this can easily offset the initial investment in security. This way both business and employees can benefit.

The concept of productivity was introduced and developed in organizations to assist, evaluate and improve their performance. Initially, productivity was calculated by dividing the result of production and number of employees. Other ways of measuring productivity appeared over time when comparing production output with the use of other resources, eg energy, raw materials, inputs, among others (Singh et al., Apud KING, 2007).

## **3. Materials and Methods**

For the development of the work were necessary bibliographic bases for the study in order to get a better understanding of the problems faced in the referred industry, in order to find and eliminate the root cause of the problems. Concepts focusing on work safety management for increased productivity and articles were considered relevant research to advance the work.

The research will be field research, where all the necessary information was collected to be able to carry out the current article that aims to create a health and safety management at work in order to make employers more aware to invest in the safety of their employees. This paper presents graphs that show the

accident rate before and after the implementation of the work safety awareness work.

Observations were carried out on the spot, and documents were analyzed, especially those related to procedures and work instructions related to Occupational Health and Safety in which we sought, to verify which OSH management practices are developed in the company, highlighting their best initiatives and the main difficulties.

The company is certified according to ISO 9001 (Quality Management System), and its OSH system is based almost exclusively on regulatory standards established by the Ministry of Labor. The considerable effort made by the security technician in the performance of his duties stands out, and one of his major complaints is the failure of some employees to comply with the established safety rules. This resistance, most of the time, starts in middle management, which ends up generating conflicts with other employees, who are not obliged to follow them either. The safety technician's work is developed individually with each manager, according to the level of acceptance of safety-related norms and procedures, always trying to develop a personalized work program to instill the safety culture in the most resistant. The company has 112 employees and risk level 3 due to its classification and according to NR 4, has the SESMT correctly sized for its structure and activities.

The organization does not have trained operators, they perform their activities without proper safety training for each area, corrective, preventive, predictive maintenance procedures are out of date, and a daily checklist for workers' health and safety is not in place. being performed.

The main difficulties faced by the Company in OSH management are presented below:

Resistance to change, Difficulty in elaborating safety procedures and instructions, Absence of occupational safety and health performance indicators, Low employee awareness rate, Lack of safety training for employees, employee turnover.

To solve the problems mentioned, it was necessary to create an action plan in order to implement the Safety procedures, and with the OSH system in place in the company, the number of employees removed due to work accidents and occupational diseases would reduce considerably. Expenditure on hiring replacement workers would also reduce.

It is noteworthy that when an operator leaves, it is necessary to replace him, where a new operator will be trained and able to perform the activities with the same knowledge and agility of the injured employee after some time, and during this route productivity will be affected. by the lack of agility of the new operator, learning of the process, and consequently the quality of the products will be affected.

## **4. Application of Study**

### **4.1. Company Characterization**

The research was conducted in an industry of the Manaus Industrial Pole, where its main follow-up is the metallurgy and assembly of gymnastics equipment, where it has the welding, blasting, painting and equipment assembly processes.

The company faces some types of problems related to low productivity. One of the main reasons is the high turnover of process operators and absence due to work accidents, directly affecting the production process. And this happens because the official operator of the post, needs to leave work due to work

accident, and the main cause for the occurrence of these accidents is the lack of Occupational Health and Safety Management in the company. And in order to minimize the number of occupational accidents and sick leave, there was a need to implement OSH Management.

#### 4.2. Main Reasons for Accidents at Work

The productive sector of the company is composed of the production and metallurgy sector, being concentrated in these two sectors the largest number of employees with registered work accidents, where the main reason for these accidents is the unsafe condition imposed on workers. There are two basic components involved in workplace accidents: the human factor and the environmental factor. The human factor can act through individual predisposition for the occurrence of physical, psychic, family and professional problems, while the environmental factor is evidenced when the worker is exposed to certain external agents that, when they manifest, cause the morbid event.

The problem of accidents in the workplace becomes even more worrying when it is already known that it can be easily avoided by adopting preventive measures that are simple and cost-effective.

Below we list the sectors with occupational accident occurrence during the year 2018:

Table 1: Accidents at Work by Sector

<b>WORK ACCIDENT BY SECTOR Period Jan / 2018 to Dec / 2018</b>	
<b>Sector</b>	<b>Accident Amount</b>
<b>Metallurgy</b>	9
<b>Production</b>	6
<b>Maintenance</b>	4
<b>Engineering</b>	1
<b>Materials</b>	1

## 5. Results and Discussions

### 5.1 Plan of Actions and Improvements Applied to the Process

After the identification and follow-up of the failures, action plans were made to minimize occupational accidents, and consequently the increase of the production process.

Table 2: Action Plan Implementation Schedule

<b>Occupational Health and Safety Management Implementation Schedule - OSH</b>				
<b>Item</b>	<b>How will it be done?</b>	<b>When?</b>	<b>By whom?</b>	<b>Status</b>
<b>Presentation of the company's OSH system to managers.</b>	It will be individually presented to each manager the importance of deploying the OSH system, and how it will positively affect productivity.	Jan / 2018	Occupational Safety Technician	Accomplished
<b>Elaboration of the OSH Procedure.</b>	The Integrated Management System (SGI) sector, in partnership with SESMT, will elaborate the security procedure that presents guidelines to be followed to maintain the safety	Jan / 2018	SGI / SESMT	Accomplished



	of all, taking into consideration the Regulatory Standards (NR's).			
<b>Presentation of the OSH procedure to all employees of the company.</b>	There will be an integration with all employees, where the OSH procedure and its real importance will be exposed. Everyone should sign the list of presence in the integration making the procedure aware.	Jan / 2018	SESMT / SGI	Accomplished
<b>Conducting Weekly Security Dialogue - DSS.</b>	Every week a meeting will be held with the sectors to report on the safety facts of the previous week, such as: Accidents occurred, Incidents, unsafe conditions, etc.	Jan / 2018	SESMT	Accomplished
<b>Holding of the Internal Work Accident Prevention Week - SIPAT.</b>	During a week there will be activities, lectures, dynamics and phrase contest, all aimed at job safety. The aim will be to make employees aware of working safely to avoid accidents.	Feb / 2018	SESMT	Accomplished
<b>Performing Gymnastics in all sectors of the company.</b>	Work gymnastics will be performed in the company sectors. The idea is to use gymnastics to relax the body and mind of the workers. Occupational gymnastics is primarily responsible for reducing expenses for sick leave and work accidents. It also favors increased productivity and quality of service.	Feb / 2018	SESI	Accomplished
<b>Conducting safety training.</b>	Safety training will be provided to all employees according to the risk of their work area.	Feb / 2018	SESMT	Accomplished

Source: Author

### 5.2. Changes in Employee Routine for Implementation of Action Plan

For the action plan to be implemented, it was necessary to change the routine of employees, seen as the biggest barrier to be faced by removing them from their comfort zone, but we gradually achieve success in raising awareness of all.

In the previous form, the use of PPE was not mandatory and few use the equipment that guaranteed their safety. Now everyone is required to wear their protective equipment, and this awareness has been realized through integration with everyone, showing the importance of using it and the consequence of not using it in both physical and disciplinary areas.

No occupational gymnastics were performed with the employees, now every day occupational gymnastics are performed separately by sector, since each sector has its gymnastics plan prepared according to the SESI gymnastics teacher schedule, after the participants performed the gymnastics sign the attendance list. At the end of each week, a gymnastics participation report is made by sectors and sent to the company's managers and director.

The security survey is being conducted daily, which consists of checking all sectors to identify unsafe conditions and acts that may put the safety of employees at risk. When the risk is identified, a safety inspection report is issued which is then sent to the area manager and company director. In the report, the area manager is requested to correct and eliminate the risk condition. After correcting the problem, the report is finalized. Every end of each month is presented at the indicators meeting the sectors in which

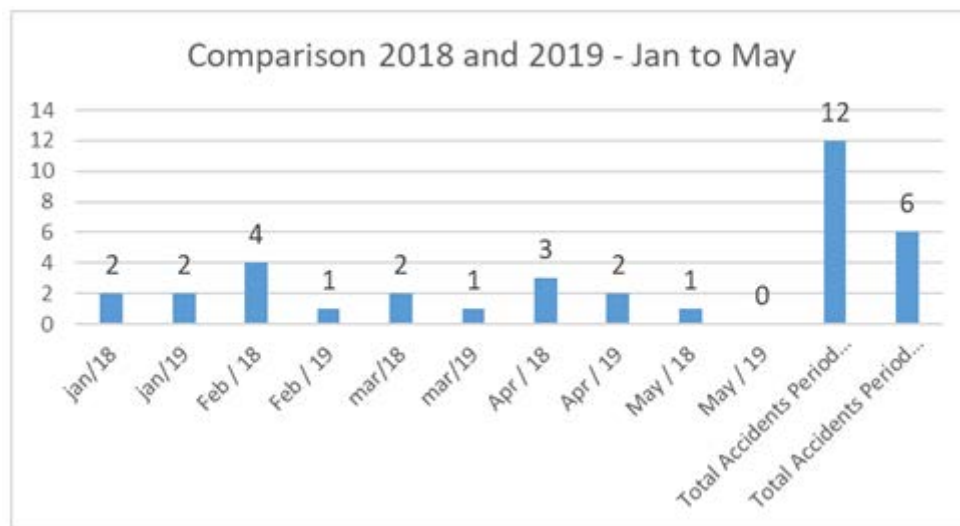
there were the most occurrences, which makes managers supervise any condition that may cause their sector to receive any non-compliance.

The Weekly Security Dialogue (DSS) is being held weekly, which addresses issues related to security events during the week. This meeting gives everyone the opportunity to share their ideas and opinions to improve everyone's safety.

The 1st Internal Work Accident Prevention Week (SIPAT) was held, with the theme, Live Health and Safety and have Quality of Life. During the week we address extremely important issues that aim to raise awareness and sensitize everyone about the importance of working safely to achieve a better quality of life. The acceptance was satisfactory and with 95% participation of the company's employees. After SIPAT, employees came to the SESMT sector to thank them for the event never before and hoping for more events of the same size.

### 5.3. Discussion of Results

After the implementation of the improvements, work accident statistics were verified over a period of 5 (five) months.

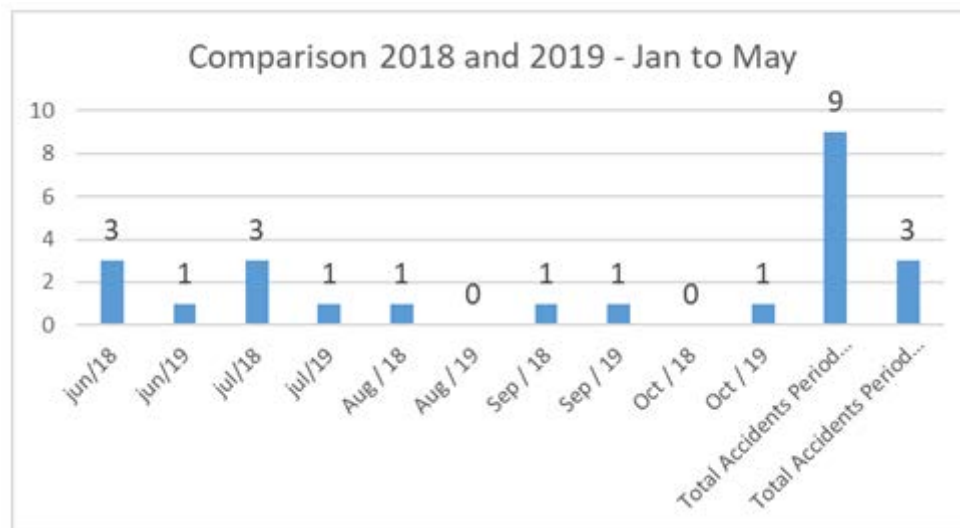


Graph 1: Graph of Accidents at Work from January to May 2019 compared to the same period 2018

Source: Author

As shown in the chart demonstration, the reduction of accidents after the implementation of OSH management was satisfactory, resulting in a 50% reduction in the reduction of occupational accidents.

In order to conclude the effectiveness in the implementation of the improvements, another statistical survey was conducted to compare with the same period of the previous year.



Graph 2: Graph of Accidents at Work from June to October 2019 compared to the same period 2018

Source: Author

From this it can be inferred that with the implementation of the occupational health and safety management system, the accident rate has reduced satisfactorily.

Table 3: Sum of annual Work Accidents

Accidents at Work in 2018 (Period from January to October)	Accidents at Work in the year 2019 (Period from January to October)
Total 21 accidents	9 accidents total

Source: Author

## 6. Final Considerations

As presented in the study, the methods used prove their efficiency and effectiveness in system deployment. Accident rates at work decreased significantly compared to the same period of the previous year, as shown in the graphs.

In line with its intended purpose, the work achieved its goal by demonstrating that when there is a management in occupational safety, accidents consequently reduce, providing a safe and harmonious working environment, so that operators can work quietly aware that their safety is protected. and the production plan will continue as planned, reaching the end of the month with its goal reached, zero accident and production plan completed.

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# **Analysis of the Use of Photovoltaic Solar Energy as a Source of Alternative Energy in Manaus City**

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## **Abstract**

*The need for other sources of renewable energy is present, due to sustainable growth and aiming at the dull use of fossil fuels, which is a non-renewable energy responsible for the greenhouse effect and, in its end, can generate conflicts between countries, due to its dependence. . Brazil has an advantage, in front of other countries that already use this energy source frequently, because it is the country with the highest rate of solar radiation, is not enjoyed in abundance, because it is not so accessible due to poor incentives and lack of technology knowledge. As a clean and sustainable alternative photovoltaic solar energy becomes attractive. Based on these data, this work conducts an analysis of the photovoltaic solar grid system on grid (grid) system, to take as an alternative energy.*

**Keywords:** Photovoltaic solar energy. Sustainability. Renewable Source;

## **1. Introduction**

Expressly, humanity's incessant need for energy grows over time and is directly linked to development due to the remarkable use of new electronic devices. Nowadays, the search for renewable and non-

polluting energies is growing, because the sources of fossil fuels are finite. [4]

Brazil is quoted to reach 1,000 megawatts in 2017, according to the caveat of the Brazilian Association of Photovoltaic Solar Energy (ABSOLAR). 60 thousand residences, with 5 inhabitants in each. [3]

The application of photovoltaic solar energy connected to the electricity grid in homes would be a renewable alternative and would modify the energy scenario of our country, reducing CO<sub>2</sub> emissions on the planet. [7] states that several countries are investing in solar energy applications, investigating from the characteristics of solar radiation that reaches the Earth, including new technologies to make it technically and economically viable, making the most of this energy. "For the complementation of hydropower, an energy source with several particular characteristics is needed: clean (non-polluting), non-scarce, distributive and that can be used in homes, industries and commercial establishments.

To gear this system in Brazil requires aid, research, search for this photovoltaic solar system, market demand, for such events it is necessary assistance from the Government, creating a scope for its evolution. [9]

This system allows you to save money and involve the environmental issue, because in its energy generation, it does not emit pollutants, its fuel is sunlight and it does not emit any noise, while achieving energy autonomy. Reasons why photovoltaic solar energy is on the rise worldwide. Therefore, the advantages of using solar and photovoltaic energy such as: savings on energy bills, decreased demand for energy from the national system, thus delaying the construction of new hydroelectric, thermoelectric and nuclear plants - which generate numerous environmental impacts. - In addition to being a source of renewable and clean energy.

Therefore, this work is related to a research of the use of this photovoltaic solar system connected to the electric grid, in a single family residence, analyzing its operational efficiency, benefits, demand in the marked.

## **2. Theoretical Foundation**

### **2.1 Photovoltaic Solar Energy Scenario in Brazil**

According to [5] photovoltaic solar energy is generated with sunlight, making this conversion of light to electricity, and this photovoltaic cell is made of a semiconductor material, one of those responsible for this effect.

In Brazil, there was an increase in the production scale related to photovoltaic energy in more developed technology markets, bringing a decrease in the price and increasing the application of clean energy, as stated. [2]

Still in Brazil, photovoltaic solar energy has always been tied to programs that propagate this system in regions where there is no access to conventional energy, isolated regions, with rural growth power. By the dissemination of these programs, in Brazil hears an amplification of the isolated system, in 2004, 30 thousand systems were appointed. [1]

The solar energy sector will undergo changes, due to actions taken by the Federal Government with encouragement from the Ministry of Mines and Energy, believe that by 2024, about 700,000 users in the commercial and residential area had the solar photovoltaic system, installed on their properties, lowering

their energy bill. [6]

Due to its tropical climate, Brazil has a solar irradiation of 2500 hours / year, making use of the isolated photovoltaic system, benefiting distant areas with conventional grid deficit, aiming at the environmental part, making society aware of the preservation of the environment, something of high relevance and use energy that brings a cost benefit to the social [7].

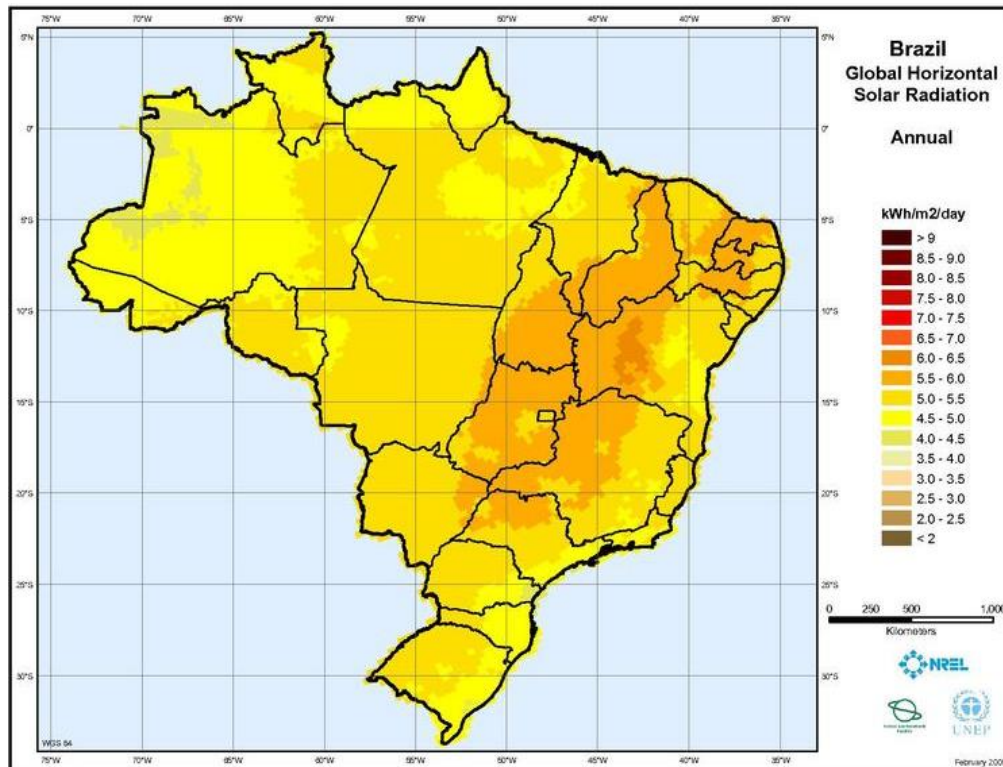


Figure 1- Solar Map of Brazil

Source – Global Horizon. (Brazilian Atlas of Solar Energy, 2019)

## 2.2. Environmental Impacts Caused by Photovoltaic Energy

The environmental impact caused by photovoltaic energy in the environment, results in toxic fluids and its installation requires large areas, causing major impacts to the natural habitat. [11]

Both solar photovoltaic and other power plants usually have positive and negative environmental impacts on the environment, which can be small and medium sized, since solar energy does not emit as many pollutants in its electricity generation as it does. the most common energy generating industries, as quoted [10]

In the execution of a photovoltaic solar plant, the loss of local vegetation is taken into account. Solar plants are not only built in areas considered desert, where there is no vegetation to be removed. chosen to build the solar plant. [13]

Materials such as glass and aluminum are major contributors to the environmental impact of pollutant emissions when it comes to photovoltaics, as these materials are a major contributor to the production of photovoltaic modules, and silicon removal also generates an impact. environmental. [8]

Na construção das usinas, o solo é descampado modificando a áreas no modo ambiental, a vegetação protege o solo de possíveis erosões, devido ações naturais como chuvas e ventos, a compactação da área

pode vir gerar outro problema, o número de vazios diminui o deixando mais denso dificultando a infiltração da água gerando modificação nos cursos de hídricos superficiais. [14]

### 2.3 Photovoltaic systems

To install any of these types of systems in homes there is no need to make changes to it, considered simple to perform the system adapts to the situation. [15]

According to [17] the technologies related to the modules have evolved and in the junction of the civil construction with the photovoltaic system there are no impediments, being possible to install glass modules in facades aiming the architectural question of the place, flexible thin film modules used in civil construction adapt. Depending on the surface, it is commonly used those installed on the roofs following the slope, and can be replaced by module tiles.

Photovoltaic systems are classified into three types: isolated, hybrid and connected to the grid, providing consumers with electrical independence, making their own power generation.

- Isolated systems: Used in hard to reach areas where there is no mains power supply.

Its generation is made with solar modules installed by capturing sunlight, with off grid inverter converting the continuous energy to alternate and all generated energy is accumulated and stored in batteries. [16]

[5] states are used for rural areas to assist in water pumping, urban street lighting installed on doors, home lighting.

- Network-connected systems: System to which the utility is connected.

This system connected to the network compared to the isolated one has advantages mainly in the cost aspect, 30% cheaper. [17]

It works as follows: the power kit is installed at home with the on grid inverter responsible for changing the energy captured by the modules, after this inversion the energy is directed to the light board responsible for the power distribution throughout the house. [5] Since this system does not use batteries to store energy, the clock is changed by a bidirectional, measuring the energy produced, consumed and surplus energy, directed to the utility accumulating credits for days of low production.

- Hybrid system: the difference between this system and the others connected to another power system other than the conventional connected to the grid, is connected to the wind. [18]

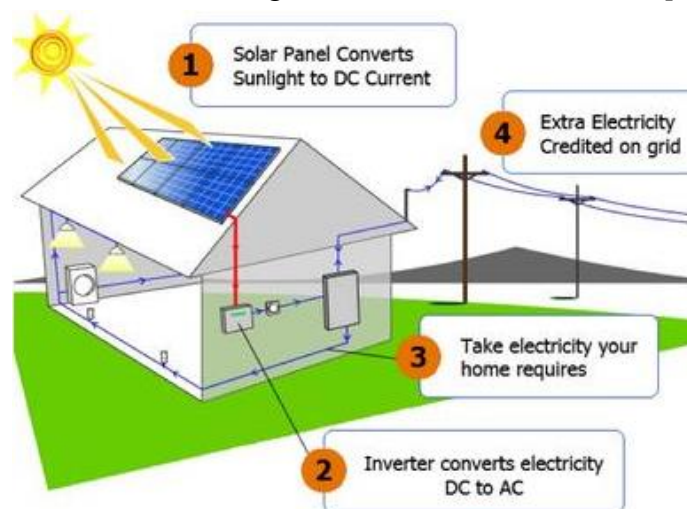


Figure 2 - System connected to the mains



Source - kewsolar, 2019

### **2.4 Feasibility of the system**

In fact, the solar photovoltaic system is not popular for its market value even though it is not a new technology, but because of its high cost there is no considerable demand in the market compared to the conventional grid system, but with other program launches. countries, there may be a drop in value. [17]

It is possible to use photovoltaic solar energy and make a profit even with its value and make a comparison with the conventional system, which always suffers from readjustments, making your account more expensive, the establishment in question was paying a bill of 14 thousand reais the value of system implementation is 28 thousand reais. Data obtained from his study show that in 4 years, the owner could recover the amount invested in the system, knowing that it has a useful life of 25 years. [20]

[21] realized the photovoltaic system and a rural area, investment of 106 thousand reais, can be financed by the bank or with own resource, with its own income in 9 years was 20 thousand reais, over 25 years its income is of 989 thousand reais, financed by the bank in 11 years its free income is 83 thousand, at 25 years has an accumulation of 1 million.

## **3. Methodology**

The research is characterized in exploratory research, conducted by case studies, [19] states that this type of research aims to make an analysis of content such as books, articles, interviews, case studies related to the research area, giving an insight on a particular theme revealing ideas and concepts, making room for further research.

The study arose from the dependence of society on electric energy sources of energy are the main drivers of the development of a country, the diversity of energies show the level of development of a certain place linked in the sectors, commercial, industrial and residential with regard to environmental issues. sustainable.

Excessive consumption of fossil fuels can cause environmental problems such as extraction and use and may generate future problems in social issues when this resource runs out, another system that causes serious problems is the use of hydroelectric flooding nearby areas expelling inhabitants around them. , loss of fauna and flora disrupting the ecosystem.

With these data, bibliographical research began, analyzing the Brazilian context in relation to photovoltaic solar energy, showing the solar potential that it has to implement and invest in clean, renewable and not scarce energy, and may be equal to pioneer countries. In this technology, seeking quality of life for the whole, the use of this system in Brazil is minimal, due to its cost and lack of incentives for research and implementation and part due to lack of knowledge.

In view of this lack of knowledge I conducted a field survey of 13 (thirteen) people asking such a question: "What do you think about photovoltaic solar energy as a source of energy? ", After this question, 7 (seven) people did not know, 4 (four) people agreed that it could be a good choice to solve problems with existing sources, 2 (two) people do not agree for its value to be high and think that worth it, with that generated questions of the same about the system, in which I selected the most frequent,

prepared a questionnaire with 11 questions.

Preparing the questionnaire with 10 questions, I sent this questionnaire by email to a company that works installing the solar photovoltaic system, located in Campinas in the state of Sao Paulo, CSE SOLAR.

### ***3.1 Photovoltaic Solar Energy Questionnaire.***

#### **Questionnaire**

1- What types of solar modules available in the market?

A: Monocrystalline silicon solar panels, polycrystalline silicon, thin film, amorphous silicon, cadmium telluride.

2- Which one has the best cost benefit?

A: For cost-conscious consumers the polycrystalline silicon panel is indicated, its average efficiency is 14 - 20%, and they are cheaper, but those who prefer to have better efficiency the monocrystalline is indicated, efficiency of 15 - 22%, but its value is higher

3- Installation value system connected to the mains, in a residence that has 4 residents?

A: The values vary, there is no standard answer, it depends on the number of panels, a house that consumes 500 kwh / month uses 10 to 12 260wp panels, to supply 100%, a complete installed system costs from 5,000 to 15,000 reais Kwp .

4- What is the cost of maintenance and time to perform?

A: They are very resistant, maintenance is to clean the panels with water, can be done about 4 times a year, depends on the location if there is a lot of dust.

5- System lifetime?

A: Systems connected to the mains have a service life of 30 to 40 years, 25 panels warranty, insulated systems have 2 years warranty and 5 years service life.

6- How do I get the solar photovoltaic system?

A: First, an analysis will be done on your electricity and consumption bill, after this analysis your project assembled according to your need, you buy this kit, the amount can be funded and the installments can be the value of your account or smaller.

7- What is the average return time after investment?

A: It depends a lot on the value of your system and region, but the estimate is 4-9 years.

8- How many days does it take to install?

A: It takes 2-3 days to perform the installation, interference with your routine is almost nil.

9- How to monitor what I am using and producing?

A: The company that makes the installation monitors its production make regular visits to ensure maximum production and or access the company's portal and can monitor production in real time.

10- What is photovoltaic solar energy?

A: It is the use of solar rays as a source of energy, captured by the panels that heat semiconductors generating electricity, photovoltaic is this conversion of light into electricity.

## 4. Conclusion

With this work, I intend to reach more public for photovoltaic solar energy research, is an important advance for energy autonomy and sustainability issues in Brazil's energy matrix, with the support of the Government, this source will become easy. facilitating financing at its cost of implementation.

Analyzing all the issues mentioned in this paper, it is concluded that photovoltaic solar energy is promising, its environmental impacts are minimal in its production, but in its power generation is clean, does not emit noise and pollutants, in front of other pioneer sources in Brazil. We can analyze that when it comes to construction, we can seamlessly combine this energy with projects already consolidated or projects in plant, taking into consideration the aesthetics of the environment. The purpose of the questionnaire is to bring knowledge to people and answer frequent questions about this energy source, the lack of information generates consumer insecurity generating barriers to this energy source, the question directed to 13 people, where 7 did not know As far as photovoltaic solar energy was concerned and 4 knew it, 2 did not agree that it could solve problems, due to its high cost, this shows how much knowledge and investment is needed to expand this technology in our territory.

Finally, this work aimed to show that Brazil has sufficient solar irradiation capacity to invest in this source, reduce CO<sub>2</sub> emissions, barriers due to the lack of incisive incentives to reduce system costs, environmental impacts of energy and reinforcing the lack of knowledge needing to advance on this issue.

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# **Environmental Management of Gabriel Correia Pedrosa Children's School in Manaus - Amazonas, an Application of Environmental Education**

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## **Abstract**

*The implementation of Environmental Management in elementary schools encourages the development and sharing of correct environmental solutions, cost reduction and resource optimization, conservation of school physical spaces and commitment to the management process. In this context, it is proposed to apply an Environmental Management Plan at Gabriel Correia Pedrosa Nursery, located in the Compensa II neighborhood, Manaus-AM, seeking to identify as environmental activities. An exploratory research was used to define the problem with greater precision, to identify methods of action or to obtain additional data, having as pedagogical objectives the introduction of paradigm changes that lead the individuals of Education to be inserted in democratic processes of transformation of the problem. human-nature relationship. An analysis of the data allowed the elaboration of methods*

*of implementation of the Gabriel Correia Pedrosa Nursery PGAE model guided by the following steps: an environmental perception through the early diagnosis of activities and a thematic methodology of the nursery EA. Thus, the nursery develops activities to finalize the student on environmental issues in order to raise awareness - and use a multiplying agent, carried out in 2019, as the following activities: activities and studies with plants and flowers for cultivation and irrigation; interaction with soil, without working the nursery garden; implementation of fruit trees for children and environmental educational tours. The Nursery seeks to implement the highest level of GEA, going from 5R to a change, reinventing a way of life, being described by 7R.*

**Keywords:** Environmental Education, Environmental Management, 7R's;

## 1. Introduction

The environmental area, today is the focus of the most discussed issues in the world, as it involves various segments of society, linking the areas that make up the tripod of sustainability. With the prospect of increasing population and the process of globalization, there is an increasing need for the conservation and preservation of natural resources for the use of future generations.

Thus, the initial process for recognizing these changes and the need to maintain resources, recognizes from environmental education, an essential condition for change in the correct use of these resources. In this context, the school can be considered a space capable of contributing to the construction of new concepts and social and environmental relations.

Environmental Management (GA) has been gaining increasing space in organizations, where increasing ecological awareness is visible at different levels and sectors of society, encompassing different companies and educational institutions. The adoption of international environmental management standards was one of the measures found to ensure environmental conservation and sustainable development [1].

This management process aims to create techniques, plan, organize and manage economic and social activities in order to make rational use of natural goods, as well as comply with current environmental legislation [2].

The implementation of GA in primary schools has the following benefits: good school-community relations, strengthening and enhancing institutional image and market share, improving cost control, reducing incidents involving civil liability, conservation raw materials and energy, stimulating the development and sharing of environmentally sound solutions, reducing costs and optimizing resources, conserving the school's physical spaces and commitment to the management process [3].

In addition, it provides the involvement of all who integrate the school space, disseminating environmental responsibility to the entire community. However, it is necessary to observe the characteristics of each educational institution and the form of application that the GA must assume, given the reality of the school community, considering its structure and location [4].

In 1992, with the holding of Rio 92, United Nations Conference on Development and Environment, also called ECO 92, the consecration of the concept of Sustainable Development gains connotation. This

highlight resulted in the elaboration of relevant documents, resulting in the creation of Agenda 21, national and local, resulting in the active participation of society to assume responsibilities, focusing on social, environmental and economic improvement.

Aiming at building people's capacity on environmental and sustainable development issues, Chapter 36 of Agenda 21 launched the four basic challenges for the implementation of Education with Sustainable Development (ESD): improving basic education; reorient existing education; develop public understanding; knowledge and training [5], the author also highlights [...] Environmental Education (AS) as a discipline that emphasizes the relationship between men and the natural environment, the ways to conserve it, preserve it and administer it. their resources properly [...].

ESD is comprehensive, encompassing EE and its relationship to sociocultural factors and sociopolitical issues of equity, poverty and quality of life [5].

Thus, it is assumed that AE cannot be conceived only as a school content, because it implies awareness based on political, economic, cultural and scientific factors [6].

Thus, it is evident the importance of citizens' awareness to act responsibly and maintain a healthy environment in the present, knowing how to demand and respect individual and collective rights, changing their relationships with the environment, as a person as a collective being. in the future [7].

In order for EA to evolve into a GA proposal it is important to aggregate different areas of knowledge within a cross-cutting perspective, integrating all teachers, students and the community [8].

The concept of Educating for Sustainability indicates an educational component, the preservation of the environment, depending on an ecological awareness; and the formation of conscience depends on education, making it possible to expand knowledge, paradigm shift, reframing values, attitudes, seeking to improve skills, prioritizing the integration and harmony of individuals with the environment [5].

Considering all this importance of the environmental theme and the integrated vision of the world, in time and space, schools stand out, with project-oriented actions and participatory processes seeking self-confidence, positive attitudes and personal commitment to environmental protection implemented, in an interdisciplinary way [9].

Given the above arguments, the importance of the structural organization of the PGAE is emphasized, having its own pre-established delimitations [8].

The development of these new perspectives and pedagogical practices generates an educational challenge in search of a future education: transformative, integrative and interdisciplinary. GA involves practices that aim to ensure the conservation, preservation and reduction of the environmental impact of human activities, which can be worked on in public or private companies, industries and educational institutions, in the process that involves the recognition of changes in habits, awareness raising. understanding and action in activities related to this process, environmental interpretation, culminating in the conservation and preservation process [10].

In order to work GA in school environments, it is necessary to elaborate a PGAE, which is the result of coexistence with the schools and with the pedagogical work developed by them, constituting a process of systematization of the actions of AE [8], having as pedagogical objectives the introduction of paradigm shifts that lead the subjects of Education to be inserted in democratic processes of transformation of the human-nature relationship, and promoting an EA committed to citizenship and directed to the

environmental issues of the school environment.

In this context, it is proposed to apply a School Environmental Management Plan (PGAE) at Gabriel Correia Pedrosa Nursery, located in the Compensa II neighborhood, Manaus-AM, seeking to identify all environmental activities.

## 2. Materials and Method

### 2.1 Study Area

The study uses the Gabriel Correia Pedrosa Municipal Nursery, located in the Compensa II neighborhood of Manaus, AM, for the establishment of the research. Figure 1.



Fig.1 Location map of Gabriel Correia Pedrosa Nursery, Compensa II.

Source: Own authorship (2019).

The Corrêa Pedrosa Municipal Day Care Center was created by Municipal Decree No. 2,666 of December 5, 2013. The construction of the day care center began in 2012 and its project was prepared by the National Education Development Fund - FNDE [11].

The idealization of the day care center and its construction arose from the great need for the care of children aged between 1 and 3 years for the Compensa II neighborhood, since in the neighborhood there was no educational institution that could attend this age group. The institution currently serves not only the nursery phase, but also the preschool, counting on the number of ten rooms that function as a reference room [11].

### 2.2 Data Collection

Research is exploratory, used to define the problem more accurately, identify relevant courses of action or obtain additional data [12].

Having as pedagogical objectives the introduction of paradigm changes that lead the subjects of Education to be inserted in democratic processes of transformation of the human-nature relationship and to promote an EA committed to citizenship and directed to the environmental issues of the school



environment, will be researched and modeled. the PGAE, marked by [8].

The data analysis allowed the elaboration of the methods of implementation of the PGAE model of the Gabriel Correia Pedrosa Nursery, guided by the following steps: the environmental perception through the previous diagnosis of the activities and the thematic elaboration of AE in the Nursery.

Regarding the data analysis, [13] presents considerations, emphasizing the importance of the researcher's previous knowledge about the researched subject, as well as his theoretical background, common sense and ability to argue so that he can collect the data and describe it in the best way. Thus, aiming to summarize, classify and codify the data, to achieve the desired means of research, through a quantitative analysis using statistics and / or qualitative-quantitative.

A field research was also performed, which according to [13] is a methodology that allows the researcher to deepen his research theme, developed in natural scenarios, through direct observation, survey or case study.

### 3. Results and Discussion

The Gabriel Corrêa Pedrosa Municipal Nursery currently has 40 employees, of which 18 are effective through a public tender, 13 are contract employees and 9 are outsourced [11] (Figure 2).



Fig.: 2 Gabriel Corrêa Pedrosa Municipal Nursery

Source: [11].

The day care center has capacity for 228 children. The thirty professionals who make up the day care center are divided into teachers, pedagogues, pedagogical support, nursing technician, psychologist, concierge, general service and cooks [11].

The studies by [8] helped the Gabriel Corrêa Pedrosa Nursery in the elaboration of a basic model of PGAE, constituting a process of systematization of the actions of AE, having as pedagogical objectives the introduction of paradigm changes that lead the subjects of Education to be inserted in democratic processes committed to citizenship and directed to environmental issues around the school. Thus, the nursery develops countless activities in order to insert the student in environmental issues in order to

sensitize him and make him a multiplier agent.

Initially, in 2019, the nursery performed the following recreational activities: interaction and learning with plants and flowers for cultivation and irrigation; interaction with the soil in the work of the nursery garden; implementation of fruit trees for children and environmental educational tours.

For the following years, the Nursery has the following activities intentions: introduction and use of selective trash bins, used to segregate the waste, besides collecting the organic waste to feed the composer; use of educational toys with natural resources, composting made with organic waste from the kitchen to prepare the fertilization of the garden, which will be used for learning planting and cultivation [11].

In the first moment of the environmental perception analysis, the lack of adequate infrastructure in the Nursery for the disposal of solid waste, highlighted the lack of continuing education courses in the area of EE for teachers of Public Basic Education.

Another point to be considered is the teachers' little concern with environmental issues regarding sustainable water consumption, besides the condition of applied knowledge, so that the information is deepened and absorbed in such a way as to guarantee the continuity of process.

The importance of PGAE can be observed and recognized in the National Curriculum Parameters (PCN) created by the Ministry of Education in 1997, which underscores the undeniable importance of future Brazilian generations to responsibly and sensitively instruct environmental preservation, making it sustainable [14].

It is important to highlight that the first stage started raising the awareness of Creche employees regarding solid waste management. However, according to [15], proper waste management involves adopting the policy of 5R's: Rethink, Reduce, Reuse, Recycle and Refuse (Table 1).

From this perspective, educational practices should guide the search for pedagogical proposals that aim at changing habits with social attitudes and practices in the construction of competences, analytical skills and the active participation of stakeholders, and this challenge leads to thought reform [16] .

Tab .: 1 Representation of EA's 5R's for proper management.

5R's of Environmental Education	
Rethink	Rethink the need for consumption and the production and disposal standards adopted.
Refuse	Refuse possibilities of unnecessary consumption and products that generate significant environmental impacts.
Reduce	Reduce seeking to avoid waste, consume less products, preferring those with lower potential for waste generation.
Reuse	Reuse to prevent trash that is not trash by reusing everything that is in good condition. Be creative, innovative using a product in different ways.
Recycle	Recycle by transforming materials that are discarded into other products through industrial or craft processes.

Source: [15].

The EA process is not only about a module that works to implement the process, but rather, advancing from the effectiveness and continuity of activities seeking to achieve the established goals.

Environmental education work in primary education should raise the awareness of staff and students about their values, attitudes, commitments, and capabilities needed for environmental improvement.

Conscious consumption depends on everyone's participation, where the progress of methodological actions is indicated. The 5R's methodology reaches an even higher level, the 7R's, including the desired, reinventing a new way of life [17] (Table 2).

Table 2 - Description of the different moments to reach the 7R's

TIME	3R's	5R's	7R's	META
1st	Reduce Reuse Recycle			Short term
2nd		Reduce Reuse Recycle Reuse Rethink		Mid-term
3rd			Reduce Reuse Recycle Reuse Rethink Refuse To recover	Long term
TARGET	WASTE	WATERS	Habits	PRACTICES

Source: Elaborated and Adapted [17].

There is a range of actions and interventions that can be done to reduce the amount of waste produced. Some are quite simple and depend solely on having the knowledge and practical experience of everyday actions [17].

The nursery seeks through new insertions to work in this perspective, knowing all the obstacles given to GA. Even because the information passed on to the student must be continued and incorporated into their time, becoming part of it.

Sensitization of education professionals and other public servants involved in the project is of fundamental importance to achieve the proposed objectives, awakening conscious citizenship with responsibility for social transformation, improving the basic concepts of EE [18].

A posteriori, the Nursery has the following activities intentions: introduction and use of selective trash bins, used to segregate the waste, besides collecting the organic waste to feed the composer; use of educational toys with natural resources, composting made with organic waste from the kitchen to prepare the fertilization of the garden, which will be used for learning planting and cultivation [11].

#### 4. Conclusion

From this perspective, sustainability becomes an obligation to future generations from the moment when EA's knowledge becomes assimilated and intrinsic to our actions, satisfying the sustainability tripod.

According to the conception and perception of individuals in a given community, so that they reflect, understand and discover the importance, there will be effective participation in projects involving EE.

The study presented here is just one of the possible initiatives of working with EA in day care, even in the face of great difficulties and challenges in basic education, articulating educational actions, appropriate conditions and training for educators so that they can work on environmental education themes and activities.

It should also enable the criticality of students, based on concepts and playful actions, developing the values of environmental practices with interventions based on the awareness of individuals in the process, awareness to take the EE as part of themselves, administer the interpretation actions, so that, in fact, it is developed and absorbed, until it reaches the desired model, acquiring forms and tools for the execution of environmental awareness.

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# **Solid Waste Generated by Amazon and Tapajós River Vessels: An Environmental Education Activity**

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## **Abstract**

*Given the lack of research on solid waste generated by vessels and often incorrectly discarded, it became clear the need for a new methodological approach focusing on the knowledge of this theme. Thus this study was conducted focusing on the process of awareness of users of a vessel that made the route that traveled the Amazon River and Tapajós, using an environmental awareness activity, with results and immediate observations. From this, the waste was quantified before and after the interventions, which occurred from the clarification of the environment, solid waste generation, natural resources, water, among others. The research took place aboard a vessel that connects Manaus-AM to Alenquer-PA, evaluating the before and after the intervention. Given this, it is verified that the evaluation process achieved positive results in the minimization of solid waste generated, ensuring that the study has immediate effect, but the intervention measures need time for consolidation, given the responsibility of environmental education, which needs different approaches, under different eyes and with depth of knowledge, even if it requires a long-term process. Therefore, the importance of this type of activity is verified, aiming at the correct destination of the solid waste generated, in any circumstance, mainly in vessels, in different rivers, considering the condition of this natural resource. In addition, user awareness and education through environmental education is mandatory to better understand the impacts caused*

*by different changes over time and needs to be an effective tool to ensure the success of habit transformation processes and quality improvement of life.*

**Keywords:** Awareness; Incorrect disposal; Water resources;

## 1. Introduction

The waterway modal has always stood out in the transport sector in the north of the country, even presenting itself as a major driver of international trade. As a result, the globalization of markets and the intensification of international transactions over the last 30 years have boosted the flow of goods and boosted the expansion of the port sector, which in turn has proved to be a more appropriate alternative, given the possibility of from larger displacements, with lower associated costs, compared to land or air transport, for intercontinental travel.

[1] says that managing the environment in the port area is a complex challenge that involves many levels of knowledge. Most of our port environmental managers, when they exist, do not have an operational, environmental or even social framework appropriate for the implementation of appropriate management models in an environment marked by the complexity of the processes.

Also in the context of port environmental management, in which one aspect is highlighted through the management of waste, which is still ineffective, whether operational, vessel or cargo aspects.

Although specifically ship-generated waste is subject to international regulations, such as the International Convention for the Prevention of Pollution from Ships - MARPOL 73/78 Convention [2] and the International Organizing Maritime (IMO) Regulations [3], there is still little effectiveness under stricter conditions.

Given the above, we have the UN specialized agency, responsible for the safety of navigation and prevention of maritime pollution caused by ships, where developed countries have been implementing their own policies through regulations and proactive initiatives by sectoral entities and port authorities.

According to [4], the residues of vessels and residues from port activities are pointed as one of the main factors that cause the impact of the activity. However, the implementation of proper waste management in face of regulations on the subject is still a factor to be improved.

Water pollution by solid waste has been growing every year. In general, these are dumped mainly by people who in boat trips made in the State of Amazonas, especially in those municipalities with greater tourist potential such as Parintins, Maués, Barcelos, among others.

It is noteworthy that although some boats maintain a collection system, many passengers are not aware of these issues and end up dumping these wastes directly into the rivers.

This situation is especially aggravated during the holiday season, as it considerably increases the number of boats. Part of the non-biodegradable "waste" submerges and the other part goes to the beaches harming the floodplain agriculture and even the ecotourism process. Although this aquatic waste is mostly made of chemically neutral materials, what causes concern is the decomposition and sedimentation that is occurring in the riverbed and in particular in the floodplain areas, changing the normal conditions of this environment, with repercussions. unpredictable for the fauna [5].

In Brazil, the process of most intense urbanization began from the 1960s, but in the Amazon, the intensity

began to occur only 20 years later. Today, most people live in cities where about 70% of the population lives in urban centers, which demystifies the image of a depopulated and strictly rural Amazon [6]. With the increase of small urban agglomerations and the emergence of medium-sized cities in the Legal Amazon, the weaknesses of an urban network were revealed that are related to the impediment of the flow of people, goods and services, highlighting the great distances, the lack of infrastructure in the cities. transport and communication sectors and material and educational resources [7].

Belém and Manaus, two major cities in the Region, have been losing out in terms of urban population to medium-sized cities, a phenomenon that occurs throughout Brazil, showing a deconcentration of the urban area of these cities to increasing urbanization of medium and small cities [ 6].

According to [8], the urban environment characterized by high demographic density, unbridled generation of solid waste, modification of biodiversity, removal of native forest, soil impermeability, among others, generate a set of environmental problems such as water pollution, occupation river banks, lack of basic sanitation and pollution of the whole sphere.

Another characteristic of urban space is the consumption and production pattern that surpasses the regeneration capacity of natural systems verified in urbanization processes, with great demand for food, transportation, housing, energy and comfort, aiming at meeting human needs in life. modern [8].

In this sense, river navigation is responsible for the flow of production and locomotion, allowing the survival of several municipalities, towns and other production centers, in addition to the development of the Amazon, where river transport in many locations is solely responsible for trade and transportation. displacement of people [9].

The Amazonian waterway system, the largest in Brazil, is made up of the Solimões-Amazonas Waterway, the Madeira Waterway and the Tapajós Waterway. The main navigable rivers are: the 1,620 km Solimões River, the 1,508 km Amazon River, the 2,449 km Purús River, the 310 km Negro River, the 398 km Rio Branco and the 110 km Jari and Trombetas Rivers each, the 1,052 km Madeira River, the 212 km Aripuanã River and the 345 km Tapajós River. These waterways with about 80% of the economically navigable inland waterways in Brazil, 36% are used to transport passengers and cargo, called mixed vessels [10].

Therefore, river transportation in the Amazon was fundamental in the late nineteenth century for the rubber cycle, which generated economic interests of private groups in the exploration and introduction of new ships, since the monopoly of the Grão-Pará Trade Company Maranhão, with the objective of developing agriculture and commerce, having a considerable fleet of ships, including warships [10].

Even today many river craft are built by hand (informal), through knowledge acquired from masters in shipbuilding, in which they were directly linked to the nineteenth century shipyards, when they made medium and small boats, called “boats”. “inline and pleasure engines”, taking advantage of the entire model and architecture of the larger overseas vessels, particularly the United States and Europe [11].

In the Amazon Region, passenger and cargo waterway transportation is carried out by inland waterways. According to [4], its study counted 602 vessels in 317 regular lines. One of the main lines connects the two main capitals of the Northern Region (Belém / PA and Manaus / AM) with 1,642 km away. The number of passengers using waterway transport in the Region is approximately nine million per year.

Through the exposure presented, the aim of this study was to quantify the solid waste of a large vessel



that navigates between the Amazon and Tapajós rivers (AM-PA), implementing environmental education from an immediate and effective approach to the generation of environmental awareness.

## 2. Materials and Method

### 2.1 Study area

The study was conducted in the waterway mode between the Amazon (Amazonas) and Tapajós (Pará) Rivers (Figure 1).

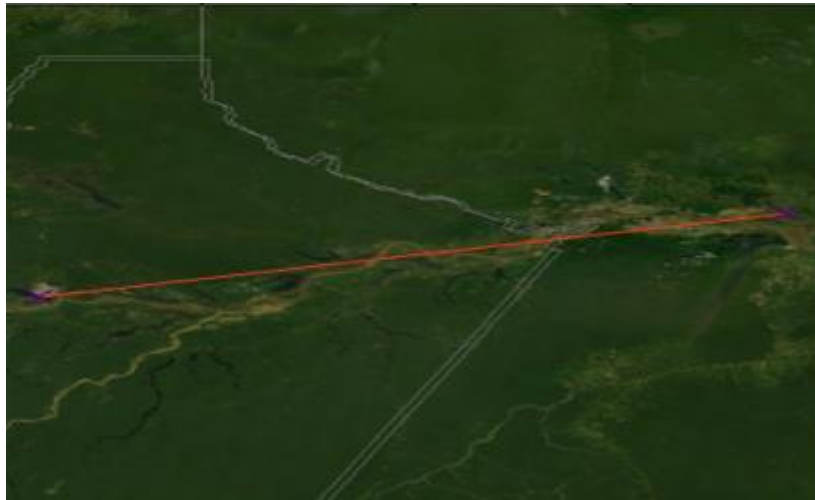


Figure 1 - Map of the vessel's trajectory location for collecting waste data.

Source: Thiago Fernandes (2019).

The climate of the Region is characterized by humid tropical, whose air temperature varies between 24°C and 26°C. The average annual rainfall is 2205 mm higher than the average of all basins in Brazil - 1,761 mm. The average flow in the Amazon basin is 132,145 m<sup>3</sup> / s and a water availability of 73,748 m<sup>3</sup> / s [12].

The type of approach adopted in the research occurred through the quantitative exploratory method. According to [13], by adopting an exploratory and descriptive approach, the researcher should be open to their findings. Even if you start the work from some theoretical scheme, the researcher should be alert to new elements or dimensions that may arise during the work.

The present activity can be classified, in a case study, using a vessel, in depth character. The Monte Cristo ferry boat, one of the largest waterway transports, bound for the municipality of Alenquer-PA, with representation in its respective cargo and passenger transport segment, where waste was measured and classified before and after an activity. environmental.

The environmental approach to encourage users and crew sought, based on the concept of environmental education and aiming at environmental awareness, on board in the waterway mode, to instrumentalize reflection, seeking to observe behavioral change, thus obtaining the representativeness of sustainable development and preservation of the environment. Thus, a proposal for a lecture on environmental education was made during the trip, seeking results that immediately described the intervention process.

In the quantitative analysis, the study provided four separate collection bins for segregation of the collection of solid waste generated on the vessel, placed in the upper wagon where most passengers are

located. The total amount of waste generated by a 50 kg precision scale was measured using plastic gloves to handle the contaminated material and 50 l plastic bags.

Between one collection and another, an intermediation was presented through a short explanation about environmental education. It should be emphasized that the weighings were performed before and after the educational approach, in order to observe a small change in the conception and sensitization of the information, in order to constitute, in fact, the waste collection information, seeking from a specific condition. indicate the completion of this activity.

### 3. Results and Discussion

The purpose of the evaluation process is to observe the results seeking to infer about the minimization of solid waste generated by the vessel's users and crew, and to ensure that the study initially led to a sensitization process; and long-term awareness of vessel users about their role in reducing, mitigating or not disposing of waste incorrectly.

In this context, an intervention lecture was given to highlight the environmental awareness theme and its impacts on the rivers. Therefore, it is extremely important to deepen the real situation of how the generation and disposal of waste occurs, obtaining positive effects immediately through this intermediation (Figure 2).

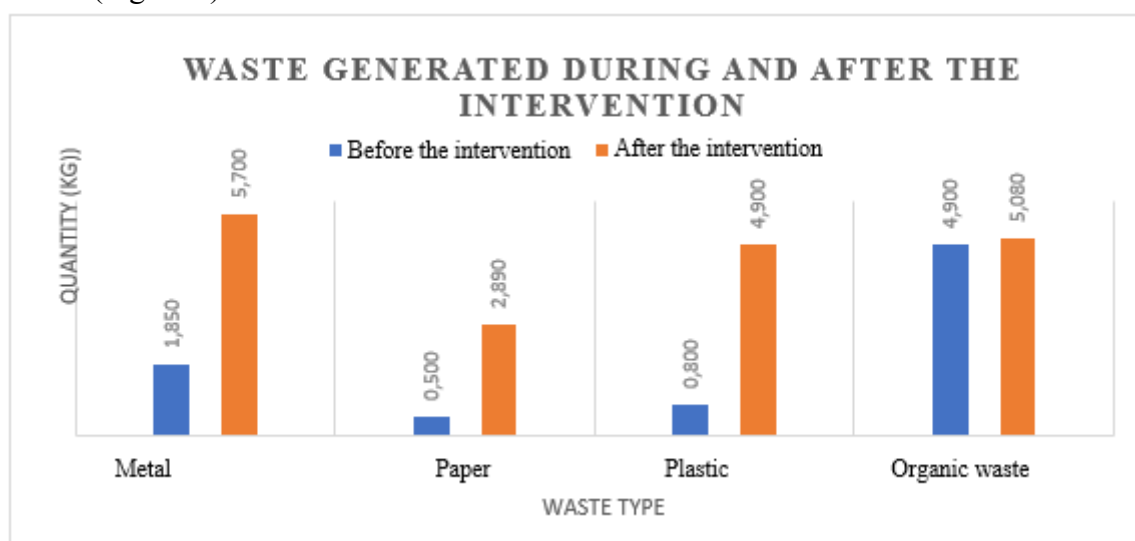


Figure 2. Description of the types of waste generated during and after the intervention.

Source: Own authorship (2019).

The main sources of waste observed in this study allude to the main materials generated within the environment, considered as solid waste, two of them (metal and paper), the most treatable materials and currently the most recycled in the world, highlighting as still a problem. , the plastic waste.

Water pollution is one of the impacts with the most drastic consequences, having immediate damage due to its polluting capacity, can also cause major ecological disasters, with the destruction of large areas in a short time, depending on the material disposed [14]. . The authors also mention that not only in this condition there is degradation, since they act as a wastewater deposit, the result of human neglect.

Thus, in order to report the accounted data and compare the before and after the implementation of the

selective collection dumps, we sought to understand the efficiency of the intervention within environmental education, described through a statistical analysis demonstrating the results achieved (Table 1).

Table 1 - Data collected before and after for each type of waste.

Statistical Measures	Before the intervention	After the intervention
Sum	8,050	18,570
Average	2,013	4,643
Variance (s <sup>2</sup> )	4,041	1,482
Standard Deviation (s)	2,010	1,218
Amplitude	4,400	2,810
Inferior limit	0,500	2,890
Upper limit	4,900	5,700
Coefficient of variation (CV%)	24,971	6,557
CI (95%)	1,970	1,193

Source: Own authorship (2019).

The total value of the discarded waste difference increased by more than 100%, showing less data variation after the intervention, which characterizes rapid response, but it is not possible to describe if this condition is constant, since education needs time to be effective.

According to [15], the attention that should be given to environmental resources, given the emergency, linked to its use, established an ethical order to reduce this resource, starting an ecological wave, with political responses and daily behavior, including the construction of ecological politics by the way of thinking (perceptions) and the way of acting (actions) and that must present cognitive and affective form. The continuity of the aspects, demonstrated by a formative activity, needs new knowledge, which needs to be systematized, in order to obtain better results [16]. The authors also mention that environmental education promotes procedural and punctual interventions, with a strong individual component, when observing behavior, but with collective orientations aimed at legal action and global thinking.

Environmental education is a continuous process whereby knowledge and information related to environmental issues becomes an important factor to understand how it can become a beneficial agent for the environment [17] and can directly interfere with degradation and preservation of the environment. understanding the types of waste generated and how to carry out their implementation process (Figure 3).



Figure 3. Illustrative mosaic showing the activities.

Source: Own authorship (2019).

The management of environmental activities is necessary to establish a coordinated relationship between the different activities that cause environmental impacts, especially when talking about water resources in large basins.

According to [18], there is no way to talk about water, not to mention health, sanitation, and natural resources in general. Thus, the relationship between environmental education and the insertion of social issues should be described, enabling conditions to initiate the transformative process, with the expressive participation of society [19], centralizing its implementation, and environmental education and the consolidated management model. “Continuously, differently and permanently”, not just performing specific actions, such as booklets, lectures and campaigns, but using the political context based on mobilization and training.

#### 4. Conclusion

The development of the study showed the importance of the environmental approach to encourage the awareness of passengers and crew in the proper disposal of waste generated during travel in waterways, aiming at reducing the impacts caused to the environment. The lectures given emphasized the theme of environmental awareness and had satisfactory results in minimizing waste.

It was found that during the research there was no supervision at the waterway port by the responsible body, which aggravates the situation constantly, given the lack of technicians in the area and legislation relevant to this modal type.

Finally, the research results showed the importance of the disposal of solid waste generated in vessels, and the awareness and awareness of users through environmental education, which, however simple, any intervention becomes important, so that individual actions , become major activities and can add environmental multipliers.

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# **Briquetting as an Alternative for the Use of Urban Wood Waste as a Mitigation Process on Environmental Impacts in Manaus**

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## **Abstract**

*Waste generation has become one of the most important issues of the century, every production process has significant losses due to the lack of proper management, especially wood waste, which becomes environmental liabilities, given the search for low environmental impact solutions, such as Microusinga. Briquettes The scenario for initial investments that would be R \$ 63,706.62 in fixed costs for implementation purposes and R \$ 109,274.02 in variable costs for the first month, added up to R \$ 792,980.64 (20%) of the amount spent in the year. 2018. The results of this research reflected that briquetting is an economically viable technological alternative that sets precedents for sustainable development in the Amazon, and may prove to be a powerful instrument for environmental compensation and cooperation among generating agents, collectors and the public authorities. , where it successfully fulfills its social function, generating cultural change and change and attitude towards waste disposal, reduction of generation, reduction of pressure under native forests, and minimization of environmental liabilities.*

**Keywords:** Briquettes Wood waste; Technological alternative; Mitigation of Environmental Impacts;

## **1. Introduction**

A considerable portion of the sawmill industries and logging companies in the country are unaware of the potentials for the proper utilization of their residues and by-products, due to the low technological level employed in their industrial processes. some effective use (MELO et al. 2016).

The National Industry Confederation (CNI) Profile Report (2016) states that the state of Amazonas has the second largest industrial GDP in the northern region, and its industry represents 34.8% of the state's economy, where it denotes high technological levels developed by the local industry that allows the promotion, organization and development of the waste recycling industry. Efforts to convert waste into raw materials are bringing environmental improvements and generating income for people from vulnerable social groups.

In this context, the reuse of wood due to favorable chemical and physical factors allows it to be applied in several recycling segments, besides promoting high advantages in terms of homogenization, burning control, high calorific power, density and humidity (SANTOS)., 2015).

Silva (2014) points out that the demand for these wastes is for use in composting centers, lining farms or ends up being discarded without any specific and effective use.

In 2010, the National Solid Waste Policy (PNRS) was sanctioned by Law 12.305 / 2010, which seeks to mitigate environmental impacts through its objectives, generating, reducing and reusing waste management regardless of material. Since then it has been trying to achieve investments in technological innovations to improve product manufacturing that generally result directly in the reduction of waste production.

Therefore, in order to properly treat waste we need to classify and characterize it and its condition, origin, physical, chemical and biological characteristics need to be observed in order to properly dispose of all waste generated according to with their relevant legislation and technical standards.

Technical standard NBR 10.004 / 2004 classifies the waste according to the potential for environmental and public health contamination, wood waste is classified as non-hazardous Class II waste, which is divided into inert and non-inert IIA and IIB respectively for IIA waste wood waste, biodegradability, combustibility or water solubility are considered.

Noting that wood residues that are present in Construction and Demolition Waste (RCD) and are considered according to PNRS as Class I - Hazardous Waste, being inert waste and cannot be disposed of in landfill.

Wood waste is generally characterized by its variable size, high humidity index, low density index and large volume; Plant waste requires large areas for storage, in addition to the difficult access to this raw material in remote places, which makes collection and transportation difficult, being some of the reasons that underuse this material (DONATO, 2016).

Surveys carried out Trugilho (2010) find that Brazil has attractive and favorable conditions for the briquettes segment, that is, by a combination of factors, such as the high concentration of vegetal residues and the high calorific power (PC) associated with these residues.

In this context, the Amazon region has vast residual logging potential, which is little explored that can bring many benefits to the region through the appropriate use of available timber resources (MELO et al. 2016). According to the Institute for Conservation and Sustainable Development of Amazonas (IDESAM) and Vianna (2013), Manaus and Itacoatiara are municipalities that concentrate the largest number of wood processing companies, which, because of this, present significant amounts of waste and byproducts during their processing. Therefore there is an intrinsic relationship between your income and the end performance, in a sustainable way.



According to Vianna (2013), from 2010 to 2011, wood processing in the Amazon generated 61,000 m<sup>3</sup> (10,980,000 t) of waste, the largest source in Itacoatiara, with a 31% share, followed by Manaus representing 17%, and Iranduba, with a relative share of 13% of the total, this amount only for the timber industry.

However, Iranduba consumed almost the same 31% of Itacoatiara generation in waste, this is due to the large ceramic pole of the

33%, but Iranduba is in second position because of the movement and consumption of the municipality of Itacoatiara that consumes 95% of its waste for local energy generation and charcoal production.

With the report released in 2019, Semulsp showed survey data, considering that in the previous year approximately 8,570 t / year were collected, being 725,874 t / month and 0.011 kg / inhabitant of pruning and urban afforestation waste with participation of 0,9% of the total waste disposed in the landfill in the year, was spent on collection / transportation approximately R \$ 3,187,303.94, and it is estimated a final disposal cost of R \$ 731,792.3 / year, considering the average value. R \$ 85.39 t, charged by the two concessionaires responsible, totaling R \$ 3,919,096.24.

However, in contrast to other types of waste, urban wood waste such as caskets, sawdust, wood shavings, cuttings, saw dust, twigs and logs from public pruning and those originating from civil construction have potential and their direct burning does not. is exclusively one of them, it is necessary to use technical studies of alternatives for better use of these wastes (DONATO, 2016).

Although urban logging waste is of little significance compared to that generated by the large logging industry, it is important in the urban context as a whole (FERRO, 2018). Where the Municipality as a social / environmental actor does not have, or does not have sufficient sorting mechanisms in place, temporary or definitive packaging of bulky waste and large generators, such as: Transshipment and Screening Areas (ATT), Voluntary Delivery Points (PEVs), Voluntary Delivery Locations (LEVs).

According to the Municipal Secretariat of Cleaning and Public Services (SEMULSP) (2017), Manaus has only four Voluntary Delivery Points (PEV's) and seven storage sheds, while the Transshipment and Sorting Areas (ATT) are. non-existent, violating laws and retreating to the National Council of the Environment (CONAMA) which, through Resolution Conama No. 307/2002, makes its implementation in all municipalities of the country mandatory, as a way to eliminate the impacts of the lack of control of related activities. environmentally inadequate generation, transportation and disposal.

In this context, the municipality does not dispose of Class IIB inert waste landfill, Complementary Law No. 01 in its Art.2, paragraph III, limits the disposal, however, does not prohibit, that is, by programming the collection service of Construction and Demolition Waste (RCD) up to 50 Kg packed in plastic bags, these can be disposed of in the landfill.

Therefore, it is necessary to create (ATT), (PEV'S), (LEV'S) and construction and demolition waste recycling centers that will meet the needs of the municipality, as well as organize and develop a new model. management of recyclable solid waste, with real compensation to the citizen.

The lack of proper management by the Government, and non-compliance with federal determinations, are one of the determining factors that make waste into environmental liabilities (FERRO, 2018).

Technical Standard NRB No. 15.515-1 / 2011 conceptualizes environmental liabilities as: "Damages inflicted on the natural environment by a given activity or by the set of human actions, which may or may



not be economically evaluated". In this context it is constituted to create ways and means of environmental compensation to minimize environmental damages, applying penalties for infringement to the environmental legislation.

In this theme, Mello; Annunciation (2015), emphasize the need to achieve high efficiency rates and improve the production process, as well as highlight the search for the development of new mechanisms and systems of environmental protection, this is due to the new market model and high figures presented in the balance between yields and waste generated in production.

According to Hartmann et al (2009), the best solution for waste disposal is that in which the binomial environment and profit are combined in such a way that both the environmental guidelines and the financial result are satisfactory, consolidating this vision as the manufacture of wood waste briquettes.

According to Lopes (2017), briquette is an ecological firewood that effectively replaces gas, electric power, charcoal and mineral and firewood, as well as other fuels used in various industrial processes.

Briquette is a direct substitute for firewood in many applications, including residential use, in industries and commercial establishments such as

ceramics, ceramics, bakeries, pizzerias, dairy, food factories, chemical, textile and cement industries, among others.

Santos (2015) points out that the advantages of the compaction of agricultural and forest waste presented are of an imprint, energy, environmental, logistic, operational, and in contrast to the logging in the Amazon, these advantages are seen as obstacles due to the low utilization of the material. raw materials and inefficient outflow logistics.

According to Trugilho (2015), native wood has variable calorific value, depending on the forest species, being the chemical composition responsible for this variation, being directly related to the lignin, ash and extractives contents. Therefore to measure the calorific equivalence between materials, for viability purposes, we will use the Lower Calorific Power (PCI) among materials used for direct burning purposes which are: wood in logs, chips and sawdust.

Second (Quirino, 2007); (Donato, 2014), briquettes have Lower Calorific Power (PCI) averaging 4,553 kcal / kg, and compared to crate and drywood firewood, according to the LPF / IBAMA Forest Products Laboratory, these firewoods have Lower Calorific Power (PCI) averaging 1,450 kcal / kg. (Table1):

Table 1 - Comparison of properties between briquette and wood.

FACTOR	WOOD / WOOD	BRIQUETTE
MOISTURE	80.00%	12%
CALORIFIC POWER	1,450 kcal / kg	4,553 kcal / kg
DENSITY	314 kg / m <sup>3</sup>	700 kg / m <sup>3</sup>

Source: Donato (2014) and Quirino (2007).

Where according to the data 3.0 t of firewood would be needed to supply the energy demand, contained

in 1 t of briquettes.

- 1 t Briquette = 18,966,072KJ
- 1 t Firewood = 6,066.80KJ

Thus, this research aims to analyze as potential environmental and social incentive the implantation of waste compaction Microusin (briquetting) in a composting plant existing in the municipal landfill of Manaus / AM, as it presents a better logistic and operational solution with interconnection with the municipalities of the Manaus Metropolitan Region (RMM), based on real data provided by the Municipal Secretariat of Cleaning and Public Services (SEMULSP).

## 2. Materials and Method

The project is classified in bibliographic research, which consists of theoretical references previously analyzed (GIL, 2010). Exploratory, seeking to provide greater familiarity with urban waste wood (PRODANOV; FREITAS, 2016). The deductive method is also used, based on data through public policies and reports, always making use of the previously acquired logical and purely formal reasoning (Gil, 2010).

### 2.1 Study area

Manaus Municipal Landfill is located at km-19, state highway AM-010 (Manaus-Itacoatiara), located in the western region of the city of Manaus / Amazonas (Figure 1).

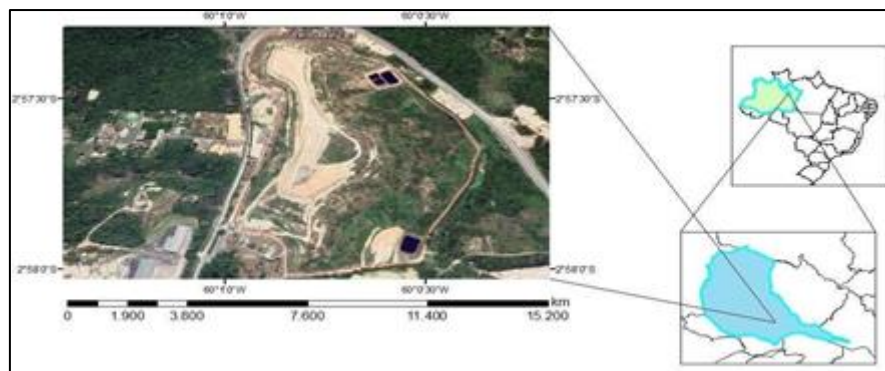


Figure 01. Manaus Municipal Landfill.

Source: Own authorship (2019).

### 2.2 Data collect

For the implementation of the mini-briquetting plant on the perimeter of the Manaus Municipal Landfill, it is necessary to estimate the actual amount of waste that is disposed of in the landfill and to analyze the management plans according to the effective compliance with the municipal legislation regarding the studied waste. in this research, which are: urban cleaning waste, construction waste, and urban commercial waste from small and large generators, those from sawmills and trades in general, located in the city of Manaus.

Surveys and studies conducted by the Ministry of Environment and Sustainability (MMA), Brazilian Institute of Environment and Natural Resources (IBAMA), Brazilian Agricultural Research Corporation International Educative Research Foundation and Publisher © 2019

(EMBRAPA), and the effective compliance with the resolutions of the National Council of Environment (CONAMA) to the Manaus Solid Waste Master Plan (PDRS-MANAUS), and the performance of the Municipal Secretariat of Cleaning and Public Services (SEMULSP).

In the availability of the data used in this research, the reports available on the websites of the observed companies are not disclosed in detail data such as: packaging waste disposal, and construction wood, where these two types of waste are included in the waste category. not specifying which types of waste are present.

Adopted the methodology for feasibility analysis based on the studies by Quirino (2014); Rodrigues (2014); Silva (2007); We sought to observe and follow all the basic and conditioning issues for the sizing of the briquetting plant of the Forest Products Laboratory - LPF / IBAMA. Also in this context, we consulted the Brazilian Journal of Agrotechnology, which deals with content on clean technology for production and sustainability, Revista da Madeira (REMADE), Brazilian Journal of Agrotechnology (REBAGRO) with their studies focused on construction, export and alternative studies technologies for waste wood use in the Brazilian market.

### 3. Results and Discussion

From the analysis of the reports for the technical / financial feasibility for implantation of briquetting plants, the project fits in the industrial sector and consists of the implantation of a production system, that is, were studied: installed capacity of production, average prices of the region, labor cost, production and labor regime, as well as the structure of total monthly costs, where, according to Quirino (2014), the basic project is characterized by the calculation of the total value of investments from more detailed engineering studies. to subsidize the contracting of the works.

For sizing and installation briquette machine area (Table 2), we will follow the calculation basis based on production capacity per month, hours worked, packaging capacity for storage and turnover.

Table 2 - Production of Briquettes per kg / month and H / month.

MACHINE PRODUCTION	3,060 Kg / h	176 h/mês
	8h / day (WEEK)	
WORK REGIME	4h / day (Saturdays)	
<b>TOTAL BRIQUETTES / MONTH</b>	<b>538,560 Kg / Month</b>	

Source: Own authorship (2019).

The nominal values informed by the manufacturers were considered: Biomax Machinery and Equipment Ltda and LIPEEL - Integrated Solutions for Biomass, for calculations of productive capacity, as follows: Specific Weight of wood waste considered on average 180 kg / m<sup>3</sup> and humidity of 16% according to equipment supply companies.

The production and storage area will be 280 m<sup>2</sup>, and for its construction, prices related to the civil construction of the state of Amazonas were consulted, which is R \$ 1102.38 considering labor and

materials employed (IBGE, 2019).

The construction of briquettes storage and production warehouses requires a considerably small covered area, and according to Revista da Madeira (2010), only 50 m<sup>2</sup> is required to hold 30 tons of packed briquettes. However, a total area of 200 m<sup>2</sup> will be built, considering public use areas and areas for better circulation of personnel and equipment.

While the solar dryer will be 100 square meters and will meet the criteria described above, however it will be installed in a pavilion apart from the production area, free of any solar and air barrier. The solar dryer to be built will be the black pepper solar dryer, developed by the Brazilian Agricultural Research Corporation (EMBRAPA), where it comes up with an innovative architecture that employs simple materials such as wood and plastic, which eventually becomes an alternative to low costs and great drying efficiency of various raw materials.

The area to accommodate the shredder and its operators will be in an outdoor area near the solar dryer pavilion for operational management purposes, and will have 100 m<sup>2</sup> to obtain higher quality of the produced shavings.

Thus, based on the synthesis presented, the following sizing and projections for the installation (Table 3).

Table 3 - Costs per m<sup>2</sup> for the construction of the storage shed and production of briquettes.

PLACE	PRICE (R \$) / m <sup>2</sup>	AREA m <sup>2</sup>
SHOP FOR PRODUCTION	1102,38	100 m <sup>2</sup>
STORAGE SHED	1102,38	100 m <sup>2</sup>
SOLAR DRYER	1102,38	30 m <sup>2</sup>
GRINDING AREA	-	100 m <sup>2</sup>
AMOUNT	R\$253.547,40	300 m <sup>2</sup>

Source: IBGE (2019), Research Directorate (2019), Price Index Coordination (2019), National System of Costs and Indexes for Civil Construction Research (2019).

The briquette machine has the production capacity equivalent to the amount of waste received per day at Manaus Municipal Landfill, about 23 t / day. Figure 02 demonstrates the basic mechanisms of a briquette machine.

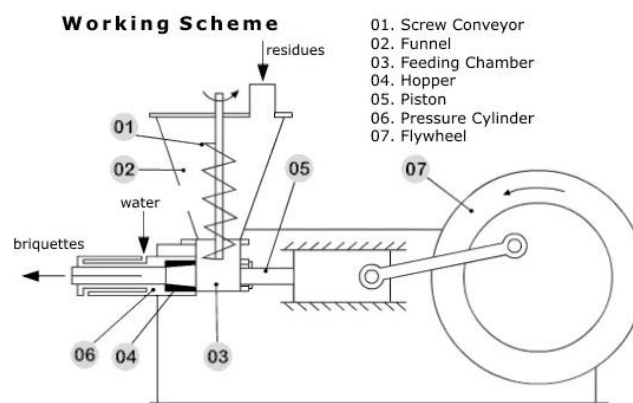


Figure 02. Mechanisms for compaction.

Source: Biomax Machinery and Equipment Ltda (2019).

The shredder model has the capacity to handle a larger volume of waste than the collected and generated, about 36 t / day, that is, where considering the need to shred logs up to 300 mm in diameter. The use and acquisition of chainsaws are necessary to reduce the branches and larger logs for subsequent shredding ensuring the useful life of the equipment.

According to quotations made with the national manufacturer in 2019, the values of initial investments in machinery (industrial equipment) were acquired (Table 4).

Table 4 - Costs to acquire machinery to start the production of briquettes.

QTD	EQUIPMENT	BRAND	MODEL	CAPACITY	VALUE (R\$)
1	BRIQUETTER	BIOMAX	B115/220	24 t / day	238.100,00
1	CENTRAL COMMAND FRAME	OWN	PADRÃO	X	16.900,00
1	DIESEL CRUSHER	LIPEEL	PDU/300	36 t / day	129.500,00
2	Chainsaw	NAGANO	MN6000	X	395,1
AMOUNT					CAPACITY

Source: Lippel (2019), Biomax (2012), Nagano (2019).

The plant fits into an industrial scale and it requires expenses with initial industrial facilities for its full operation as water, electricity, telephone, internet among others. The cost of these facilities is projected at 10% of the value of purchased machinery and equipment as adopted by Silva (2007); Rodrigues (2014). For the acquisition of machinery, furniture, office supplies and Personal Protective Equipment (PPE), investments of R \$ 7,000.00 were estimated considering the demand for these utensils in daily activity. The depreciation of assets, for Hosset al. (2008, p. 213), can be attributed to the process of allocation of expense or cost due to the useful life of goods acquired by companies, ie loss of initial value due to wear, being 10% for machinery, furniture and utensils and 4% for buildings, determined by the IRS and adopted in studies by Silva (2007); Gomes; Pepper (2010); Rodrigues (2014) (Table 5).

Table 5. Initial Fixed Costs for operation and annual depreciation values of assets.

SPECIFICATION	FIXED COST (R \$)	ANNUAL DEPRECIATION (R\$)
INDUSTRIAL EQUIPMENT	384.690,20	38.469,02
INDUSTRIAL INSTALLATION	38.469,02	3.846,90
MOBILE AND EQUIPMENT	7.000,00	7.00,00
BUILDINGS (SHeds AND DRYER)	253.547,40	63.386,75
TOTAL VALUES	683.706,62	105.702,67

Source: Own authorship (2019).

For the composition of Variable Costs (CV), according to Rodrigues (2014) production, packaging utensils and industrial labor, and from this we can estimate and project on a monthly scale all Variable Costs (CV), the annual energy power required by Microusina de Briquetes, evaluated by Rodrigues (2014), According to previous studies, it is estimated at 446772.48kWh / year. The tariff modality for the demand and consumption of electricity is the green tariff where, with a cost of 0.721060 (ICMS free) R \$ / kWh, totaling R \$ 322,149.76 per year and R \$ 26,845.81 per month, with electric power. According to Amazonas Energia S / A (2019) this modality is applied to Group A consumer units (Switched on Medium and High Voltage) supply voltage below 69 kV and contracted demand equal to or above 300kW.

Uses of packaging for briquettes packaging correspond to the production of 538,560 t / month of briquettes, packaging of briquettes by 10 kg paper packaging, correspond to 53,853 packages / month. According to the company MF RURAL (2019), the cost of packaging is around R \$ 1.31 (unit), where monthly total of R \$ 70,548.21 would be spent on packaging.

At Microfine Briquetting the cost of industrial labor includes the payment of eight (8) employees, who are responsible for assisting in the loading and lowering of branches, logs and leaves on the shredder machine three (3), operating the machine and briquettes logistics three (3), and administrative staff two (2). For a salary of R \$ 990.00 per month, with a payroll of R \$ 11,880.00 / month, which equals a payroll of R \$ 142,560.00 / year, including social charges and other benefits that according to Rodrigues (2014) is 50% of the salary paid (Table 6).

Table 6. Variable enterprise costs for the first month.

SPECIFICATION	QNTD	VALUE (UNT)	VARIABLE COST (R\$)
ELECTRICITY	446.772,48 kWh/ano	1,07 (R\$)/(kW/h)	26.845,81
PACKAGING (10KG)	53.853,60	1,31 (R\$)	70.548,21
LABOR + CHARGES (50%)		990,00 (R\$)	11.880,00
	8		
AMOUNT			109.274,02

Source: Own authorship (2019).

The results of this research reflect briquetting as an economically viable technological alternative, based on the composition of briquetting plant implementation costs, representing approximately 20% of the amount spent in the same year, compared to the values destined for collection / transportation and final destination. , from pruning waste in the previous year, totaling R \$ 3,919,096.24 in expenses (Table 7).

Table 7. Breakdown of Fixed Costs and Variable Deployment Costs.

SPECIFICATION	FIXED COST (R \$)
INDUSTRIAL EQUIPMENT	384.690,20

INDUSTRIAL INSTALLATION	38.469,02
MOBILE AND EQUIPMENT	7.000,00
BUILDINGS (SHEDS)	253.547,40
TOTAL	683.706,62
SPECIFICATION	VARIABLE COST / MONTH (R \$)
ELECTRICITY	26.845,81
PACKAGING (10KG)	70.548,21
LABOR	11.880,00
AMOUNT	109.274,02
TOTAL VALUE COMPOSITION OF COSTS (CF AND CV)	792.980,64

Source: Own authorship (2019).

By projecting variable costs over the annual range, R \$ 1,311,288.34 would be spent to keep Microušina fully operational, considering the minimum depreciation data, the fixed costs would remain the same over the ten year interval, so the fixed annual costs and variables revolve around R \$ 1,994,994.96, representing only 51% of the value spent today, plus collection / transport and final destination. No investment scenarios were analyzed for briquettes commercialization, such as unit cost and sales price. However, it is possible to make comparisons of costs and economic indicators, simulating different scenarios of a wood waste compaction system exclusively intended for commercialization.

#### 4. Conclusion

This research approached a budget proposal, for the implantation of the plant of an urban wood waste briquetting Microušina in the municipal landfill, as a way of expanding the capacity of reuse and reduction of losses in the destination process.

This work enhances a viable alternative for urban waste utilization, adding environmental and social value. By simulating scenarios it was shown that it is possible to produce a new product, which could replace part of the wood consumed in small businesses and homes as a form of sustainable economic attraction in compensation for the correct disposal of their waste.

The scenario for initial investments revolves around R \$ 683,706.62 in fixed costs for implementation purposes, and R \$ 109,274.02 in variable costs for the operation in the first month, added up to R \$ 1,994,994.96 annually. 49% economy, translating into green economy, efficient and shared management and social / environmental responsibility.

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# **Evaluation of the Basic Sanitation Legislative System in Manaus - Amazonas**

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## **Abstract**

*This study dealt with the legislative system of basic sanitation in the city of Manaus. From this approach we sought to develop the research from the parameters of the Brazilian legislation related to the basic sanitation sector, as well as to identify the important conducts on sustainable development. Understanding the importance of the subject in evidence, it is worth mentioning that Brazil has a considerable volume of freshwater in the world, and likewise, the Amazon has in its watershed much of that water in its rivers. Therefore, the objective of this investigation was to analyze the legislative system of basic sanitation of the city of Manaus - Amazonas, in order to understand the actions developed by this system. For the construction of this study, the methodology adopted was the bibliographic research with a qualitative approach, in order to reach the proposed objectives. Regarding the legislation that deals with basic sanitation, many advances in the sector were obtained. Most of the population does not have access to basic sanitation services, even if provided for by Brazilian law.*

**Keywords:** Basic sanitation; Sustainable development; Basic sanitation legislative system;

## **1. Introduction**

In the last three decades, the debates about the importance of sanitation, as a basic necessity, have taken place urgently, where immediate actions were required to improve this condition, making its notoriety in Brazil expressive. In this scenario, the relevance of the discussions on the theme of basic sanitation stands

out, considering that the lack of it can cause various inconveniences to the population, such as damage to health.

Faced with this theme, [1] in his article 225, when dealing with environmental issues, states that it is the duty of all to protect and ensure the preservation of the environment for future generations, this implies that environmental constitutional responsibility encompassing all sectors of society, however, it is observed that we have made little progress on these issues.

According to studies by [2], it is inherent to basic sanitation, a set of measures aimed at ensuring environmental conservation and disease prevention, which may be linked to social, economic, political and cultural factors. Therefore, it can be seen that when it comes to basic sanitation, in general, it is noted the scope of water supply systems, rainwater drainage, urban cleaning, sewage and other systems.

According to [3], Brazil holds much of the world's fresh water, and Amazonas concentrates much of that water in its rivers. Although the state can count on a vast area of rivers, access to water and especially to basic sanitation services, water through its treatment does not reach all residents of the region. In this scenario, the 2030 agenda for sustainable development describes equal and universal access to clean water as well as basic sanitation as one of the millennium's main goals.

In Brazil, the milestone in the expansion of the sanitation sector is represented by the creation of the National Sanitation Plan (PLANASA) in 1971, characterized by the channeling of FGTS resources, strong increase in the coverage of water supply services, reduced investment in depletion. sanitation, exclusion from other sanitation actions such as urban drainage and solid waste [4]

From the 1988 Constitution come new conceptions about public policies focused on basic sanitation in Brazil. In this sense, [2] emphasizes that, for the new constitution, basic sanitation is a fundamental right of the citizen and an indispensable requirement for the promotion of quality of life. Thus, it is understood that basic sanitation refers to actions directed to the conservation of the environment, in addition to disease prevention, implying combined actions between social, economic, political and cultural factors encompassing these systems.

It is important to add that the regulation of the Federal Basic Sanitation Policy was implemented by means of [5], whose innovation is the possibility of hiring, by the holders, private providers of sanitation services, in addition to the possibilities of institution of collection. for the use of basic services and user penalties.

In this sense, it is found that for the services to have a satisfactory coverage and reach the whole population, it is essential the efforts and participation of the federal, state and municipal spheres, each acting according to the constitution, so that the actions directed to the improvement. sanitation were implemented.

However, some actions are already being used and thought so that the negative impacts generated by economic development are minimized, one of them concerns the sustainable and conscious management of natural resources, such as clean energy, where some countries have invested heavily in basic sanitation, such as reduce the impacts on the health of the population. Unfortunately the reality of these investments is still noticeable only in developed countries.

Considering the arguments of [6] about environmental practices, it is clear that in defining the concept of sustainable development, they consider the economic, environmental and social aspects, delineating the

impacts of human actions on the planet, and although it is following a constant agenda in such debates, it is observed that some positive changes towards the generation of methods that articulate this process, resulting in environmental policies backed by robust and efficient legislation.

Regarding the role of organizations towards sustainable development, they are also governed by guidelines for the preparation of sustainability reports. Such reports determine the principles and performance indicators used to measure and report economic as well as environmental and social performance. Accordingly, a number of agencies that set environmental performance indicators are considered: The Ethos Institute [7], the Dow Jones Sustainability World Indexes [8] and the Global Reporting Initiative [9].

In the last decades the urban network of the whole country, has undergone expressive changes, that is, the growth of the urban area is an irreversible factor, however, what is observed today, is a disorderly growth deprived of any planning.

According to [10], rapid urban growth is expected to continue in the coming years. In this sense, approximately 54% of the world's population lives in urban areas, with the urgency of planning more sustainable cities.

Given this, the objective of this study seeks to analyze the legislative system of basic sanitation in the city of Manaus, seeking the Brazilian legislation as a reference regarding the basic sanitation sector, identifying relevant actions on sustainable development.

## **2. Materials and Methods**

According to [11], the technical procedures adopted in scientific research, refers to which technique to use to obtain the expected and unforeseen results in the project, among the most commonly used techniques can be highlighted: the bibliographic research in which technically seeks the results. based on material already published, such as the careful and systematic evaluation of books, journals, documents, texts, maps, photos, manuscripts and even material available on the Internet, etc.

For this, the classification and ordering of the information contained in the bibliographic sources was followed, so that they would allow the construction of ideas and the construction of specific objectives. Initially, an exploratory reading of all bibliographically collected material was performed, from a quick reading, in order to judge if it was interesting for the pre-project such information. Following, there was a selective process of these sources through a deeper reading of the sessions that met the inclusion criteria defined in this methodology.

The research aimed to promote an analysis about the legislative system of basic sanitation focusing on the city of Manaus / AM, seeking to describe the significant benefits achieved over time. Highlighting the importance of implementing public sanitation policies, understanding that this way we can guarantee health and quality of life to the population.

## **3. Results and Discussion**

The environment has a direct influence on the daily life of society, so it is essential that the current rules

of the country are respected, thus, it is possible to combine social and economic development with sustainable development.

Another important factor is directly reflected in the individual's life, that is, the benefits generated by sustainable urban planning for people's quality of life are innumerable, considering that the greater the reach of basic sanitation to the population, the better the quality of life. Life is offered to this population.

In the case of the city of Manaus, it has a territorial area of 11,401,092 km<sup>2</sup>, and with an estimated population of 2,094,391 inhabitants, according to data from [12].

In this scenario, according to studies of [3], data on water supply in the city of Manaus, from 2005 to 2014 show that the percentage of people served had significant growth, as well as the extension of the network that is currently above 3,000 km to serve the population.

Recently a study published by [13] with the 100 largest cities in Brazil shows that Manaus occupies the 97th position among the 100 largest cities in the country, being among the 20 worst according to the published ranking, the study is based on information generated by SNIS and shows that Manaus has evolved little in terms of investment in infrastructure.

According to the Manaus Municipal Sanitation Plan Elaboration Advisory Report, the water supply in the city of Manaus comprised about 98.6%, and this is due to the set that covers the Manaus city supply system, is based on four surface abstractions, on the Rio Negro, which accounts for 87% of the city's raw water abstraction, the water distribution system had a total network length of 3,537.33km and in 2013 the municipal distribution system served 275,421 active connections, equivalent to 336,515 active savings. From this context:

Manaus water supply systems from surface sources comprise the following systems: - Ponta do Ismael System (Water Treatment Plant - ETA I and ETA II); Mauzinho System (ETA Mauzinho); Ponta das Lajes System (PROAMA). Completing this system, there are a series of deep tubular wells that capture water in the Manaus underground aquifer, the Alter do Chão aquifer, called (Well System).

With regard to the management of supply services, this is the responsibility of each municipality, where each chooses how to manage the services. Some municipalities choose to grant their management to the private sector, as there are those who prefer to pass to the public power, which are classified as autonomous systems, for example, SABESP, COPASA, Manaus Waters.

Considering the state of Amazonas, 12 of the 62 municipalities have their water supply, sewage collection and treatment services under the management of COSAMA and in the city of Manaus these services are in charge of the Manaus Ambiental company that owns the concession of the supply systems, sewage collection and treatment [3].

According to research by [15], the city of Manaus is among the cities with the best structure when it comes to water supply and sewage system. However, [14] states that this does not mean that this structure is adequate, and that these services need to improve in order to prioritize the service to the population with more efficiency and quality. In the case of adequate service, with water supply, in the case of individual solutions, the supply of drinking water per well, spring or cistern, with internal piping, in any case without intermittences (stoppages or interruptions).

In this scenario, it is important to highlight the data from the Brazilian Association of State Sanitation Companies [16], which shows that in Manaus, between 2002 and 2016, the water supply index rose to the

population, in this case the index rose from 81% to 88%. It is understood that it was a great advance in this system, however many challenges need to be overcome for the coverage area to be expanded and reach its fullness, and this service must be offered as efficiency and quality, as these are prime factors for the health of the population.

From this perspective, [14] as one of its main goals for the northern region, predicts that by the year 2033, 94% of urban homes will benefit from water supply. Regarding the sewage system, the projection for the same year is 87%. Given these data, [3] defends the idea that although there is a trend of growth in these service networks, regarding the sewerage, it is observed that does not walk at the same speed as the water supply network, ie, exhaustion interconnection is much smaller.

Finally, it is added that the supply of treated water and sewage is a major problem for the country's development. Given that, according to the Diagnosis of Water and Sewage Services, published in 2014 by [13], it pointed out that the treated water supply in Brazil reached 82.5% of the population in 2013 and only 48.6% had access to sewage [17].

Within a general analysis according to data from [18], when it comes to Municipal Sanitation Policy, it is observed that it is present mainly in more populous municipalities, for example among the 42 municipalities with more than 5000.000 inhabitants in the In 2017, only 29 confirmed that there is a concern in the municipality with these issues.

Thus, municipalities count on [14], which aims to promote the expansion of this service to the entire municipality. What is observed is a small advance, since in 2011, 22 municipalities presented their basic sanitation plan. And considering the national scenario, a percentage of 2,126 municipalities stated that they had elaborated their policy for the development of basic sanitation services, that is, 38.2%. The data reveal the need for investments in basic sanitation policies for the population in order to remedy and / or prevent damage to public health.

According to information from [13], Brazil is still one of the countries that has evolved least in the area of basic sanitation. This implies in concluding that there have been no major advances in these issues, since both the supply of treated water and the collection and treatment of sewage are far from universal access, which can lead to serious damage to the health and quality of life of the population.

#### **4. Conclusion**

The present study made important considerations about the basic sanitation legislation of the city of Manaus. In this sense, it was possible to draw an overview of the situation of this service with the population. Given the relevance of this theme, it is known that the issues associated with basic sanitation in Brazil, have been constantly debated mainly in recent decades for understanding that this is public health.

Thus, with regard to legislation that covers the rights of the population to access basic sanitation, research has shown that since the 1988 Constitution the debates on this theme have gained increasing prominence in expanding to all areas of society, size is its importance. The Constitution also reiterates that basic sanitation services are fundamental rights of the citizen, and the State must guarantee their access to all.

In this scenario, the study also highlights the role of public sanitation policies for cities, in this context it

is worth highlighting the importance of the planning already carried out, seeking to promote the expansion of these services. In fact, public policies, but to understand the process of generating plans, should be in charge of implementing them.

Another highlighted issue, in this study, points out that the city of Manaus has undergone a process of very rapid urban growth in recent decades, unfortunately sanitation policies have not accompanied the development of the city, a fact that contributes to the problem faced today by much of the city. Although the population has the right of access to basic sanitation services provided by law, it does not have the same, which has generated numerous problems for the population, especially those of public health, because basic sanitation services are considered essential. , since from this we can promote the minimum conditions of social development.

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## **Energy Efficiency Analysis in a Higher Education Institution in Manaus - Amazonas**

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### **Abstract**

*Thinking about solving the problem of high consumption and high cost in the electricity bill, this study proposes to present proposals to increase the energy efficiency of the site. In this sense, it is proposed an energy efficiency analysis of a Public Higher Education Institution in the Municipality of Manaus, Amazonas. A building survey was performed on the appliances and components of the building's electrical system, as well as an assessment of electricity bills to measure consumption. In order to verify voltage, current and power, electric measuring instruments were used to elaborate proposals aiming at increasing the energy efficiency of the site. Through the results obtained during the building survey at the IES, it was possible to observe the anomalies of the systems and indicate proposals for repair or replacement of equipment to increase the energy efficiency of the building. From the results obtained from the invoice it was possible to propose a new value of demand contract and by comparing the collected data, we identified the appliances that make the electric system less efficient, in this case, the air conditioners. Recurring payment problems with overconsumption were encountered. Adhering to the proposal of a new contract value with possible annual savings of R \$ 22,543.92 referring to the payment of the demand portion in the electricity bill. It is also proposed to replace current lamps with LED tube lamps, reducing energy consumption by 9,122 kWh / month and saving R \$ 3,263.57 per month. As for the proposal presented for the HVAC system, given the exchange of existing appliances for new and energy efficient, was not viable. Despite representing a reduction of 41869.91 kWh / month, the expected investment is not paid.*

**Keywords:** Lighting, Power factor, Electrical system;

## **1. Introduction**

Since its discovery, electric power has become a primordial element in human life. Unquestionably, this asset provides comfort and help in the social and economic development of a country.

Energy is used in simple household appliances or in systems made up of more complex ones, which bring together various equipment. These devices and systems, during their operation transform forms of energy, part of that energy is lost due to environmental conditions and the characteristics of the materials used during this process [1].

In order to solve this problem, energy efficiency emerges, which offers the possibility of using less energy to provide the same services, as well as the simple use of electricity consciously and rationally, which is to achieve the best possible cost benefit [ 2].

In other words, “energy efficiency measures the quality of energy use for the purposes it serves society” [3].

It was considered, within the framework of the PNE 2030 national long-term energy plan, as an energy gain through autonomous efficiency progress, and in accordance with the actions taken by the EPE in the preparation and biennial review of the PNE [3].

Regarding the laws and legal aspects that deal with the theme of energy efficiency, Law N °. 9.478, August 6, 1997, in Article 1, item IV, states that one of the principles and objectives of national energy policy is “to protect the environment and to promote the conservation of energy”.

According to decree No. 9.864 of June 27, 2019, in its article 1: “The maximum energy consumption levels or minimum energy efficiency levels of energy-consuming machines and appliances manufactured or sold in the Country, and of buildings constructed there, shall be regulated by the provisions of in this decree, based on technical indicators, by the steering committee under the coordination of the Ministry of Mines and Energy (MME) ”.

For the national electricity sector were considered by 2030, 5% reduction due to autonomous progress. In addition to this 5% reduction in demand, another 5% imposed by additional target, thus requiring the implementation of energy efficiency, detailed in the PNE [3].

Several countries have employed actions that promote energy efficiency, as well as incentives for the use of alternative sources of energy (wind, solar, hydro, etc.) according to data from the Ministry of Mines and Energy (MME) ”.

For European Union (EU) for example, it is increasingly important to reduce energy consumption and waste. In 2007, EU leaders set the target of reducing EU annual energy consumption by 20% by 2020. Energy efficiency measures are seen as a means of achieving sustainable energy supply by reducing greenhouse gas emissions. , improving security of supply and reducing the cost of imports, as well as enhancing EU competitiveness.

Energy efficiency is therefore a strategic priority of the energy union and the EU promotes the principle of energy efficiency where the future framework of post-2030 action is being negotiated [4].

In Brazil, the federal government created the National Electricity Conservation Program (Procel) in 1985,

under the command of the Ministry of Mines and Energy (MME) and executed by Eletrobras, with the purpose of reducing energy losses, the costs of and sectoral investments [1].

The Procel Seal indicates to the consumer which products have the best energy efficiency levels in their category (ceiling fans, refrigerators, etc.). This way, it is possible to know if the product consumes less energy than another equivalent without the seal [1]. A good way for consumers to check if the desired product is economically and environmentally viable.

Thinking about solving the problem of high consumption and high cost in the electricity bill of a unit, this study proposes to present proposals to increase the energy efficiency of the site.

From this context, the study presents as its objective proposals for improvement in the electric energy management of a public higher education institution, in the city of Manaus, Amazonas.

## 2. Materials and Method

### 2.1 Type of study

A case study was conducted as a research strategy. The case study investigates a contemporary phenomenon within a given real-life context, especially when the boundaries between the phenomenon and the context are not well defined, thus facing a technically empirical situation in which there will be variables in identification and analysis. of data to achieve results [5].

### 2.2 Area of study

This study was carried out in a public institution of higher education, in the city of Manaus-AM.

The public institution, autonomous in its educational policy, has the mission of promoting education, developing scientific knowledge, particularly about the Amazon, together with the ethical values capable of integrating man into society and improving the quality of human resources in the region. where it is inserted.

### 2.3 Data collect

Initially, we conducted bibliographic research as proposed in regulatory standards on efficiency and on segments of the electrical system that may undergo changes to reduce electricity consumption such as lighting and air conditioning; building electrical installations; guides; technical manuals for energy efficient equipment; and tariff structure based on the Brazilian regulatory standard.

It followed the survey of the installed load in the building, analysis of electricity rates, the collection of data related to the site consumption, as well as the analysis of system characteristics and proposals for efficient use in energy.

For the economic evaluation stage, the investment analysis methods were used: Net Present Value (NPV) and Capital Return Time (TRC).

The NPV is the algebraic sum of all discounted cash flows for the time  $T = 0$  determined by the equation:

$$NPV = -k + \sum_{i=1}^n \frac{F_{ci}}{(1 + TD)^i} \quad (\text{Eq. 1})$$

Where:  $k$  represents the initial investment;  $F_{ci}$ , the discounted cash flow that corresponds to the difference between the income and expenses realized in each period considered in R \$;  $TD$ , the discount

rate;  $i$ , the time in years and  $N$ , number of periods.

The CRT was calculated from:

$$TRC = k / RM. \text{ (Eq. 2)}$$

Where:  $k$  represents the initial investment;  $RM$  or monthly return (amount saved per month).

For the survey of installed loads, it was necessary to identify what types of equipment are working on site, the number of hours, hours of use and the power consumed of each device to determine the share of consumption that each has in the total energy. electric

The survey of installed loads was carried out in August and September 2018. To obtain the data was verified at each building location, where for the lighting system: the types of lamps used, the type of reactor for fluorescent tubes. , quantity of each lamp and reactor, their rated power and hours of use per week at the most and least requested times.

For the HVAC segment, the type of appliance (Split or window), manufacturer, class, if there is a PROCEL rating seal, cooling capacity in BTU / h, quantity, rated power and number of usages per week at peak and off-peak times. Appliance time (h / w) was used due to the classrooms and laboratories operating at different times each day of the week. These hours were determined via the ensaement worksheet provided by the unit's quality department.

In this study the used power values of the devices were nominal power values (values specified by the plate manufacturers close to the actual power values).

From the power data obtained or from standard values specified in manuals, the load was divided into 10 groups: air conditioning (window, split and central); lighting (2x40 W, 2x20 W, 2x16 W luminaires, 100W incandescent lamps and 40, 45 and 25 W electronic compact lamps); drinking fountain; coffee machine; computers and notebooks; refrigerators; printers; projectors; microwave and laboratory equipment.

The instruments used for data collection were: clamp meter ET-3200A to measure voltage and current; Wattimeter ET-3200A pliers to measure power values given the condition of many constants and metric tape measure to measure the study area.

To collect the data from the lighting system, a Minipa model MLM-1010 digital luxmeter was used.

In order to verify the consumption of electricity bills, it can be verified in which months there is a higher energy consumption of the site, as well as which factors are causing additional costs due to penalties in the legislation on the composition and collection of the electricity tariff. .

Following the lighting and air conditioning system began by collecting data on the luminous flux of the lamps used in the lighting system in operation of a certain area chosen for the analysis.

According to ABNT NBR ISO / CIE 8995-1 2013, each environment has a certain level of lighting to be suitable for the accomplishment of a given task.

Illuminance is measured in LUX ( $lx$ ), the unit of measurement used by the luxmeter, using the equation.

$$lx = lm / A \text{ (Eq. 3)}$$

Where:  $lm$  means incident lumens  $A$  ( $m^2$ ) area of incidence.

To measure this luminous flux following criteria established in ISO / CIE NBR ISO / CIE 8995-1 which determines the distances between the illuminance measurement points.

To analyze the system characteristics and proposals for energy efficiency, the building's electrical system

analysis was performed, such as: how much each segment of the system consumes electricity; the appliances that make up each segment of the electrical system efficient and, if well used.

Measures can be developed to increase energy efficiency and stipulate through technical calculations how much each proposal will bring about reduction in electricity consumption and thus perform economic analysis.

### 3. Results and Discussion

The survey of installed load made it possible to determine the installed power of each group of the system (lighting, air conditioning and others) making it possible to calculate the electricity consumption per month, establishing the representation of each of these inputs (figure 1).

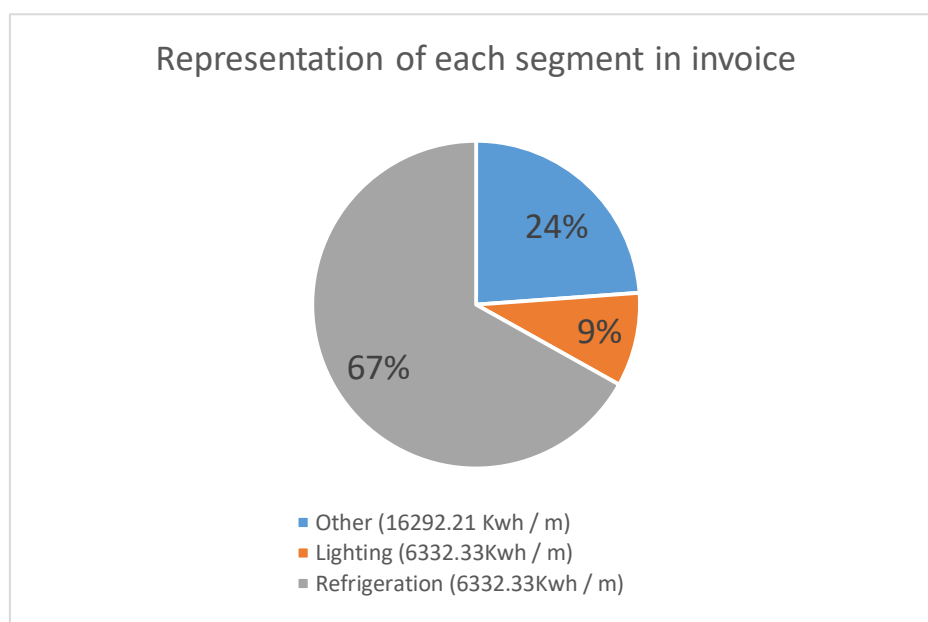


Figure 1 - Representation of each segment on the May 2018 invoice.

Source: Own authorship (2019).

As observed, the largest portion of the tariff composition is in the HVAC sector, representing R \$ 45,702.08. The second largest portion is in others (office equipment, electrical machines, appliances, consumption of the outside of the building) this amount represents \$ 16,292.21 and finally the lighting sector, representing \$ 6,332.33. Through this study it was possible to analyze the difficulties of each segment and present solutions for each one, without the need to turn off the electrical appliances (table 1).

Table 1: Tariff composition.

SECTOR	VALUE	%
COOLING	45.70	67
	2,08	
OTHERS	16.29	24
	2,21	
LIGHTING	6.332,	9

Source: Own Author (2019).

Looking at the table, the tariff composition of the refrigeration sector represents the largest expense (67%) in the final amount of the electricity bill and the lighting sector only 9%. This result is not surprising, as the cooling and air conditioning system is one of the main challenges for reducing electricity consumption. Air conditioning systems account for about 20% of commercial electricity consumption.

For the residential sector, air conditioning accounts for 33% of consumption, where equipment has 10% of the country's total electricity consumption, with the compressor being the critical component in the refrigeration cycle [6].

Invoices represented the possibility of reducing energy supply expenses. It was observed that the institution's demand contract, in ten of the twelve months targeted by the study, was penalized, given the excess representing an annual cost of R \$ 80,360.64, given the saturated demand values.

Given this, the average value of 737 kW was calculated as the ideal value of demand to be contracted for the current consumption situation, where this value was simulated, with data from the twelve energy bills. It can be seen that the amount consumed by the university exceeds by some months the value proposed for a new demand contract, but does not exceed the tolerance value allowed by the concessionaire. If the demand contracted by the unit was 737 kW, no penalty would be paid for excess demand consumed. This represents an annual cost of R \$ 57,816.72, a saving of R \$ 22,543.92 over 12 months.

Considering that the demand consumption profile of the next twelve months is close to the months that have elapsed and using the facilities offered by ANEEL 456 resolution, it is recommended to request the power concessionaire, through the immediate revision of the supply contract. . This measure does not require economic evaluation as this resolution does not provide for any type of investment to request revision of the supply contract [8].

In the analysis of a possible change of the tariff modality, the simulation of the energy tariff billing of May 2018 showed that if this month were billed in the blue horo-seasonal mode, the tariff value would be R \$ 69,198.68 against R \$ 60,831.14 of the amount invoiced in green hourly mode, ie, would be paid R \$ 8,367.54 more with the blue hourly seasonal mode.

This billing simulation was also performed for the previously calculated demand value (737 kW) and the values obtained in the simulations were R \$ 66,013.99 for the blue time-seasonal mode and R \$ 65,630.05 for the green time-period, being paid R \$ 383,94 more in the blue time-seasonal mode.

From these simulated tariff values for the month of May we can conclude that the green hourly seasonal tariff should be maintained as it generates a lower energy tariff value expenditure, but only the one month simulation should not be taken into consideration. For this decision making, it is necessary to simulate all other invoices used in the study.

Carrying out the load and the analysis of invoices, were analyzed the lighting and air conditioning systems of the building, from the data obtained establishing the current situation of the system.

Currently 94% of the university's lighting system consists of tubular fluorescent lamps representing a consumption of 16640 kWh / month and the energy bill a cost of \$ 5,950.47, these lamps compared to LED tube lamps are 25% less efficient. .

The LED uses 82% less electricity than an incandescent light bulb. A domestic LED light bulb has a lifetime of 50,000 hours, compared to 1000 hours for incandescent light and 6000 hours for fluorescent light, a technology that makes it possible to reduce the amount of lamp changes or maintenance costs [7].

The proposal presented to increase the energy efficiency was to replace the current lamps with LED tube lamps, for this, it was verified the specified power values and illuminance conditions that each lamp and the place. By replacing light bulbs, a reduction of 9122 kWh / month and a saving of R \$ 3,263.57 in energy tariff were achieved, making the proposal economically viable.

From the calculations made for the lighting system, it was found that the NPV is positive from the second year, with a profit of R \$ 3,263.57 and with a total value for 5 years of calculation the profit of R \$ 59.374, 12.

The CRT is shorter than the life of other lamps and is an economic indicator used in the study, indicating that the investment is being made.

In the HVAC system, it was found that the university has 15 window type air conditioners, with more than 10 years of use, in replacement process.

More than 50% of its system is composed of 48000 BTU / h devices, represented by 88 splits devices, of which 45 have the PROCEL seal of efficiency, being 24 A-rated and 21 B-rated devices. which do not have a PROCEL seal represent a consumption of 4,169 kWh / month and the energy bill represent R \$ 14,924.7.

Replacing the air conditioners indicated in the study will bring a reduction in energy consumption of 41869.91 kWh per month and a savings in the energy tariff of R \$ 2,831.37. In economic calculations for air conditioning, NPV was negative, but TRC presents the calculated value less than the useful life of the device being a non-viable investment.

#### **4. Conclusion**

Through the results obtained during the building survey at the IES, it was possible to observe the anomalies of the systems and indicate proposals for repair or replacement of equipment to increase the energy efficiency of the building.

Through the analysis of the results obtained from the invoice it was possible to propose a new value of demand contract and by comparing the collected data, we identified the appliances that make the electric system less efficient, in this case, the air conditioners.

Recurring payment problems with excess demand consumption have been identified. Adhering to the proposal of a new contract value with possible annual savings of R \$ 22,543.92 referring to the payment of the demand portion in the electricity bill.

It is also proposed to replace current lamps with LED tube lamps, reducing energy consumption by 9,122 kWh / month and saving R \$ 3,263.57 per month.

As for the proposal presented for the HVAC system, which was the exchange of existing appliances for new and energy efficient appliances, was not feasible. Despite representing a reduction of 41869.91 kWh / month, the expected investment is not paid.

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# **Electrical Surge Protection Device (SPD): An Alternative to Reduce Material Loss**

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## **Abstract**

*The SPD is undoubtedly the equipment designed to protect the electronics of any building, one of the protections that together with proper grounding and SPDA, are widely used by industry to protect their equipment and people. This research shows the importance of SPD for electrical installations in general, shows that we still do not have the risk of encircling all electrical protections in our homes, which lead to inquiring. Why not use all safety measures in our residential electrical installations, viewed as people who build a bus camera rated by a qualified professional, to guide their client, explaining to him the importance of a safe installation, ie the values with electrical material are still elevated for safe construction. In this research, some brands of SPD were analyzed and compared as to the method of manufacture, classification and prices, a survey that also did not comply with Law No. 11,337, of July 26, 2006. Determines the obligation that the buildings have a system grounding and electrical installations used with the use of conductor protective earth, as well as making the presence of conductor protective earth mandatory in the electrical appliances it specifies. Law 12,119 / 09, of December 15, 2009, amends art. 2 of Law No. 11,337, of July 26, 2006, to better detail the scope of its content and to adapt the nomenclature used to the technical standards used. "Art. 2 Electrical and electronic equipment, with metal housing marketed in the Country, classified in class I, in accordance with the relevant national technical standards, the items allowed for use in earth protection and with plugs, are also allowed in accordance with Brazilian technical standards.*

**Keywords:** Electrical surge protection device, grounding, cost-benefit;

## 1. Introduction

About 100 million lightning strikes every year in Brazil, so it is currently the country with the highest incidence of lightning in the world, causing huge damage to equipment and electronics [1]. Despite the protection of lightning rods, lightning strikes produce an electromagnetic field that radiates throughout the region as an indirect discharge of energy, especially over power and telecommunications networks.

According to a study by [2] the incidence of lightning across the country has increased, knowing that, studies show that the electrical surge can present high frequencies occurring for a short time. Outbreaks can be of voltage or current and can originate from lightning, electrostatic discharge and the switching of inductive or capacitive electrical charges.

Upon reaching a city's electricity distribution network, indirect discharge eventually causes a momentary increase in voltage, or transient overvoltage, which can cause irreparable damage to electro-electronic devices [3]. SPD offers a complete, high-performance solution against overvoltage driven by power lines, safely protecting electrical and electronic equipment.

SPD is highly recommended in all electrical installations, especially in regions where the incidence of lightning is very high. It can be installed in the electrical circuit diagrams with grounding systems in accordance with the main current regulations of the country.

This surge protection device protects your equipment against lightning burns. [4] defines SPD as: "Device designed to limit overvoltage's and divert surge currents, contains at least one nonlinear component". The same standard classifies SPD into two types: voltage switch and voltage limiter.

A SPD, ideal voltage switch, can be represented by a switch connected in parallel with the circuit or equipment to be protected. This switch is controlled by the voltage value at its terminals, where the voltage is below a certain limit, remains open. However, if the voltage reaches the limit, automatically closes, the specified limit for switch close ( $U_p$ ) must be less than the voltage value supported by the protected equipment ( $U_w$ ). It is important to note that the continuous operating voltage ( $U_c$ ) cannot cause the switch to close [5].

Lightning can damage electrical and electronic equipment in three ways.

The. direct: when lightning strikes a building and causes damage to both construction and equipment. The protection in this case occurs by lightning rod, Franklin type and / or Faraday cage; B. Indirect: When lightning strikes in the vicinity of a building, overload damages equipment via the power grid. Protection is provided by electrical grounding with SPD; ç. Electromagnetic interference: When lightning strikes a nearby building and generates electromagnetic waves capable of inducing dangerous voltages for any electronic equipment. The solution is SPD specific to each device.

Thus, the electrical surge is a transient wave of voltage, current or power that has a high rate of change over a very short period of time. It spreads throughout electrical systems and can cause serious damage to electronic equipment. Electrical surges are usually caused by lightning strikes, network maneuvers, and on / off of large machines.

Speaking of lightning strikes, whenever lightning strikes near a facility / power grid, surges are generated that can even reach appliances connected to power grids, data lines such as internet and cable TV and telephone lines. . Most lightning-generated outbreaks are caused by indirect discharges, that is, even if the

lightning strikes miles away, this incidence generates an electromagnetic field that radiates from the environment and transfers a portion of the ray to a metallic conductor.

Another very common source of electrical surges is when power companies switch or maneuver their grids, causing power outages in certain neighborhoods or streets. Not just blackouts, known as blackouts. Thus, reclosing attempts are sources of electromagnetic disturbances, including the electrical surge.

Electrical surges occur continuously when large motors start and stop. Outbreaks can be generated either by elevators in commercial and residential buildings or by standard equipment such as air conditioners or washing machines. Each time they are started and stopped, motors generate transient overvoltages that can cause immediate, medium and long term damage to equipment connected to the same power grid.

The SPD consists of a zinc oxide (ZnO) or silicon carbide (SiC) varistor associated with a safety device which can be one of the following components: gas spark arrester; air spark; avalanche diodes or suppressor diodes; varistors and PTC or thermistors.

The function of the varistor in a SPD is by continuously reducing the surge wave, while the spark is intended to cut the peak of the incident wave, rapidly reducing the voltage wave, protecting the varistor if it is subjected to a peak greater than its rated capacity. When in normal operation, the SPD displays green and when damaged, red [6].

According to [7], SPD is a device designed to limit transient overvoltages (voltage attenuator or surge suppressor) or to divert surge currents (voltage switch or short circuit) [8].

[8] says that in order for the designer to properly analyze and compare products, manufacturers should provide the following SPD information: manufacturer's name or trademark and model; mounting method or protection mode, accompanied by the positioning sketch on the installation; maximum continuous operating voltage  $U_c$ , which is the nominal voltage of the SPD (one value for each protection mode), and nominal frequency; test classification (class I, II or III) and discharge parameters; maximum current  $I_{max}$  (KA), parameter of the wave on which the SPD was tested;  $I_{imp}$  pulse current (KA) and load  $Q$  (A.s), for SPD class I (value for each protection mode); rated discharge current  $I_n$  (KA) for SPD class II (value for each protection mode); Voltage protection level  $U_p$  (value for each protection mode); withstand temporary overvoltages and withstand short-circuit currents at the point of installation.

### **1.2 Minimum Parameters**

Minimum parameters to be included in the SPD nameplate data as well as design specifications: SPD Class I:  $U_c$ ,  $U_p$ ,  $I_{max}$ ,  $I_{imp}$ ,  $Q$  and test  $T1 / T2$  curve; Class II SPD:  $U_c$ ,  $U_p$ ,  $I_{max}$ ,  $I_n$ ,  $Q$  and 'T1 / T2' test curve and Class III SPD:  $U_c$ ,  $U_p$ ,  $I_{max}$ ,  $I_n$ .

[9] used [7] to classify SPD at each level of protection. Establishing three types: Class I, intended for protection against overvoltage caused by lightning strikes on or near buildings; Class II, intended for overvoltages of atmospheric origin by indirect loads and Class III, intended for electro-electronic equipment.

CLASS I has a high surge exposure capability with a minimum of 12.5 KA of impulse current ( $I_{imp}$ ) according to [9], item 6.3.5.2.4- "d".

Thus, the classes have different applications as: Class I, it should be applied near the main entrance of the power grid and the main equipotentialization bus, BEP, in buildings equipped with lightning rods, as per

the requirement of [9] and next information technology (ETI) equipment, such as a secondary element fed directly into the primary cabin or switchboard, increasing reliability, lower residual voltage, and long life against overvoltages and transients caused by lightning strikes or power grid switching inductions [10].

CLASS II also acts against maneuvering overvoltages with a minimum surge exposure capacity of 5 KA rated current ( $I_n$ ) according to [9], item 6.3.5.2.4- "d". It must also be applied near the main entrance of the power grid and the main equipotentialization bus "BEP", in buildings equipped with (I) or not (II) lightning arrester, as required by [9] or as a protective device. class II, in switchboards, with information technology (TSI) equipment, among others, against overvoltages and transients caused by lightning strikes and frequent switching inductions in the power grid [10].

CLASS III, is given by means of a fine protection, adjustment, providing a lower residual voltage and, consequently, an effective protection for the equipment, applied next to the information technology equipment (TSI) and others, with lower current consumption. at 10A, connection in series with the load.

The devices must be installed in a coordinated manner, producing a ripple effect, that is, firstly, the SPD with higher capacity of exposure to surges, then with medium capacity and, finally, the most sensitive SPD are installed [10].

[9], in item 5.4.2.1, establishes that all buildings within the Brazilian territory that are totally or partially fed by area line and where thunderstorms occur more than 25 days per year, must be provided with SPD. (zone of influence AQ3), SPD is also required.

There are suppressor protection elements applied in SPD to protect equipment connected to the power and signal network are:

The. spark plugs, are made up of two separate electrodes (GAP), dielectric Air or Gas. They have low conduction velocity (response time) and high current capacity; B. Air sparklers can be classified into two basic groups: open and encapsulated. Open sparklers are used as first-rate defenders when their drawbacks - fire hazards, disruptive voltage varying with weather, pollution, etc. They are without prejudice to the purpose of protection.

Old coal protectors fit this type and their discharge capacity is low; they are uneconomical and virtually no longer used. Encapsulated spark arrestors are also referred to as isolation or coupling spark arrestors and are used where two circuits cannot be permanently in contact but must be at the same potential when lightning is influenced [10]; ç. Gas cutters are constructed by two or three electrodes inside a glass or ceramic tube, separated by a well-defined distance, of the order of (one) mm, the volume being filled by a rare gas.

The breaking voltage will be determined by the distance between the electrodes and the gas pressure. Durability and the ability to withstand high currents is determined by the material of the electrodes, while the leakage current is given by the quality of the glass or ceramic material used.

When used in telephony, sparks must support the short current of a power line that falls over the telephone line. If the current is greater than that specified for driving or if the defect is not interrupted before the specified time, the spark arrester may be destroyed, with danger to telephone users.

To reduce this possibility, some spark arresters have a safety device at the terminals externally, increasing the current and the bearable duration. Air gap spark plugs are indicated for application in class I and are

subject to environmental conditions, such as atmospheric pressure, relative humidity and temperature, which thus differ (Table 1).

DISADVANTAGES	BENEFITS
<b>Low protection margin for fast forward outbreaks.</b>	It has a large current conduction capacity of tens of KA.
<b>Usually short circuit to ground.</b>	It has a long life.
<b>It produces high frequency oscillations due to the sharp drop in voltage between the electrodes.</b>	It has a very low capacitance, not interfering with the operation of high frequency circuits.

Table 1. Advantages and disadvantages of using spark arrestors.

Source: [3]

Suppressor diodes are high conduction speed semiconductors and low current capacity. They are applied as secondary protection elements in hybrid configurations and better known as solid state elements. The response time of a suppressor diode ranges from one (1) picosecond near the substrate to one (1) nanosecond at its terminals [10].

Varistors are resistors whose value of electrical resistance depends on voltage. Resistance is not constant, resulting in a nonlinear relationship between voltage and current.

Applied in class I, II and III, they feature high driving speed and good current capacity. The number of brands, types and origin is numerous, and the technical characteristics of current and voltage of this component vary from manufacturer to manufacturer with the same diameter and thickness [10].

As a general rule, the diameter of the varistor determines the withstand impulse current value, thickness, voltage and mass and power capacity.

PTC or Thermistors are temperature sensitive and overcurrent semiconductor polymers or resistors. Its resistance value increases rapidly when a certain temperature or current is exceeded, such as reversible fuses. Typical application is in the manufacture of hybrid protectors normally applied to signal networks. Every electrical installation needs a grounding that ensures its perfect operation and also the safety of people and equipment. Several technical standards, as well as the NR-10 regulatory standard of the Ministry of Labor and Employment, require that all electrical installations be grounded. Having a good grounding is important in the case of lightning, given that the lightning current is injected and circulates in the ground [11].

Thus, there are different grounding applications, including houses with TN-C Systems, where the electrical installation of the vast majority of Brazilian homes does not comply with [9], which recommends the use of the TN-C grounding scheme. S with protective conductor (PE) and equalization bus. In most buildings there is only the neutral conductor, grounded at the entrance to the building.

Although not recommended, the current standard is possible, with some limitations, where SPD should be installed in these buildings and improve the protection of electronic equipment. Importantly, even though it is possible to install SPD in buildings without the protective conductor, it is ideal that the electrical installation be redone to meet the recommendations of the standard [9].

Primary SPD for power lines should be installed between phase and neutral, preferably at the installation

source, with one required for each phase. Some utilities have already standardized the installation of SPD inside the metering box.

According to [12], secondary circuit distribution boards (QDC) located more than 20 m from the power input or general distribution board (QDG) must also be equipped with Class II SPD.

Importantly, the choice of SPD nominal voltage (275 V for 220 / 127V systems) takes into account temporary overvoltages (caused for example by a neutral conductor disruption). At this rated voltage value, the SPD will not operate due to overvoltage caused by the neutral disruption.

In addition, for protection of equipment that meets the withstand levels of [9] (in this case, withstand voltage  $U_w = 1.5\text{kV}$ ), the rated voltage SPD 275V ensures an adequate protection margin because the protective voltage of the SPD ( $U_p = 1.2\text{kV}$ ) is below the voltage withstand by the equipment.

If the possibility of neutral disruption is remote, a lower rated voltage SPD may be used. Under these conditions, a SPD with  $U_c = 175\text{V}$  could be used in 220 / 127V systems when connected between phase and neutral or phase and ground. The lower rated voltage SPD will have a lower residual voltage. However, if the neutral breaks, the SPD will be in permanent operation and the overcurrent protection system will actuate and remove the SPD from the circuit.

The previous reasoning for 220 / 127V grids also applies to 380 / 220V grids, provided that the relevant values of  $U_c$  and  $U_w$  are considered.

Primary SPD should preferably be installed at the installation source, both on power and telecommunications lines. The choice of class and level of protection should follow the criteria already discussed in the previous item.

in the previous item.

Secondary Circuit Distribution Boards (QDC) located more than 20 m from the source of the installation or the General Distribution Board (QDG) must also be protected with class II SPD. Appliances or electronic equipment located more than 10m from the QDG must also be protected by SPD Class III, such as refrigerator, dishwasher, microwave, among others.

Similar to the above, multi-input electronic equipment such as power and telecommunications should be protected by combined SPD. Examples of such equipment are televisions with connected signal input (eg coaxial cable), cable modem, ADSL / VDSL modem, cordless telephone, among others. It is worth mentioning that the local potential equalization performed by the SPD is fundamental to ensure the protection of this equipment. This combined SPD are also called Multiprotection SPD (SPDM) [5].

## 2. Materials and Methods

### 2.1 Type of study

The type of approach adopted in the research comes from the descriptive method, having as research sources the books, booklets, ABNT, NR and websites of companies that produce and market the SPD that served as the basis for knowledge and brings as a qualitative result the importance in continuous safety improvement in building electrical installations, because we must be concerned with all safety methods such as SPDA, grounding, DR's and SPD for safe building.

We sought to evaluate the types of SPD in the market, in terms of manufacturing method, classification

and price, where it was found that practically all manufacturers use the same methods and classify their SPD in the same way according to [4] and [9].

## 2.2 Data Collection

Data collection was done through bibliographic reference searches, to consult various books, booklets, ABNT, NR and websites of companies that produce and market the SPD that would help to base on the chosen theme, was also used. Information via web, consultation of scientific articles, monographs and NBR that helped me in understanding the topic addressed.

Siemens, Schneider, MTM and Clamper brands were compared, minimum parameters that must appear in the data on the SPD board. When choosing a SPD, many factors should be taken into account, such as where the device will be installed, in order to determine which class to use, and the key factors to determine, such as the maximum operating voltage of the device. device and its maximum discharge current.

## 3. Results and Discussion

When it comes to low voltage electrical installations, it is crucial to highlight the use of protective devices that ensure the integrity of the electronics of a home, while preserving the heritage of electricity users. The standards adopted by ABNT are advancing more and more, encouraging the use of SPD that increases the necessary security that is intended.

In this way, older installations lose their capacity and may pose potential risks, so it is mandatory to carry out appropriate renovations when they are convenient. By observing these recommendations, we can avoid numerous disorders that may cause unpleasant situations and irreparable losses.

Basically, we can say that the utility of the lightning arrester is the same as that of SPD, since they work as internal protection for homes. However, taking into account the functional aspect, we say that each protects the building differently. These devices constitute an SPDA (Lightning Protection System) regulated by technical standards [9], [4] and [13].

Looking at the cost-related financial issue, the lightning arrester system is costly to install, but it is recommended for buildings and industries, as well as places with essential equipment that must be preserved.

Finally, the results of this study showed us that practically all the protection devices available on the market are produced by the brands mentioned above are composed of equal components, the great differential between them is in the value added to each brand, where the company stood out. CLAMPER which is synonymous with protection for the market. It is your brand.

This achievement is the result of a relentless pursuit of excellence and improving people's lives. The company is today recognized by the market as a leader in research in development and manufacture of electrical surge protection devices (SPD) for the various segments of the national and international market.

The SPD, installed in the power distribution box, which aims to protect the power grid. This gives Clamper VCL the best value for money.

We exemplify that in a medium size house, having as characteristic living room, kitchen, two bathrooms and three bedrooms. Have the following electronics: two units of LCD TVs that cost \$ 2,500; a Blu-ray player that costs \$ 400.00; a stereo that costs \$ 500.00; a video game device that costs R \$ 1,200.00; a home theater device that costs R \$ 700,00; a cordless handset that costs \$ 200; a computer device that costs \$ 1,500; a refrigerator that costs R \$ 1,200.00; a washing machine that costs R \$ 1,000.00; a stove that costs R \$ 500,00; a microwave device that costs R \$ 400,00; a grill that costs \$ 200.00; an electric oven that costs R \$ 500,00; two electric showers costing R \$ 100.00 and ten compact fluorescent lamps that cost R \$ 100.00, totaling R \$ 11,000.00. All prices of items being estimated from average market values.

Many other home appliances are known to be present in homes of this type, but this estimate fits most homes.

This means a product of \$ 49.00, being able to prevent a loss of about \$ 11,000.00 in the event of a major electrical surge, with appliances cleared for damage caused by electrical discharge. The VCL can act hundreds of times without replacement. Therefore, it is more difficult to estimate the actual cost x benefit ratio. Even so, it can be said that it is a low investment for the protection and tranquility of the offer of its products, as the inconvenience caused by a large electrical surge goes beyond the financial losses. It is recommended that each device be separately protected with its most suitable Clamper.

#### 4. Conclusion

Studies show that the use of SPD's can reduce the damage caused by overvoltages caused by lightning strikes or even those that may be caused by maneuvers or maintenance on the power grid.

It is believed that the use of SPD's will become more common, there should be an awareness of professionals, both those who design and install. Electronic equipment is a valuable asset that has been gained over the years and increasingly is a fundamental tool for human work. The loss of this equipment represents losses not only with maintenance or replacement, but, in most cases, the biggest losses are due to their unavailability.

By using SPD's, you get the assurance that the property is protected, but it is very important to use recognized, efficient and reliable products developed and manufactured by those who deeply understand the subject. The obtained results, showed the importance (SPD), is, therefore, the ideal solution to prevent against electric overloads and disturbances. It functions as a circuit breaker that can be installed either on the Switchboard or between the equipment and the power outlet (in this case individual).

Protects the internal supply circuits in the premises or equipment used from overloads caused by lightning surges with high voltage pulses, discharging it directly to earth via existing grounding conductors.

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## **A Sustainability Analysis of Different Types of Asphalts**

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### **Abstract**

*The present work aimed to analyze ecological asphalts, aiming at their influence on the tripod of sustainability in the social, environmental and economic spheres. The option of using eco-rubber asphalt and EVA as a raw material for paving roads and highways is a bet for a more resistant material that requires less nature degradation and easier maintenance. One of the main reasons for the degradation of flexible pavement is the wear caused by the time of use, as well as the traffic of vehicles carrying excessive loads. This study reports some alternatives to multiply the improvement of reverse logistics of waste tires and EVA (ethyl vinyl acetate) plastics, facing problems related to environmental impacts, which directly affect the Brazilian population. This project is important because it is directly linked to sustainability and the development of the environment, facing renewable and suitable alternatives to be employed, such as ecological asphalts, and their benefits. Among the benefits of ecological asphalt we can mention the contribution to the environment by reducing the amount of waste tires improperly discarded in nature and the durability of ecological asphalt compared to conventional asphalt where it showed greater resistance to climate fatigue. The research used the qualitative method being a study based on bibliographies, analyze and discuss the reuse of solid waste and the mitigation of environmental impacts through asphalt. Ecological asphalt seems to be more expensive than the*

*bituminous asphalt used today, however it is environmentally friendly and its effectiveness, durability and safety are noticeable advantages.*

**Keywords:** Sustainability tripod; paving; environmental impacts.

## 1. Introduction

In order to solve environmental problems, plastic waste, even though it is a problem, given the amount of material generated, also appear as a source of progress, with technological attributes, where the transformation of this waste recovered from landfills to produce a more asphalt. resistant, with ecological characteristics replacing the CAP (Petroleum Asphalt Cement), being more resistant than the common asphalt.

A sector of great importance in the waste sector is plastics, which occupies 49.7% of total waste in 2017, about 21,153 out of a total of 43,945 tons per day. Plastic obtained 1,737 tons per day recycled out of a total of 13,969, or 12.44%. This figure shows that there was a 15% reduction in the recycling rate compared to 2012 [1].

Thus the solution for waste according to [2] occurs through the National Solid Waste Policy Act [3], which lists environmentally sound disposal: waste disposal that includes reuse, recycling, composting, recovery and energy utilization in paragraph 7, and the orderly distribution of tailings into landfills, observing specific operational standards to avoid damage or risk to public health and safety and to minimize adverse environmental impacts (paragraph 8). In Article 9 of the law there is no generation, reduction, reuse, recycling, treatment and final disposal [4].

Contrary to common sense, the waste recycling production chain, and especially plastics, involves relatively complex cycles and interactions, especially as it integrates activities of a different nature and involves different types of agents (citizens, waste pickers, scrap dealers, the government, processing industries, etc.). Essentially, the cycle of this chain can be described from the emergence of waste through its anthropogenic generation, which is followed by selective disposal, selective collection, sorting and packaging, recycling (which transforms recycled waste into recycled material), industrialization (which transforms the material into a product of social interest), commercialization and consumption (acquisition of the product, putting it to use and generating waste, thus returning to the beginning of the cycle) [5].

Sustainable development has been gaining ground in the various areas of knowledge and practice, raising in institutions and scientific circles, adding sustainability values in their production processes, in order to guarantee goods and services to the present population and to promote the security that future populations also have. the right to use the same resources [6].

Based on the above, reverse logistics within a company has the purpose of managing and operationalizing the return of goods and materials after their sale and / or consumption to the point of origin, presents the main objective of preserving the environment, meeting the principles of sustainability.

The LR procedure is a great chance to expand the systematization of waste streams, disposed goods and products, also contributing to the reduction of the use of natural solutions and other environmental conflicts, ie, the reversibility system focuses on an organizational instrument. which enables reverse chain savings to contribute to enhancing the sustainability of successful chains. However, the

management of the Reverse Logistics network is still starting, with a lack of specific and unified methods, which causes companies' lack of interest in improving the management of reverse channels [7]. In practice, taking into account not only the educational process, there are companies, where managers, in making strategic decisions, include from the acquisition of raw materials to final consumption, following the flow and information about products, aiming to reduce costs and promote difference in meeting the demands, adding value to the final product, aiming at constant production and less impact on nature.

Reverse After Sales Logistics is characterized by product returns that for some reason did not please the end customer. Such products are durable, semi-durable or disposable in nature, sold through various distribution channels and returned by the direct distribution chain itself or by the end customer [8].

Given the problems related to environmental impacts that directly affect the characteristics that make up sustainability find alternatives and direct them to the reverse logistics process of large-scale disposable materials, such as waste tires and EVA (ethyl vinyl acetate plastic). ) it became essential to reduce the problems generated by these materials.

Addition of Ethylene Polyethylene Terephthalate (PET) in Petroleum Asphalt Cement (CAP) may be an alternative to increase mechanical properties as it is a plastomer, providing increased susceptibility to fatigue and thereby extending pavement life. [9] In order to provide users with comfort and safety, it is of utmost importance to consider the design of the floor, it must be conserved over the project lifetime and must be economically and environmentally viable [10].

The high growth of the vehicle fleet causes traffic congestion that demands more from the pavement not only by volume but also by reduced speed, to avoid early pavement defects, we seek to improve mechanical behavior through research for new refinement materials [9 ].

[9] also mentions that the use of reused polymers is a common measure and that the addition of PET in asphalt mixture is promising because it is an inert material, resistant and with good chemical stability. To give alternative use to PET should deepen the knowledge about its mechanical behavior in asphalt mixtures.

The most common and currently used coating is Hot Machined Bituminous Concrete (CBUQ), being a material composed of the mixture of sand, stone dust, gravel and petroleum asphalt cement better known as CAP. The CBUQ is defined by DNIT 031/2006-ES [10] Flexible Pavements - Asphalt Concrete - Service Specification as “a hot, spread, compact and hot mix, with specific characteristics, being manufactured in an appropriate plant and made up of graded aggregate and filler (filer) and asphalt cement ”.

PAC is a material used mainly in paving activities, as it has the function of aggregating the components of the mixture, being highly binder, viscous and impermeable. Impermeability is an important factor against the action of water on structures due to weather conditions. “PAC is a heat-sensitive material resulting from the distillation of specific types of oil in which light fractions (gasoline, diesel and kerosene) are removed in refining” [10].

Another model is classified as cold asphalt or cold machined asphalt mixtures, also called cold premix (PMF), are composed of coarse, fine and filler aggregates. PMF (cold premix) is usually used as a coating or intermediate layer of roads with low traffic volume. This type of mixture can be classified into dense and open mixtures [11].

Cold Premix (PMF) - It is a mixture performed at room temperature in a suitable plant, composed of coarse aggregate, filler and cold-pressed asphalt emulsion. The aggregate can be durable, crushed stone or pebble, free of clods and harmful substances. The fine aggregate can be sand, rock dust or a mixture of both [10].

When the PMF is opened, its void content can reach 20%, resulting in a very draining material. This feature refers to the need for special care with the mixture: the bottom layer of the PMF must be tightly sealed (or even closed) to prevent water from descending to underlying layers, and the PMF must extend to the edge of the shoulder to lateral drainage of water occurs.

The material of the open mixtures will have resistance basically provided by the compaction effort, given the internal friction between the aggregates; The binder promotes minimal cohesion between the grains. They are especially suitable as base or leveling layers for an existing floor [11].

Conventional pavement, due to the composition of its layers generates high cost, for this reason there is a need to look for new alternatives in the market that present a better cost-benefit, asphalt rubber presents in its composition unusable tires where this material can be used. recycled and prepared; being incorporated into asphalt binders that are used in the paving process [12].

After collecting a tire, it is taken to its final destination, which can be basically two, the reuse as an energy source or the reuse of materials that make up the tire in other products. In these two main forms of reuse, there are several subtypes that represent the final destination of solid tire waste, including rubber asphalt.

Studies related to the incorporation of EVA into the asphalt binder indicate increased viscosity and improvement in the performance of bituminous material, due in part to the solubilization capacity of EVA in saturated asphalt fractions. On the other hand, accelerated aging tests have shown that the presence of EVA reduces the oxidative decomposition process of asphalt [13].

Therefore, the purpose of the study is to make a brief analysis comparing the different types of asphalt, given their

## **2. Materials and Methods**

For the development of this study, the applied qualitative methodology [14], aimed to analyze and discuss the reuse of solid and plastic waste and the mitigation of environmental impacts through asphalt.

Bibliographic researches were conducted to support [14] the problem approached, and further clarification on the viability of the asphaltting process and its norms, in order to compare the type of asphalt composition used in the state of Amazonas and ecological asphalt, as an alternative to contribute to the preservation of the environment, also emphasizing its durability and composition in order to reduce the impacts caused by the region's climate and other variables.

Given the above, it was reported the raw material that make up the ecological asphalts, derived from solid waste and post-consumer liability to be applied, aiming at the improvement of the lanes, as well as the mitigation of damages related to the economic, social and environmental.

The asphalts and the processes aiming at their improvement and the durability in the traffic roads of the cities of Brazil were compared. Since over the century studies have been conducted on the mixture of

asphalt composition, associated with new technologies to discover its applicability.

Four types of asphalt, rubber asphalt, EVA asphalt, CBUQ asphalt and cold asphalt, were presented in order to present the best quality asphalt, a condition of adaptability for its use in the city of Manaus, AM.

### 3. Results and Discussion

From the information it was determined that the addition of tire rubber dust and plastic waste to the asphalt binder becomes a highly sustainable improvement thanks to environmental and economic advantages. This is because ecological asphalt increases the durability of the pavement and uses recycling as an alternative to reduce environmental degradation.

There are numerous advantages with increased pavement life compared to conventional asphalt; delaying the appearance of cracks in the highways and sealing existing cracks (Table 1).

Table 1: Comparison between the different types of Ecological Asphalt

TYPES OF ASPHALT	CBUQ (Standard asphalt)	EVE (ethyl vinyl acetate)	ECOLOGICAL ASPHALT (Rubber Asphalt)	COLD ASPHALT (cold premixed-PMF)
FEATURES	1. Composed of ground aggregate (sand); coarse aggregate (gravel) and the binder (Asphalt Oil Cap).	1. Demonstrates better rheological properties or equivalent to conventional asphalt.	1. Accumulate successful experiences (Private companies that run Brazilian highways).	1. Consisting of large aggregates, fines and filler
	2. Obtained in fractional distillation of oil.	2. Increased viscosity and improved degree of performance of bituminous material.	2. Use by grinding 0.30 mm until powdered.	2. Mix at room temperature with petroleum asphalt emulsion.
	3. Mixing aggregates with the hot binder in an asphalt plant.	3. Studies related to the incorporation of EVA into the asphalt binder.		3. PMF is normally used for the preservation and maintenance of deteriorated coatings.
	4. Transported by truck to your application site.	4. Indicates solubilization (dissolution) of EVA in saturated asphalt fractions.		4. classified into mixtures according to their aggregate grading and the volume of voids in the mixture;
	5. Occurs the deterioration of the environment affecting the hydrological cycle and relief forms.			5. Material used in temporary or emergency maintenance services

Source: Own authorship (2019).

Modified asphalt is one that, when additive, has improved physical and chemical characteristics, so that its service performance is superior to conventional asphalt. These additives are basically polymeric elastomer and / or plastomer type materials [15].

A study by technicians from the National Department of Roads (DNER) and the Brazilian Transport Planning Company (Geipot) show that a degraded road represents a 58% increase in fuel consumption, a 38% increase in vehicle maintenance expenses, 50% in the accident rate and up to 100% in time spent traveling [16] [17].

Thus, understanding the asphalts powders and cons among them, showing the benefits of the asphalt, can generate numerous benefits, while their characteristics and applications (Table 2).

Table 2: Advantages and disadvantages of ecological asphalts (Rubber and EVA).

TYPES OF ASPHALT	EVE (ethyl vinyl acetate)	ECOLOGICAL ASPHALT (Rubber Asphalt)
<b>BENEFITS</b>	1.High degree of softness and hardness;	1. Increased pavement life or durability (Decreased aging and oxidation of asphalt binder);
	2. Longer pavement durability up to 40% longer than usual;	2. High elasticity due to high swelling index
	3. Decrease of waste recklessly discarded on the planet;	3. Reduced risk of deformation;
	4. Greater grip, which helps to prevent accidents;	4. Reduced risk of early fatigue cracking due to increased tensile strength provided by improved elastic recovery of modified asphalt;
	5. Influence on maintenance reduction of vehicles hit by bumpy roads.	5. Contribution to the environment by reducing the amount of waste tires improperly disposed of in nature;
<b>DISADVANTAGES</b>	1. More expensive than conventional Asphalts	1. Boiler with higher heating capacity, as this type of asphalt requires temperatures above 170 degrees Celsius
	2. Lower efficiency in tropical climates	2. Requires more powerful pumps than usual
	3. Higher energy consumption in its applicability	3. Odor emitting more polluting gases and harmful to human health;
	4. Reduction time for CBUQ transport, spreading and compression.	4. High temperature machining;
		5. Stocking that requires constant recirculation of Rubber Asphalt

Source: Own authorship (2019).

Asphalt pavements should provide comfort and ideal conditions of trafficability and the appearance of pathologies generates disturbances and shortens their life span. Pathologies are caused by several factors, design error, bad weather, lack of maintenance, among others [17].

Moreover, knowing that these processes occur in favor of the community, reducing the use of natural resources and the cost of the product, as well as the use of different materials in the asphalt composition,

based on new materials, this can directly infer about sustainability, showing that The use of reverse logistics is extremely important as an environmental mitigation measure.

#### 4. Conclusions

With the proper comparative study of conventional asphalt and ecological asphalt, the great parameter to obtain the efficiency of the roadway is the durability, achieved through these new technologies that use the residues that could be deposited in landfills, presenting benefits. through the adequacy of waste treatment, its regular disposal in the environment, which can become a mitigation process, minimizing social, economic and environmental impacts.

Rubber asphalt stands out for its reverse logistics, its major challenge would be the reuse of material already disposed of in the environment, which may cause visual, soil and water impact, as well as being an indicator of disease proliferation.

The applicability of unusable tires on the roadway has numerous characteristics that demonstrate efficiency, highlighting their ability to withstand the action of weathering.

In addition to reusing a material / product, previously considered environmental passive, the pavement made by waste tires and also by plastic, has the highest durability and safety in all its extension, where its asphalt feature provides better driving comfort.

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## **Shared Economy: A Uber-Eats Case Study in Manaus City**

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### **Abstract**

*Given the prospective employment scenario that a society faces from the end of various areas due to various factors such as automation, new labor rights, lack or creation of new audiences, a shared economy caused in the midst of all this and It has become an option for the livelihood of many Manauaras. With the advancement of technology many changes occur in the way urban society uses its profits to generate income, it causes or disappears some professions, an interruption of others and the emergence of several. It was chosen to measure the data or the food delivery application that uber eats, which has about a year of use in Manaus, or even the concept of new forms of work organization, their deliverers, use modal and are directed to your destinations via GPS. This study sought to understand what is leading part of society to register in the application that is based on the shared economy. For such a survey, a quantitative survey was conducted in Manaus City to collect data required at high food ordering points per application, through a field survey, information was collected from various*

*professionals. As a result of the investigation it was possible to map the professional profile of people who are choosing to work with this economic economy, and increase the incidence of technology for the lives of these professionals, it was possible to measure what challenges this new way of earning money provides, what are the advantages they bring, if it has the same advantages and the socio-economic impact on the day to day of professionals. Finally, it was carried out by the authors who conducted the survey, where after it was completed, it was possible to complete the applications associated with the shared economy that use yes, a great work alternative using technology as a medium.*

**Keywords:** Innovation, Shared Economy, Technology, Disruption;

## 1. Introduction

According to IBGE, in recent years Brazil has lost its ability to create jobs, the name of this is technical recession. Unemployment has reached alarming numbers, where 13% of the economically active population are looking for a job, ie in a universe of one hundred million people aged 18 to 45, thirteen million are unemployed, that is more than the population of Belgium or Greece. During the first quarter of 2019, Manaus pointed out as the capital that had the highest unemployment rate in the country with about 15.9% of the workforce. In the last quarter of the previous year, the rate was 14.4%, a variation of 1.5 percentage points. According to the Brazilian Institute of Geography and Statistics - IBGE, it is the highest rate since the third quarter of 2017 when it reached 16%. In the first half of 2019, according to the agency, in Brazil these numbers have been falling, nationally, by some factors, first, because many unemployed people stopped looking for a job and chose to start their own business, second, because Brazil started to generate again. vacancies in the industry, commerce and service sectors, even if in a timid way and finally, some Brazilians found themselves in the new world economic order, the sharing economy, found in this mode the palliative solution to offer their services and generate income. Driven by the concept of economic disruption, it revolutionized the consumer society and its labor relations, changed the way income can be generated and work in an unconventional way. For it to be established it was necessary to connect people simply, that is where the technological revolution enters as a protagonist in the new relationship of consumption of products and services.

The development of the shared economy is due to the conjunction of social, economic and technological factors (BOTSMAN; ROGERS, 2011). Regarding social factors, there is a growing concern with issues related to business sustainability and concern with the impact on the environment (DUBOIS; SCHOR; CARFAGNA, 2014), as well as the desire of participants to make new social connections (SCHOR, 2015). Through the shared economy, we have access to more products without having to increase their production, thus reducing the environmental impact (BOTSMAN; ROGERS, 2011). As for economic factors, it allows people to be less dependent on employers and better able to diversify their sources of income (DUBOIS; SCHOR; CARFAGNA, 2014).

In 2016 Claudia Gasparini published in Época magazine, the article 32 professions threatened by robots in the next 20 years, the article quotes "Robots can and will replace humans in various professions". In addition, the publication of the BBC News Jobs and Careers session in 2018 with the headline "The Professions Threatened by Technological Advancements", in the study by John Pugliese, doctors,

lawyers, architects, accountants, among others may lose job vacancies. If they continue to perform routine and everyday tasks, a mathematical algorithm will easily perform them within 5 or 10 years. The G1 website of the Globo organizations at the 2018 Scholarship session published the study by British Futurologist Ben Pring, which reads, "Professions of the future: 21 jobs that may arise in the next 10 years," the article quotes "In the very near future. , the labor market will undergo strong changes. " The article also warns of some innovative professions that have already entered the market, among them are Data Detective, IT Facilitator, Cyber Cities Analyst, Machine Man Team Manager. However, services such as Influencer Digital, drivers and application deliverers using technology as their main working tool can be seen.

This research aimed to present socioeconomic details, its limitations, difficulties and an overview of how technology associated with the shared economy is transforming the delivery market, changing the lives of the delivery companies that use the Uber Eats application service in Manaus, a platform that has been growing rapidly every day, revolutionizing and modifying the way of working and generating income, also seeks to understand what leads a person to join a sharing economy system, then map the profile of the professional and finally raise the relevance technology to the professional's life.

## **2. Methodology**

At first, a bibliographical research will be performed in books, magazines, articles, websites and recently published scientific articles in order to enrich the theoretical foundation of the study. This literature review sought content from 2017 to the present.

Secondly, the quantitative research will be applied through a digital platform questionnaire, which consists of twenty-two specific questions related to the theme, the authors themselves conducted through field research interviews with the workers of Uber Eats. at high demand points for meal orders per app in Manaus.

Finally, the authors will perform a screening of the study survey, where after it is finalized, it will be possible to confront the theory with practice and to search for evidence that corroborated or refuted the hypotheses of the problem.

## **3. Results and Discussions**

### ***3.1 Shared Economy and The Socio-Economic Profile***

The present and the future of the business world are in the shared economy, and those who have participated in it in some way have been meeting their economic needs differently, at a difficult time when Manauaras are looking for work alternatives to support themselves. According to Graph 1, where 100 deliverers participated, it was accounted that 90.3% of respondents are male and only 9.7% are female. There is a higher prevalence of males interested in per-app delivery in Manaus City.

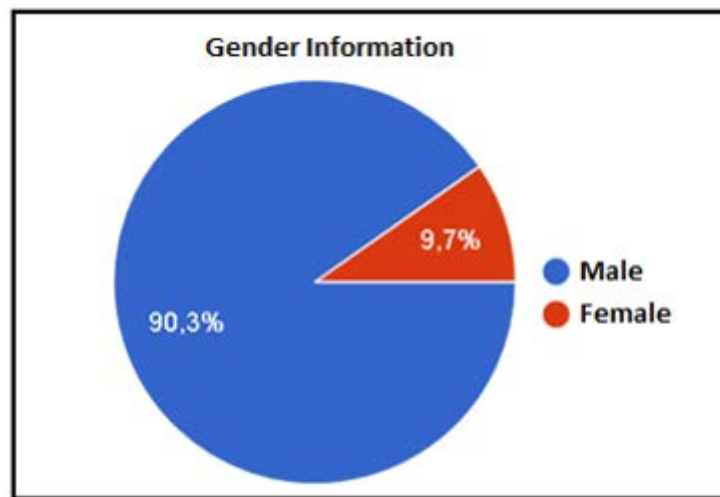


Figure 1 – Gender Information

Source: Author

It is understood that in Manaus the female audience is the least seeking to venture into an application delivery profession, according to the survey, according to the interviewees themselves, women consider the profession very risky and dangerous, so in their vast majority usually undertake in other segments. When the study began the hypothesis was that most would be male since in all field observations there was a shortage of the opposite sex, so the idea was confirmed. In the investigation, there was something that impressed a lot. The age group of people who are working in this market refuted what we thought. We thought that most of the professionals were 33 to 45 years old, because people in this age group are more prone to unemployment because Companies hardly hire people of this age, to our surprise, the younger public is the one that most seeks this. According to Graph 2, about 38.8% of respondents are 18 to 22 years old.

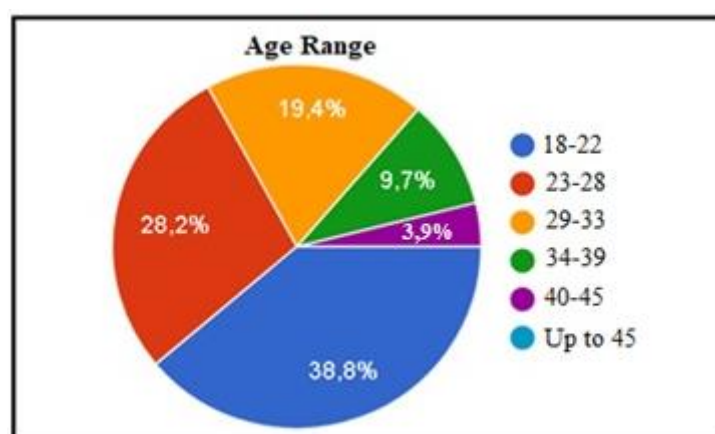


Figure 2 – Age Range

Source: Author

The means of transport used to make deliveries by Uber Eats, is the bicycle, motorcycle and car. According to the survey, about 55.1% of respondents make motorcycle deliveries. Graph 3 explains the

data better.

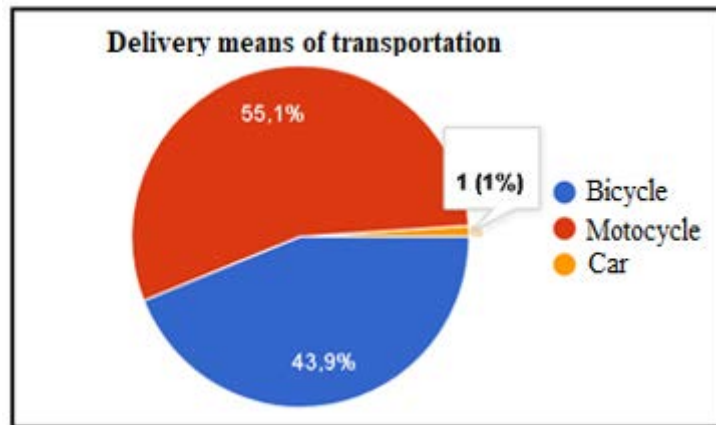


Figure 3 – Delivery means of transportation

Source: Author

In second place are those who work by bicycle represented by 43.9% and soon after those by car with a much smaller share, 1%. Most app deliverers, especially those who deliver bicycles, say they have fun riding, and the best part is that they still make money doing what they like, thus ensuring more health and quality of life.

Of the one hundred and three deliverers, 84.7% work with their own modal, a portion of 8.2% uses the means of transport provided, loaned or even rented. There are cases where the application delivery does not even have the means of transportation to do the work, so they end up looking for alternatives to perform the activity, among them, use the shared bikes MANÔbike. It is a sustainable transport option and they end up being the short-haul locomotion solution, everything a bicycle delivery boy needs.

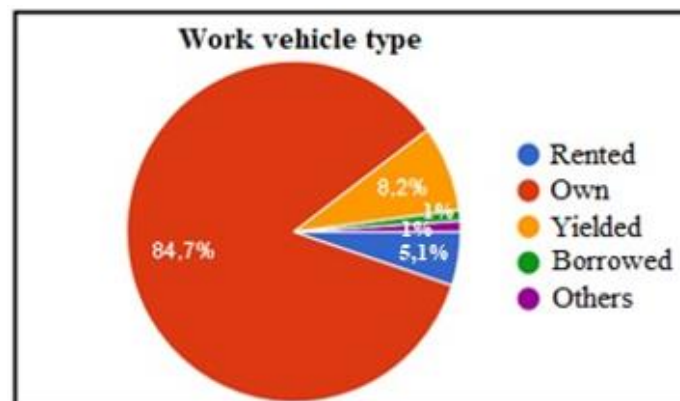


Figure 4 – Work vehicle tipe

Source: Author

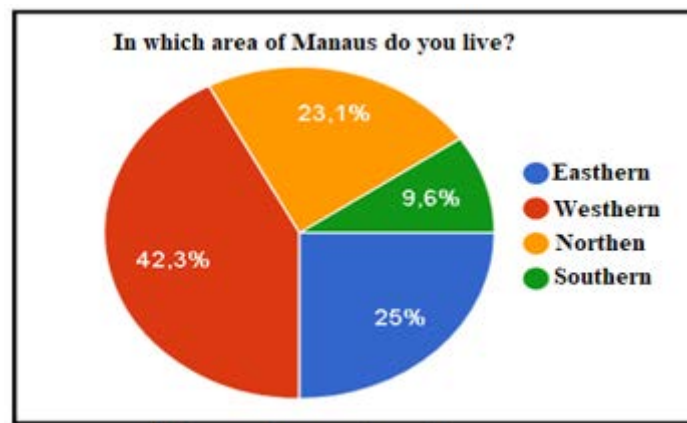


Figure 5 – Area of Manaus live

Source: Author

It has been found that most people who are using shared economy applications, about 42.3% of respondents live in the west of Manaus.

This means that, according to the survey, people living in this part of the city are more interested in entrepreneurship than in other locations in Manaus, when the study began, it was expected that the East Zone of the city would lead because it had a very large number. greater than residents.

Something very important needed to be discovered in this survey, which is why people are looking for shared-income apps, in our Uber eats survey, with The collection made it possible to confirm our initial hypothesis. Unemployment is the main factor 52%, closely followed by the complement of family income.

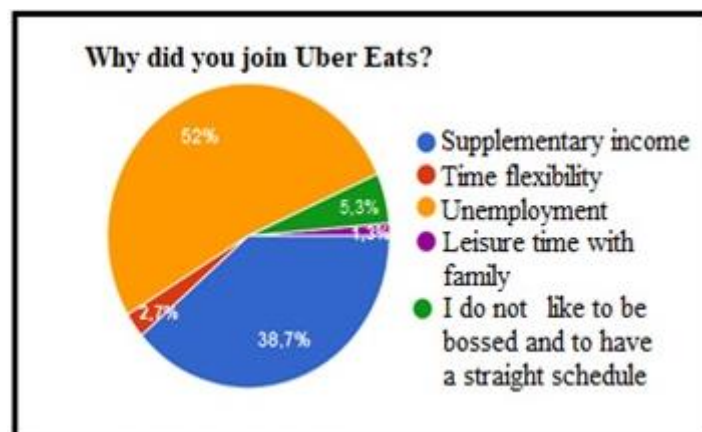


Figure 6 – Join uber

Source: Author

Forbs magazine research by technology consultant Carson Biz reports that this market, at a minimum, will remain at its current level until at least 2022, so it becomes a great investment alternative for sure with up to 4. years of certain profitability for this audience.

The Amazon goes through one of the most difficult moments in its history. According to IBGE data in the chart below, the unemployment rate is very high in the state, and each year is only increasing.



The situation in which the state finds itself, unemployment on the rise, the shared economy emerges as a great income alternative for Manauaras, despite being a self-employed job, has helped many families to support themselves in the midst of the crisis.

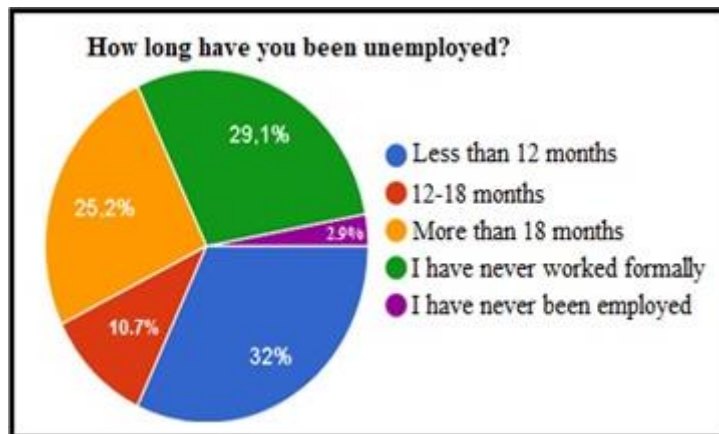


Figure 7 – Been unemployed

Source: Author

According to the study, unemployment is present in the lives of these workers for over 1 year, this is a long time for those who have family or even for those who are single. This only con-firms what the authors expected from this part of the research, where it was confirmed to be more than a year the length of stay of these people in the field of unemployment, this is the main reason people look for shared economy applications in Manaus, city is that has the highest unemployment rate in the country.

Only 24.3% of respondents have some type of employment contract, the large mass, totaling 75.7% of respondents work autonomously. This minority usually works to supplement their income, be-cause with the salary they currently receive working in a formal way, they cannot keep up and end up looking for applications of shared income to improve their income.

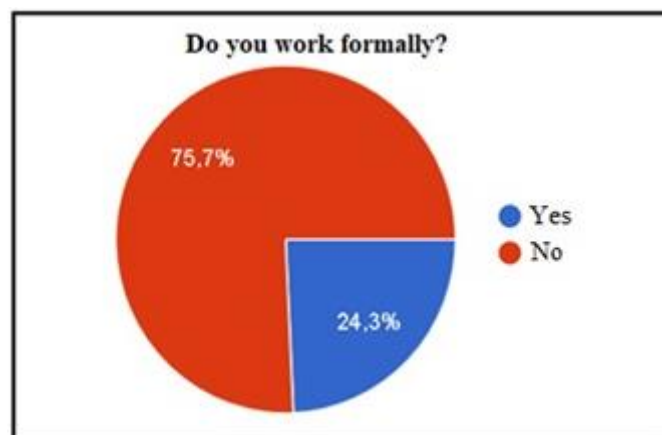


Figure 8 – Work formally

Source: Author

The survey also revealed that 73.3% of workers who use the shared economy have completed high school, but also a small part of them are in higher education or even have graduated. Although they were graduates, they could not place themselves in the labor market, others studied 4.5 years and found that

they had no vocation for that area. There are also those who, despite having a college degree, benefit from the shared economy to earn an extra income in addition to physical exercise and consequently to acquire more health.

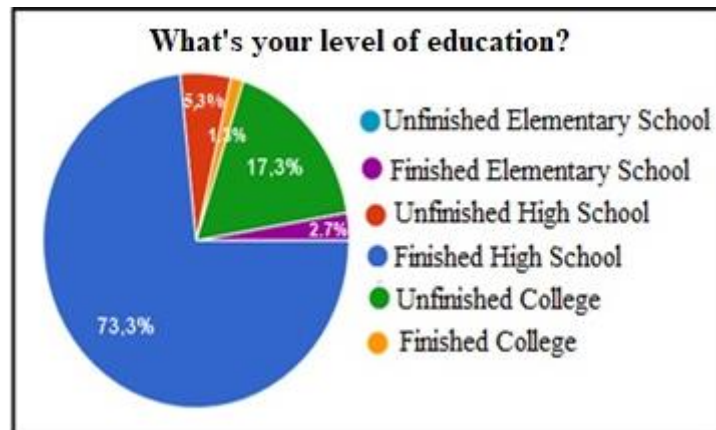


Figure 9 – Level of education

Source: Author

Most of the respondents, about 44% have their own home, but 41.3% of them live rented and 14.7% can not even afford a rent, live in the residence of family or even with friends or acquaintances. Our hypothesis was contradicted, we thought that most people who work with shared economy had no residence, because it is not a profession with CLT.

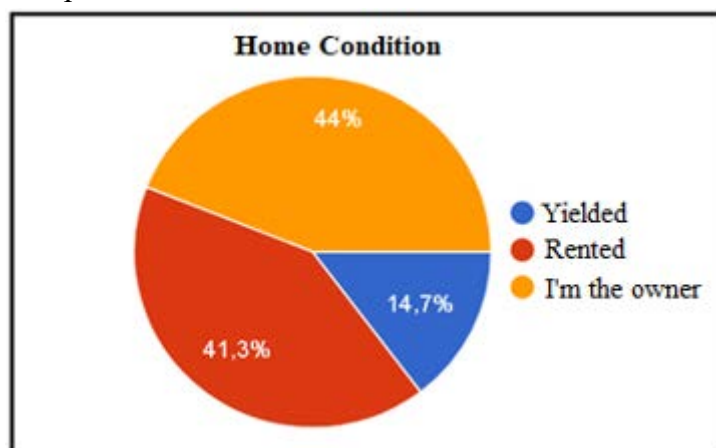


Figure 10 – Home condition

Source: Author

About 74.7% of respondents say that working as an application delivery is a very tiring activity, nature phenomena such as sun, rain and even the position that you work for a long time a day cause a lot of fatigue for them, with The survey was able to confirm what we thought. A minority of respondents reported being a pleasurable profession, but many of them only work at night, and report that the weather is more pleasant to move around and much less concerned about traffic.

### 3.2 Shared Economy and the Renewal Process

Recent surveys conducted by SPC Brasil and CNDL in all Brazilian capitals revealed that for 80.9% of

respondents say that sharing goods and services makes life easier and more functional. In addition, 68% imagine themselves participating in collaborative consumption over the next two years.

The data collected in our survey reveal that 63.1% of users who use the Uber eats application in Manaus to generate income do not know its concept or how it works, but feel its effects.

Although Shared Economy or Collaborative Consumption is not a relatively new practice, taking its first steps in the 1990s, many associates do not know what it means, meaning they do not seek to understand how the platform makes or makes a profit, only use to make life easier and find in the platform a way to generate income for their family support. Respondents were asked if they knew what Shared Economy was, had the option to answer yes or no on the digital questionnaire applied by the interviewers, those who answered not knowing what it meant, asked to explain the concept and its applications, and explain about the subject. We inform that the Economy This is a movement that is going against the idea of unbridled consumption, because the proposal is to divide goods and services without focusing only on profit, but on user experience and business sustainability. The big corporations that are embarking on this wave have become very popular and lucrative, including Uber eats itself.

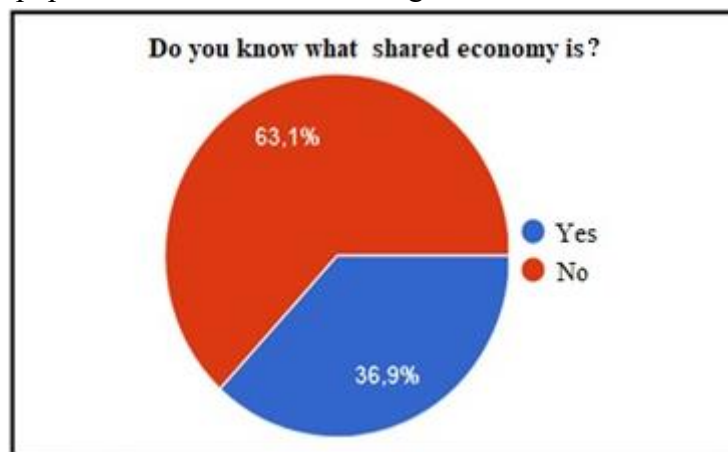


Figure 11 – Shared economy

Source: Author

This phenomenon of not knowing how the sharing economy works is mostly due to the lack of clarity from companies that do not seek to implement any kind of technical qualification or training to understand the business structure.

This lack of these policies is characteristic of disruptive companies that use collaborative consumption to generate wealth, they explain that the intention is to democratize the use of platforms without distinctions of class, race or gender, and that if they adopted similar policies they could exclude part of the base of associates. In parallel with the survey on shared economy, this research sought to know if the professionals of these platforms know what disruption is. A renewal process is a term increasingly used in the rounds of entrepreneurs and people linked to economic innovation. Entrepreneurship creates various terms from time to time and disruption is the newest among them, but what is disruptive really?

According to a SEBRAE business expert and scholar, a disruptive company is one that creates or devises actions that bring new products and services to life that create new markets and destabilize competitors that previously dominated the follow-up. services and products cheaper than existing ones and serve a

consumer audience that did not have access to the products and services of leading corporations. So when an entrepreneur launches cheaper, affordable, efficient customer-focused technology rather than high profit margins, it leaves the former market leader obsolete and takes a large chunk of existing or created customers, that is. disruption.

In our survey we sought to know whether or not users who service the Uber Eats app know what disruption is, the result was that 95.1% of respondents said no, although they realize they are suffering from its effects.

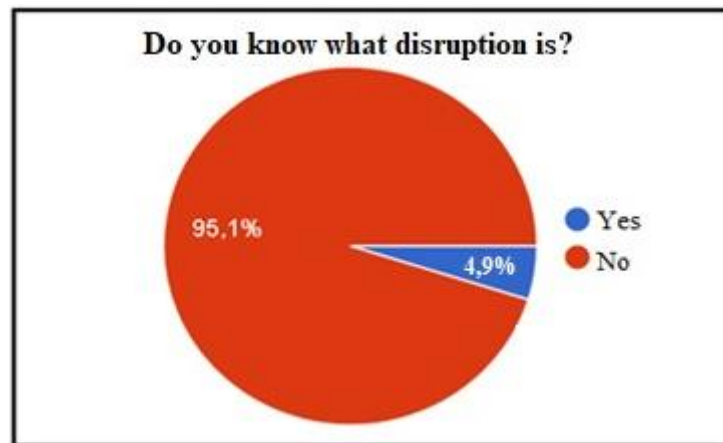


Figure 12 – Disruption

Source: Author

This confirms the previous research done by the specialized entrepreneurship and marketing centers, already mentioned, also shows the reality of food delivery workers and the level of knowledge they have about the tool they use to generate their support. They are more focused on looking for opportunities for financial growth than understanding the kind of tools and the concept she uses to create the service opportunity for them.

Unsurprisingly, the shared economy is already a reality in the modern world, the giants of this market are betting high on their products and services, their growth is in the double digits, turning simple companies and startups into major holders of consumer markets. The pillars of this entire growth lie in people, products and technology. People are the supplier and consumer market for the products and services offered by companies that mediate their relationship. Technology enters the medium to connect people to services and products.

Even in the modern world where we have access to digital components and applications, some of the interviewed users using the Uber eats app have some difficulty with the platform, 25.2% (graph 13) of users say they have difficulty with the app .

Especially when it comes to remuneration for the application, they have difficulty understanding how it works, others claim that it has difficulty with the application in terms of usability, they report that when accepting some delivery has a time for acceptance, but themselves clicking, fail to accept and lose the service. About 74.8% of respondents inform that they have no difficulties with the application, observing the profile of respondents, those who have difficulty are mostly people who are over the age of 34, who have a low level of education, But even with their limitations they choose to generate income through the

application because they perceive a great opportunity for earnings and feel included in the job market.

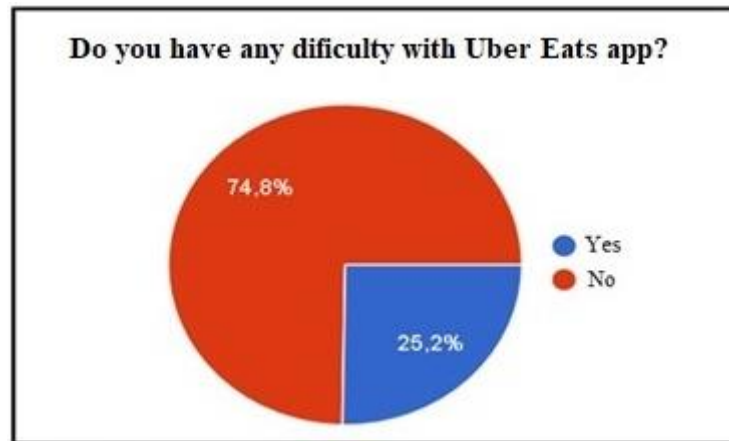


Figure 13 – Disruption

Source: Author

According to data from the 2018 survey by the Credit Protection Service (SPC Brazil) in partnership with the National Confederation of Shopkeepers (CNDL), there are about 61 million indebted Brazilians, according to the survey, 18% of respondents seek a supplementary income to pay off their debts, the survey also finds that the most commonly used forms of collaborative consumption by Brazilians are rides to workplaces, college, renting houses or apartments and sharing bicycles, coworking, and sharing of housing, also known as republic.

All these forms are opportunities that the shared economy provides its associates, the people who undergo this kind of work seek in some way to earn income, be it to supplement income or simply as their main source of income. Already for consumers see a way to save, it uses technology as a means to connect people and reduce the barriers to trading.

The survey data from this paper show that 48.5% of respondents use the Uber eats application with the main source of income, ie, the gains obtained on the platform correspond to 100% of family in-come, this trend is directly related to the main economic scenario. Manaus, where according to the IBGE National Household Sample Survey (PNAD), published in the first in August 2019, the rate of unemployment in the Amazonian population is high, above the national average, this shows that manauara found in the shared economy a momentary palliative for its financial conditions

Our survey also measured the universe of those who only seek to complete income with the use of application, this universe is 48.5%, each in its impact range, where 15.5% of respondents say that the revenue from these platforms is 99% to 70% of their gross income, that is, they earn more from the application than in their work with a signed card, but they do not leave the formal service because they like to feel stable with a signed card, FGTS and INSS. Already 25.2% of respondents say that 60% to 40% of their gross income is impacted by the application Uber eats, work on average 6 hours a day in the application and still have work with a signed card and all benefits, while only 10.7% say that the platform represents only 40% of their income, they already work up to 6 hours a day but in specific periods, such as on weekends and at night.

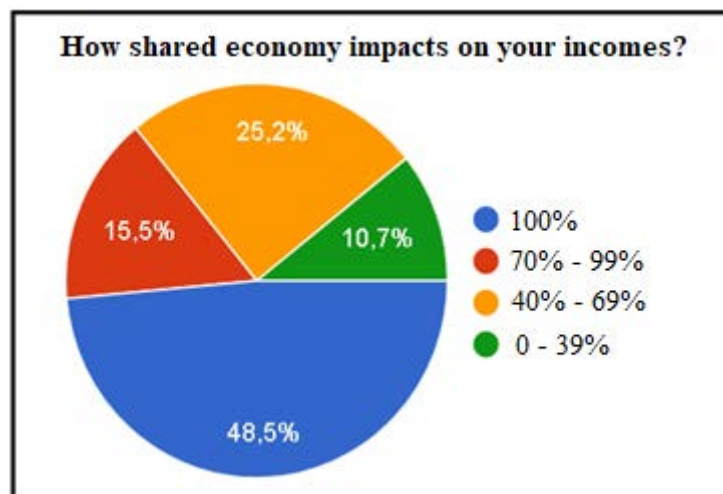


Figure 14 – Shared economy impacts

Source: Author

Recent surveys by PNAD, CNDL and SPC explain 51.4% of Brazilians with a formal contract look for collaborative platforms to supplement their income and use them mainly to pay off debt. The field research proves that in Manaus this data is very similar to the national numbers and that the Brazilian unemployment, debt and low income map have created a scenario of growth in the delivery of delivery applications, making good part of the population use the apps to make a living.

In the last decade the Brazilian has spent less on buying rice and beans to cook at home, the practicality and variety of food prepared outside the home is one of the causes. This directly impacts the household budget. The POF, Family Budget Survey, prepared and released by the IBGE in October 2019, shows that the habit of food consumption has changed a lot, according to her, food is the third largest expense in the family budget, on average. represents 17.5% of Brazilian family spending. Against this data, the Brazilian has increased the consumption of ready-to-eat and away from home products, according to IBGE, eating at home has a higher cost than eating away from home. Even so, the Brazilian sought in the last decade increases his income to cover his expenses with food, housing and transportation. In the last decade with increasing behavior, a new workforce has had to specialize, express food delivery.

Based on other surveys, our survey sought to know the satisfaction level of Uber eats members, and to understand their level of expectation with the app. The data collected report that only 11.2% are totally satisfied and have nothing to complain about, the profile of these interviewees are those who use the bicycle as a means of transport for delivery, so they qualify as the most profitable professionals on the platform, because it has no fuel costs and low maintenance costs.

Already 64.30% of respondents are satisfied with the amount they receive for delivery, they say the value is fair, but can improve and are happy with the earnings. But 22.4% are unhappy, think they could earn more from deliveries, this behavior was observed in respondents who do not have a home, so they need to demand more resources to fulfill their housing obligations. And ending only 2% are not at all satisfied with the remuneration gained via platform, this respondent profile is associated with those who claim that the remuneration of motorcycle users is the same as those who use bicycles as a work tool, they do not find this proportionality fair in addition to their high personal costs.



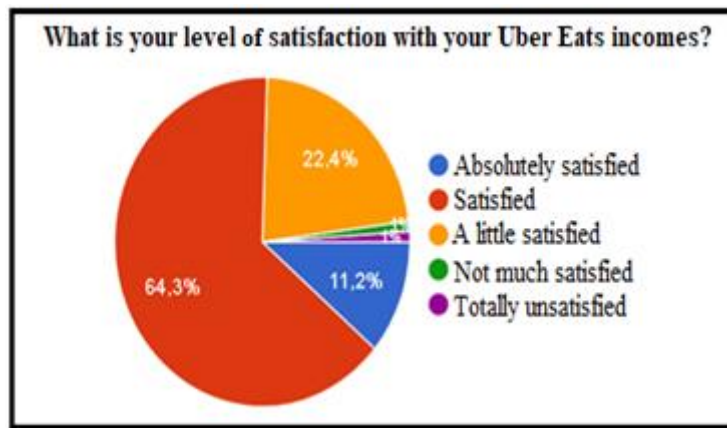


Figure 15 – Uber-eats incomes satisfaction

Source: Author

### 3.3 Shared Economy as an Income Opportunity

When we use the term Shared Economy we generically express the new form of work organization, where human activities are focused on the production of value and its sharing among those who are inserted in its business network. Companies like NETFLIX, UBER, Airbnb are the world giants of this follow-up, while the genuinely Brazilian have GogHero, Turbi, Yellow among others.

The opportunities created by this type of business are relatively attractive, as companies capture customers as their associates focus on delivering products and services to the standard set by the plat-form, this relationship eliminates the steps required to conventionally understand. They have some-thing in common, they use the desire of Brazilians to earn extra money and generate main income as their driving force for growth.

According to a survey by the Brazilian association Startups - ABSTARTUPS, the biggest barrier found by the Companies is the culture and technology barrier, research also shows that Brazil is one of the best market, not yet explored, to undertake applications aimed at collaborative consumption.

Brazilians for feeling exploited by this type of company end up not entering this economic order, the suspicions are diverse, some claim that the gains do not compensate all efforts, some think that only who really wins with this is the company, others say that if They feel exploited for having no labor guarantees, and there are those who say they need to work long hours to get the same return as a formal job.

In Brazil every working relationship must be clear and in writing Work Card and Social Security - CTPS, the work regime and the duration of professional activities that will have to be fulfilled daily, the Brazilian labor law requires that the work duration daily may not exceed eight hours and forty weekly, compensation of hours and reduction of working hours, by agreement or collective agreement. The new labor law has made these relationships more flexible, the new regime focuses exclusively on working hours, and the worker may have fewer hours of work, but finds it possible to have more than one job with a formal contract, in addition to the intermittent form of work and I work at home. Economic sharing makes these working hours change according to the worker's profile, the survey showed that 34.7% of users who work on the Uber eats platform employ 8 working hours daily on average, this professional are those who do not have activity with a signed portfolio, but has another remunerative activity and uses

other types of technology to generate income.

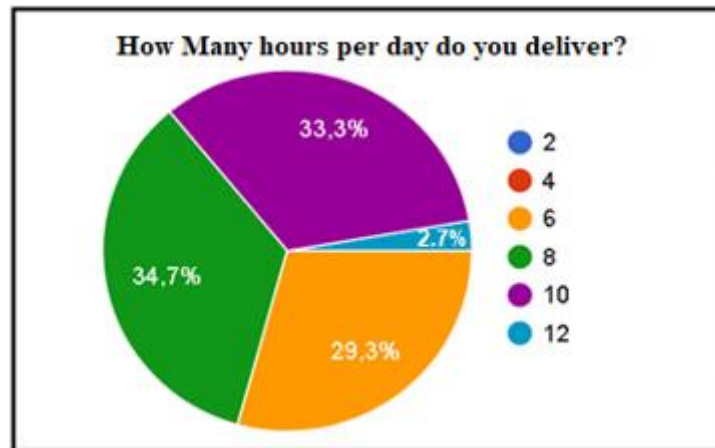


Figure 16 – Hour per deliver

Source: Author

Those who work over 10 hours a day, which together represent 35.3% of the interviewees, have no other remuneration activity, they are satisfied with their work and in some cases they work 12 hours a day, and realize that they do not have the technical qualifications to work. the formal job market or not yet looking for another way to generate income. This worker has no home of his own and the used vehicle is rented or borrowed, so it takes more working hours to meet the commitments made, such as housing and food.

The other profile that is evident in the survey and holds 29.3% and are those who have a formal contract and perform the formal hours of service, they work on the platform on average 6 hours a day, and claim that this time is acceptable for he and more than that would not be possible to perform, due to another working relationship that consumes them most of the time. They are professionals who mostly seek to supplement their income to solve financial problems.

The new economic order has changed, over time, from the working relationship in the Middle Ages to the Contemporary World, and one of the tools used for this remodeling.

It was the technology. It has opened up opportunities for formal and informal work in various segments of society, allowed for mechanization, automated processes and facilitated people's daily lives.

The survey indicates that 53.4% of respondents use other types of technology to generate income, in addition to Uber eats, the survey also shows that 46.6% do not use other technologies to complete income.

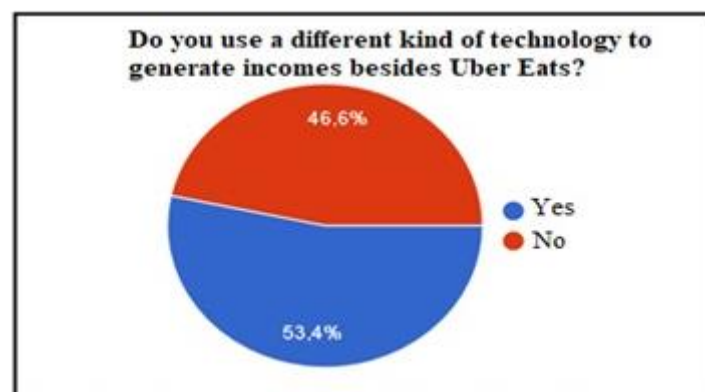


Figure 17 – Kind of tecnology



Source: Author

Respondents who answered no as a response claim that they do not use other technologies, claim-ing lack of time, lack of knowledge, others also claim that they only rely on Uber eats for brand credibility and security in Uber's proposed sharing service. earnings.

Social networking, in addition to connecting people, has also become a way of doing good business, most of our respondents said they use other platforms to create business opportunity.

Those using other technologies, 35.9% of respondents, use iFood as an auxiliary platform in their work, this phenomenon occurs because iFood is a platform very similar to Uber eats, as the largest list of bars and restaurants, allowing the worker more ordering possibilities in your wallet. Deliverers using iFood in Manaus are almost exclusively bikers, ie, non-motorized and bicycle-only deliverers, 43.9% of respondents are not part of their membership niche by this limitation. There are reports of respondents using bicycles who do not use iFood because deliveries are mostly out of their range, making delivery financially unviable and out of shared earnings proposition

WhatsApp comes third with the most widely used platform for generating income, with 20.4% of like-minded respondents using it to create some opportunity for financial gain, it being a social net-work while being a direct communication app. at no cost to those who use it and having 120 million active users in Brazil, it is constantly used for trading, according to them, allowing suppliers and customers to interact virtually and securely in their transactions, but not for food delivery. but to sell other products and services.

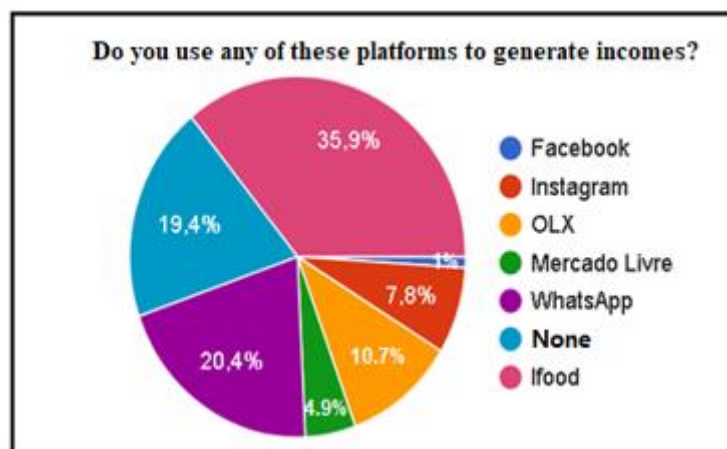


Figure 18 – Platforms to generate incomes

Source: Author

These platforms together already have approximately 208 million active users in Brazil alone, but it is little used by the delivery companies, because they are still unable or do not know how to link their type of service to advertisers of these social networks. Those who use these platforms use them, there-fore, have some kind of parallel selling business, such as selling perfume, clothes, accessories, decora-tion objects among other products.

#### 4. Final Considerations

The development of the present study made it possible to identify the socioeconomic profile of Uber Eats application deliverers in the city of Manaus, a profession that underwent a renovation process, and soon became a new opportunity to insert people into the labor market using technology. as an aggregator of values and used in the collaborative modality.

In addition, through a quantitative field survey, we also interviewed one hundred and three deliverers. The goal was to obtain more consistent data on the reality of the process, knowledge of the professionals working with the delivery application, gains, advantages, disadvantages. in relation to the work associated with the shared economy.

In general, in Manaus, the majority of the deliverers are about 80% male, have little knowledge related to disruption, but most respondents already know or have an idea of what is the shared economy. Most app deliverers justify their search for Uber Eats, either because of unemployment or to supplement their income, while a small number of them say they deliver because they want more time to study, a longer stay with their family or not. enjoy being bossy or loathe meeting schedules.

Brazil is experiencing a high rate of unemployment and the high level of indebtedness of society, and Amazonas is the state that has been most affected by the Brazilian economic situation. According to IBGE data, many people were without any prospect of no idea how to complete the family budget, until the profession of application delivery came in the midst of technology as a means of livelihood or supplement to the crisis, all this was only possible thanks to the shared economy.

In relation to companies seeking expansion for their business, it can be said that in Manaus there is a peculiar growth environment, because the distances in the urban area are small, the population even without so much technical qualification or specific knowledge, is open to these new ones. technologies. Professionals every day seek to create strategies, new opportunities that make it possible to maximize earnings.

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# **Piezoelectricity as an Alternative Source of Electric Power Generation in an Education Institution in the Amazon**

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## **Abstract**

*The development of technologies for the generation of clean and sustainable energy has brought significant changes to the energy sector in Brazil and worldwide. The newest technology is piezoelectricity, which although it has been studied for years, has not yet gained its proper space in the national and international electrical matrices. With this in mind, the present work aims to describe the process of installing a prototype carpet using piezoelectric ceramics that, through a force applied by any individual, is capable of generating enough energy for the operation of a turnstile in a HEI from Manaus-AM. The application was tested by modeling applying mathematical equations in the working of the prototype developed by APC International. Different answers were obtained considering the different dimensions for the piezoelectric parts. However, it is understood that this energy production model, treated as a new technology, presents economic viability in its implementation. One of the results demonstrates that the smaller the ceramic piece, the greater the energy production and can be adapted over time to respond to large productions. Thus, it is concluded from the calculations made that piezoelectric ceramics is an excellent alternative for the production of clean energy on a small scale, in a short time, and in the long term can reach large scale.*

**Keywords:** piezoelectric; sustainable energy; electric energy;

## **1. Introduction**

In Brazil, investment in renewable energy took strength after the oil crisis in the 1970s. Since then, the country has undergone a series of changes and adaptations, so that there was cooperation due to the increase of these sources in the national energy matrix where, From this perspective, the concern from this perspective has been generating a technological advance so that new sources of alternative energy develop.

Renewable energy comes from the use of natural resources for clean energy generation, such as harnessing wind potential, solar irradiation, water potential, among others. The use of these resources as an alternative source for power generation has grown exponentially in recent years and the search for new sources seeks to develop and provide a more efficient generation, which in fact is intensifying.

In 2016, the world's energy matrix was 86% non-renewable energy (IEA, 2018). In Brazil, in 2017, its energy matrix was composed of 56.5% of non-renewable energy (EPE, 2018), showing a decrease in energies that cause more environmental losses and resource degradation.

Even though more than half of its energy production comes from non-renewable sources, Brazil has one of the world's most renewable energy matrices, being supported by energy production from water sources (EPE, 2018).

The electricity sector accounted for 17.5% of the energy consumption produced in the country, being the Brazilian electricity matrix composed by 80.5% by renewable sources (EPE, 2018), while the world electricity matrix is composed by 24.5%. % by renewable sources (IEA, 2018).

Even though solar power generation is still underrepresented in Brazil and around the world, it has cooperated for a change in both power generation scenarios to drive sustainable power generation.

In Brazil, electricity generation occurred in a different way due to the emergence of distributed generation and the creation of Normative Resolution No. 482, promulgated by the National Electric Energy Agency (ANEEL), on April 17, 2012 [3].

Distributed generation (GD) is characterized by the production of electricity through small generating plants that use renewable sources of electricity and that connect to the distribution network of the concessionaires through the facilities of the consumer units (ANEEL, 2016).

Studies focused on the development of new sources of clean energy allowed the discovery of piezoelectric as an alternative energy source, emerging from the knowledge of French physicists Pierre and Jacques Currie who demonstrated that, by compressing piezoelectric crystals, it was possible to generate a difference of potential, where from this observation numerous studies were obtained until we reach piezoelectricity.

Piezoelectrics are crystals that react to compressions by appearing a pulse from the created electric field, which can be captured as electrical voltage. One of the basic characteristics of piezoelectric crystals is that these crystals do not have a symmetry center, since in each direction a different behavior will occur when an external stimulus is applied to these materials (JESUS et al. 2014).

According to Wang et al. (2018), piezoelectric materials are classified into crystalline materials (Quartz); piezoceramics; piezoelectric semiconductors; polymers; piezoelectric composites; and glass ceramics, and each material has its own piezoelectric and mechanical characteristics, the polymers being more

flexible and generating less energy while the ceramics are more rigid and capable of generating more energy.

Piezoelectricity is the conversion of mechanical energy generated by a compression into electrical energy. Although the technology is little known for large power generation, piezoelectrics are found in microphones, toys, electronic scales, alarms, among others. The compressions exerted on this equipment are converted into electricity to ensure their functionality (CIGOGNINI et al. 2016).

The use of piezoelectric plates for the production of electricity has a growing tendency and there is a great effort to improve this technology since, one must analyze the type of piezoelectric element to be used, one must also consider the quality of the material and the carrying capacity limits without causing damage to the material used (SILVA, 2018).

In addition, it is important to analyze the feasibility of implementing this power source in order not only to reduce environmental impacts and losses in energy transport, but also to reduce energy generation and consumption costs.

Thus, the present study aims to analyze the generation of electricity through piezoelectric crystals by simulating a generator prototype in a turnstile of a private college in the city of Manaus seeking to describe the installation process to be performed.

## 2. Materials and Method

Based on the study by LIMA (2013), a prototype was designed using a piezoelectric mat that should generate enough energy for the operation of the turnstile in a HEI in Manaus, AM.

The operating principle of the generator is based on the passage of people through the turnstile, where when an individual of a given mass applies a force on the piezoelectric mat an electric field will be generated in the sensors that will produce sufficient voltage to ensure the turnstile works.

In order for the generator to be sufficient to feed the ratchet, the system is composed, in addition to piezoelectric ceramics, of other materials to keep the ratchet on for 16h for 5 days a week.

To control the current, which will be sent to the ratchet and the battery, the LS3024EU charge controller will be used. This controller has a PWM system that ensures the least amount of voltage losses to the system and also controls the charge and discharge levels of the batteries and compensates for operating temperatures while preserving their useful life. This device also allows the battery type and output charge to be set through its panel.

For storage of surplus energy a 48 Ah stationary battery with a nominal voltage of 12 V and a reserve capacity of 65 minutes will be used. This battery has an emergency light and alarm that act when the battery charge levels are below indicated. The battery will guarantee a system autonomy of 16h, that is, if there is not enough power generation the battery will meet the ratchet need well, the battery capacity is expressed:

$$t(h) = \frac{C(Ah)}{\text{Consumo}(A)} \quad (\text{Eq. 1})$$

Where t is the autonomy time the system should have in hours; C is the energy capacity of the battery in ampere-hours; and consumption is the current the battery must have in order for the system to be powered

to function.

The piezoelectric ceramics used for this simulation was APC 850, which is made of lead zirconate titanate (PZT) and has high sensitivity to deformations in its structure. 1).

Table 1 - Characteristics of piezoelectric ceramics

<b>E</b> (Gpa)	<b>v</b>	<b>ρ</b> (Kg/m <sup>3</sup> )	<b>Piezoelectric Constants</b> (10 <sup>-12</sup> m/V)			<b>ε<sub>33</sub></b>	<b>G</b> (10 <sup>-3</sup> Vm/N)	
			<b>d<sub>31</sub></b>	<b>d<sub>32</sub></b>	<b>d<sub>33</sub></b>		<b>g<sub>31</sub></b>	<b>g<sub>33</sub></b>
<b>63</b>	0,3	7600	-175	400	590	1950	-10,2	24,8

**d: piezoelectric constant; g: piezoelectric voltage constant; ε: relative dielectric constant; ρ: density; E: Young's module; v: Poisson's ratio**

Source: APC International (2019).

The calculations performed considered four different dimensions for the ceramic pieces, so that it was possible to analyze what would be the best option for the prototype elaboration (Table 2).

Table 2 - Dimensions of Piezoelectric Ceramic Parts

<b>DIMENSIONS (MM)</b>	<b>HEIGHT</b>	<b>LENGTH</b>	<b>THICKNESS</b>
<b>POTTERY 1</b>	10	10	0,5
<b>POTTERY 2</b>	30,1	30,1	1
<b>POTTERY 3</b>	32	32	0,9
<b>POTTERY 4</b>	32,1	32,1	1,5

Source: APC International (2019).

Sensors made of piezoelectric ceramics can operate in different ways. However, for this simulation will be considered only the operation of the sensor in compression mode which submits the sensor to a mechanical stress applied in parallel to its polarization and, as a result, a thickness deformation and an electrical output potential are generated (LIMA, 2013).

APC International has developed a calculator that allows you to calculate the physical and electrical properties of the piezoelectric materials sold by them, demonstrating the voltage generated as a function of the force (N) applied to the piezoelectric sensor.

$$V = \frac{(g_{33} \times F \times h)}{(l \times w)} \quad (\text{Eq. 2})$$

Where: V is the generated voltage; g<sub>33</sub> is the piezoelectric constant; F is the force applied to Newton; h is the thickness of the sensor; l is the length of the sensor; w is the width of the sensor.

The sensors are connected in series and positioned at the ends of two overlapping aluminum plates so that the applied force directly on the mat is distributed, thus generating a mechanical force that will create deformations in the sensors and consequently producing an electric field. To isolate the contact sensors with the plates, we use fiberglass mesh that has high tensile strength; In addition to being an excellent electrical insulator, it is a material composed of thin non-rigid and flexible glass filaments joined to plastic materials.

In order to be able to turn on the turnstile, we need to understand how it works. The ratchet has a power supply (Figure 1) that has the ability to adapt to voltages ranging from 100 to 240 V and at its output has

a charge controller that allows only 12 V, with a 5% variation, up or down to the controller board, which performs its unlocking actions. The voltage source also has protection against short circuit and overheating.

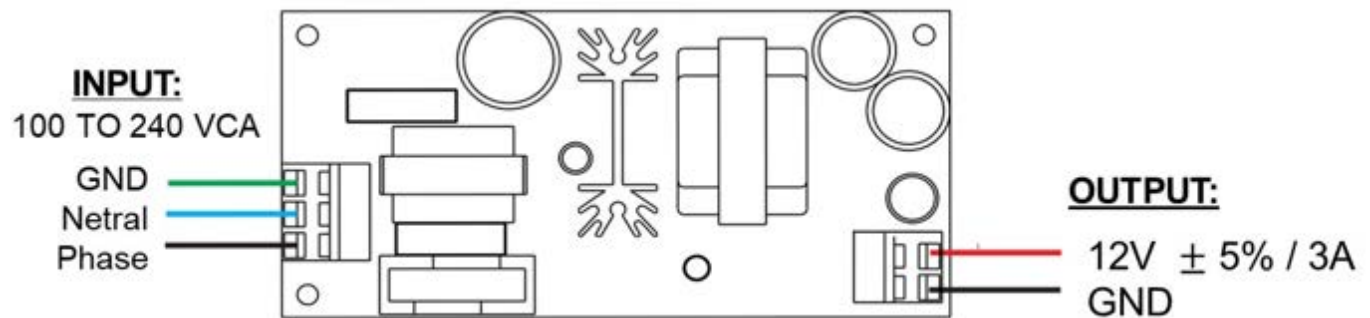


Figure 1 - Ratchet Power Supply

Source: Catrax Master, 2019 Product Manual

### 3. Results and Discussion

Applying the equations elaborated by APC International, it was possible to analyze what would be the ideal dimension for the piezoelectric ceramic piece to be used to generate enough energy for the operation of the ratchet. It was observed that the smaller the ceramic piece, the greater the tension generated (Table 3), due to the fact that the applied force is more centered on smaller pieces.

Table 3 - Voltage Generated as a function of Applied Force

Mass (Kg)	Applied Force (N)	Generated Voltage (V)			
		Ceramic Dimension (mm)			
		10 x 10 x 0,5	30,1 x 30,1 x 1	32 x 32 x 0,9	32,1 x 32,1 x 1,5
50	490	60,7600	13,4127	10,6805	17,6900
55	539	66,8360	14,7539	11,7485	19,4591
58	568,4	70,4816	15,5587	12,3893	20,5205
60	588	72,9120	16,0952	12,8166	21,2281
65	637	78,9880	17,4365	13,8846	22,9971
70	686	85,0640	18,7777	14,9527	24,7661
73	715,4	88,7096	19,5825	15,5935	25,8275
78	764,4	94,7856	20,9237	16,6615	27,5965
80	784	97,2160	21,4602	17,0888	28,3041
85	833	103,2920	22,8015	18,1568	30,0731
88	862,4	106,9376	23,6063	18,7976	31,1345
92	901,6	111,7984	24,6793	19,6521	32,5497

Source: Own authorship (2019).

CIGOGNINI ET AL. (2016) mention that in many cities have already tested this technology, where the first city to test this technology was Toulouse, France, where local authorities installed eight piezo plates on the sidewalks to produce about 480 W of electricity. Innowattech also tested in Israel, where it



installed road signs, train tracks, airport runways and subway stations, and according to the results obtained, it was possible to generate 200 kWh with the compression of 20 cars / min. highway.

The piezoelectric ceramic that presented the best results was ceramic 1, which generated the largest amount of voltage possible. Therefore, the ideal dimension to use for the prototype is 10 x 10 x 0.5 mm. According to SILVA (2018) there is a growing trend in the use of piezoelectricity, considering the responsiveness and analyzing an individual with average mass of 71.16 kg it is possible to apply a force of 697.44 N, so the generated voltage will be 21.266 V using only one piezoelectric ceramic piece. Considering an ideal condition, where the applied force is equally distributed over the five piezoelectric ceramic pieces, no energy losses will occur. Therefore, it can be assumed that the total voltage generated will be 86.4826 V. Since the ratchet needs only 12 V to operate, it can be assumed that the energy generated will be sufficient to maintain the operation of the equipment for 7 hours. h, with only one individual going through the turnstile.

Thus, the generated voltage is proportional to the applied force on the piezoelectric ceramic, ie, the higher the applied force the greater the generated voltage (Figure 2).

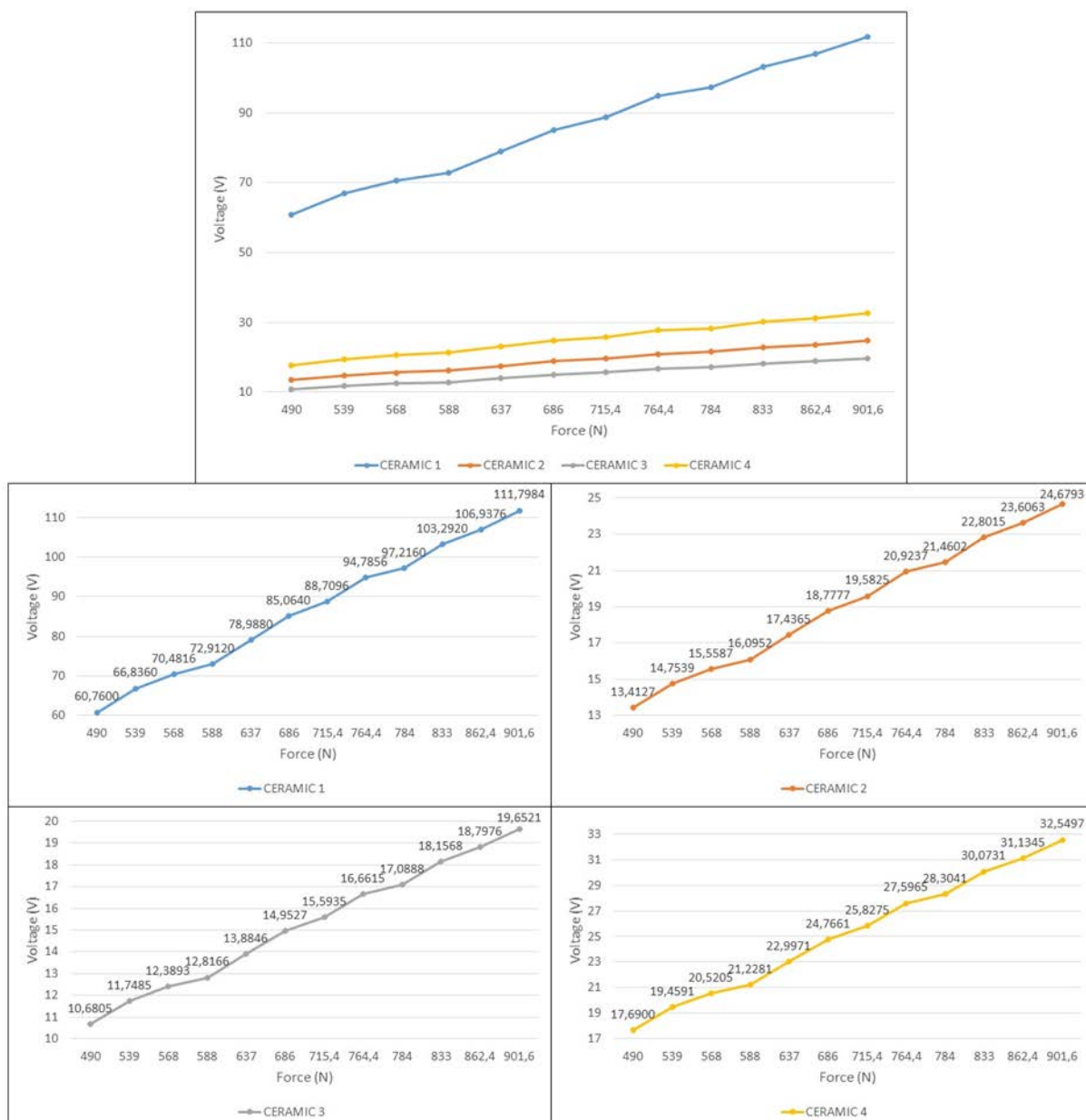


Figure 2 - Voltage Generated as a function of Applied Force

Source: Own (2019).

The investment to be made for the elaboration of the carpet prototype using piezoelectric ceramics is negligible in relation to the expenditure with electricity consumed by the evaluated turnstile (Table 4).

Table 4 - Prototype Budget

	Qnt.	Unit Price (R \$)	Total price (R\$)
APC Piezoelectric Ceramics 850	5	15,57	77,85
Stationary Battery 48 Ah 12 V	1	259,00	259,00
Aluminum Sheets 250x250x1 mm	1	11,59	11,59
Fiberglass Mesh	1 m	12,19	12,19
Wire # 2.5 mm <sup>2</sup>	5 m	0,88	4,40
Fiberglass Glue	1	24,90	24,90
<b>Total</b>			<b>389,93</b>

Through the calculations made it was possible to realize that piezoelectric ceramics is an excellent alternative for the production of clean energy in small and large scale, having a project with little investment and with considerable answers.

#### 4. Conclusion

The use of piezoelectricity in only one IES turnstile will generate a reduction in energy consumption of 4,800 kWh / month, a saving of R \$ 2,592.00 considering the off-peak tariff applied to the institution. Considering the use of this technology for all turnstiles of only one unit of the institution, the investment would be around R \$ 2,339.58 and the return on investment would occur in less than 1 month.

Piezoelectric materials are quite diverse, the prototype can be adapted for use with any other piezoelectric material, such as piezoelectric inserts, which are easier to find on the market, and are much cheaper than other piezoelectric materials. However, as a polymer, the tablets are not rigid enough to undergo large deformations and thus generate an electric field for a considerable amount of energy. On the other hand, piezoelectric ceramics, given this rigidity, adapted to the model, conditions the creation of a larger electric field, thus generating a high potential difference when compared to that generated by the inserts.

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# **Feasibility of Frying Oil After Treatment by a Biofuel Company in Manaus - Amazonas**

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## **Abstract**

*Waste generation has increased in many sectors given the demand and population growth. Reverse logistics comes to contribute to the return of these wastes to the production chain. In this context, frying oil is one of the most processed waste and transformed into new products, such as: biofuel, boiler fuel, soap manufacturing, concrete formwork release agent etc. Oil is one of the wastes whose recycling only happens by law, because it has low added value, unlike plastic, aluminum and copper, whose values are higher. The average oil consumption in Brazil reaches 3 billion liters per year, but only 2.5% of this total is recycled, the others are discarded in the wild. The aim of this study is to analyze Reverse Logistics at different points, seeking to describe the chain steps, from the final consumer, through the PEV and ending in the companies that will reuse the frying oil already treated. In Manaus, the logistics of frying oil is done by cooperatives and private companies, being MASSEG, the largest company in the segment. This research has an explanatory character, approaching a case study, which made it possible to observe the financial and environmental feasibility of reverse logistics for the collection of frying oil, carried out at Condomínio Shopping Manauara Center, in the city of Manaus, AM. To reverse this scenario, many companies are investing in the reverse logistics process. Procedures such as leaving drums empty so that they are filled with waste oil, separation of solid waste and water from oil, are already part of the*

*routine of tenants that also contribute to non contamination of water bodies. The collection, transportation, filtering, decantation and commercialization of the product already treated, for fuel purposes, is performed by the company itself. Finally, the company uses part of the treated oil to manufacture biodiesel, applied to the consumption of its own fleet, with no commercialization of the generated biodiesel. Thus there is a reduction in the use and costs with usual fuels (fossils), seeking to add the culture of sustainability.*

**Keywords:** *Reverse Logistics, Biodiesel, Waste.*

## 1. Introduction

The population increase has contributed to accelerate the problems related to the generation of industrial, commercial, agropastoral and domestic waste. Environmental impact control measures are constantly studied in order to minimize the incorrect disposal made by the population, especially with the use of reverse logistics.

Observed in the Environmental Management Program (PGA) [1], the waste from frying oil used, coming from industry, commerce and residences, has a polluting potential, if disposed of incorrectly. Thus, recycling promotes environmental and socioeconomic balance.

This waste is of great environmental impact in itself, as one liter of waste oil is capable of contaminating up to 25,000 liters of water. This occurs because the oil creates a surface film, preventing oxygen exchange and ends up killing the waste. living beings in that water body. In addition, waterproof the soil and contribute to the occurrence of floods.

According to [2], the environment, besides being impacted by the burning of fossil fuels, can also be affected in other ways, such as the incorrect disposal of solid waste, being the frying oil one of them, thrown in the soil and streams. 'water, contaminating groundwater.

In Brazil, several recycling projects have been created to reduce this potential problem, among them, the reuse of this frying oil residue. Unfortunately, even though it is one of the champions of reverse logistics, millions of gallons of oil of vegetable or animal origin are improperly dumped into the sink drains. As a result, there is an imbalance in microbial life, clogged sewage pipes, foul smells and increased operation of water and sewage treatment plants, which are forced to use more chemicals in water treatment [3].

According to Law 12.305 / 2010 [4], the responsibility and attributions are shared in the destination of the waste generated forming a chain with the following actors: manufacturers, importers, distributors, traders and consumers, responsible for the correct destination of this waste.

Currently, companies have a social and environmental responsibility, and assume the generation of waste produced until the end of their useful life cycle. Together with the individual, they must share the management responsibilities of waste generated, even as consumers become more demanding, forcing companies to adapt to current reverse logistics processes.

According to [5], reverse logistics arises through the motivation of social and environmental issues and sustainability principles, advocated by the environmental impacts caused by mismanagement in the disposal of waste, after being consumed. As a result, companies develop strategies for collecting,

disposing and reusing this post-consumer waste, positively impacting the economy and environment, making production more environmentally friendly and sustainable.

The Organic Law of the Municipality of Manaus [6] provides for measures for the reuse of vegetable oil and its residues, in order to minimize environmental impacts, from inadequate dumping on the environment, regulating the collection of vegetable oil and its residues, to mitigate these impacts. There are companies that work with meals in general, and that handles cooking vegetable oils, directly obliged to implement in its functional structure, the collection program of this material to be used for the production of biodiesel, mold release agent, soap and others. [7]

According to Art. 3 [6], vegetable oil used in food preparation is collected by private companies, NGOs and collectors' cooperatives.

Paragraphs 3 and 4 of Art. 3 [6], cited above, determine that companies from the Manaus Industrial Pole (PIM), which provide meals to their employees or have outsourced industrial kitchens, must collect this oily waste in a period of time. by the competent environmental agency, and present certification of the destination of this waste.

In order to control this collected waste, it is necessary that the generation companies, collection / transport and disposal, submit the Waste Transport Manifest (MTR), because only then, the control can be effective. This control through the MTR is generated in 4 (four) ways: 1st way-Generator, 2nd way-Carrier, 3rd way-Treatment Station and 4th way-Environmental Agency, closing the cycle of the correct destination of the collected waste. Subsequently, according to Article 5 [6], companies that do not forward these manifestos to the competent environmental agency, will lose the right to certification of collection.

Many establishments do not comply with the legislation, mainly due to lack of supervision. In addition, the population and commercial establishments pour thousands of liters of waste oil daily into the sewers, causing major problems in the different areas.

To prevent this waste from reaching the sewage system and watercourses, the problem must be tackled at its source. The population, in general, should store in drums, plastic bottles or other container, other than glass, used frying oil, and so hiring cooperatives and recycling companies to collect this stored oil.

For reverse logistics to occur, operating costs must be reduced. It is essential that this chain of stakeholders be more organized, avoiding unnecessary displacements, and also that the waste oil frying generator is aware of the various forms of reuse for this type of waste, such as soap, paint, animal feed, biodiesel etc. With all these possibilities of reuse, the discard in the middle is avoided [7], returning as raw material.

According to PNRS [4], the responsibility lies not only with the end consumer, but also with everyone involved in the process until the final proper disposal. Logistics planning should be observed, while the efficiency in this process of reusing used frying oil [7].

As suggested by [8], for the smooth operation of a reverse logistics network, the frying oil collection used, must occur from the implementation of the Voluntary Delivery Points (ENP). This facility serves to minimize the reverse flow problems that may arise in the generation of collected oil stock by checking the quality of the product received, the costs of the activity and its transportation. The most important item in the reverse logistics process is the volume of oil collected, even more than quality and price [9].

But the success of this whole operation is only achieved through Environmental Education. The ENP is only an item of this reverse logistics if the used frying oil generator facilitates the ENP for waste disposal. The process of delivery should always be attractive, because the waste has low added value and cannot at any time cause disinterest in the final consumer, with the risk of compromising the entire structure.

Given the above, the objective of this study is to analyze the Reverse Logistics at different points, trying to describe the steps in the chain from the consumer, through the ENP and ending in companies that will reuse the cooking oil already treated.

## 2. Material and Method

### 2.1 Kind of study

The methodology used in this work is based on the descriptive survey on the use of edible oil used as raw material for various products in local industries and their collection logistics.

The type of research approach is explanatory. According to [10], descriptive research aims to describe facts and / or phenomena of a given reality and explanatory research is concerned with identifying the factors that determine or contribute to the occurrence of facts and / or phenomena of a given reality. .

### 2.2 Study area

The study area is located in the city of Manaus, but it is inferred over the entire area covered by the Company, including the metropolitan region, which includes the municipalities of Iranduba, Manacapuru, Rio Preto da Eva and Presidente Figueiredo (Figure 1).

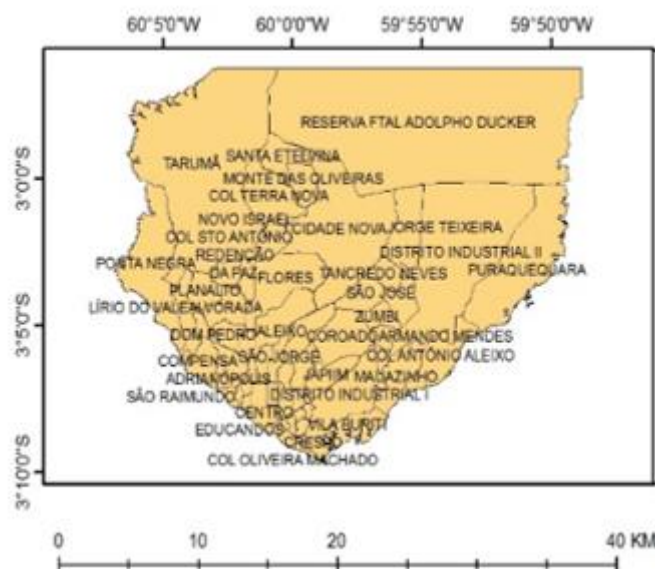


Figure 1 - Satellite image - City of Manaus and Municipality of Iranduba, AM.

Source: Thiago Fernandes (2019)

There are two actors in this case study, the first actor is represented by Condominium Shopping Manauara Center, used in the analysis as a generator, thus becoming the verification area of the information collection point, shown in Figure 2, through a satellite image.



Figure 2 - Location Manauara Shopping Center - ( $3^{\circ}06'16.0''\text{S}$   $60^{\circ}00'36.5''\text{W}$ ).

Source: Thiago Fernandes (2019)

The second actor represents the waste treatment company in Manaus, Company MASSEG Transport e Assessorial Ltda. She has the responsibility to collect the waste, transport it, take it to the Oil Treatment Station (Figure 3), then dispose of it. treated oil for companies using this product.



Figure 3 - MASSEG Company Location.

Source: Thiago Fernandes (2019)

### 2.3 Data collect

Actor 1 was selected for the study as a generator of frying oil waste, due to the large amount generated daily by their cafeterias and restaurants, having as a requirement to allocate it to a certified company, which carries out the entire waste management process (the generated oil), being the responsibility of the actor 2.

The equipment used is: 20 or 50 liter drums, suction hoses and vacuum truck, which will store the used oil in your tank. The collected oil often presents other undesirable aggregate residues, such as: frying residue (flour, bone, skin, etc.) and water, which will be separated in the filtering and decanting process at the treatment plant.

After segregation of all residues contained in the oil, such as water and other solid residues, will be able



to be marketed, with companies that will use this product for various purposes, such as: boiler burning, soap manufacturing, release agent and biodiesel [ 11].

### **3. Results and Discussion**

The average consumption of cooking oil in Brazil is around 3 billion liters per year, with only 2.5 percent being recycled in any way by the market. Unfortunately, the rest is discarded unevenly in the environment by industry, commerce and the general population, causing major damage to nature [12].

One of the actions that contribute to the irregular disposal of oil waste in nature is the lack of “environmental education” and the lack of knowledge that this waste can be transformed into a product, returning to the production chain.

To better understand the reverse logistics process of frying oil in the city of Manaus, collection follow-up was done at Condominium Manauara Shopping Center. The company has contracts with several retailers (cafeterias and restaurants), where waste oil is collected.

As [13], for the preparation of various foods, the frying confers characteristics, pleasant, with great acceptance by the consumer when the oil is still new. However, when its acidity increases due to constant frying, its darkening occurs. This feature is a warning to avoid its consumption. It can cause various types of manifestations harmful to health, such as obesity, hypertension, diabetes and cancer.

So that the collection procedure occurs in a way that does not cause major inconvenience to the commercial establishment, especially to customers. This service is performed after the mall closes. 20 liter drums are left to let shopkeepers fill them with used oil. The drum has a screw-on lid, a fixed sieve to prevent solid waste from being placed along with the oil, and a sticker with the collection company contact phone. On average the collection is done twice a week.

In Shopping Manauara Center Condominium alone, the collection takes place in approximately 10 snack bars, a total of 400 liters of oil per week and 1,600 liters per month. The collected oil itself will cover the collection logistics when it returns to the production chain. Shopkeepers store the oil in drums, and when the capacity of the container is close to the limit, request its collection.

At the time of collection, when the full drum is replaced by an empty one, the certificate of destination is given, containing the volume, date of collection, and place of destination. The shopkeeper pays nothing for this service. After being asked to remove the full containers, the company supplies the shopkeeper with empty and clean drums for the next collection cycle.

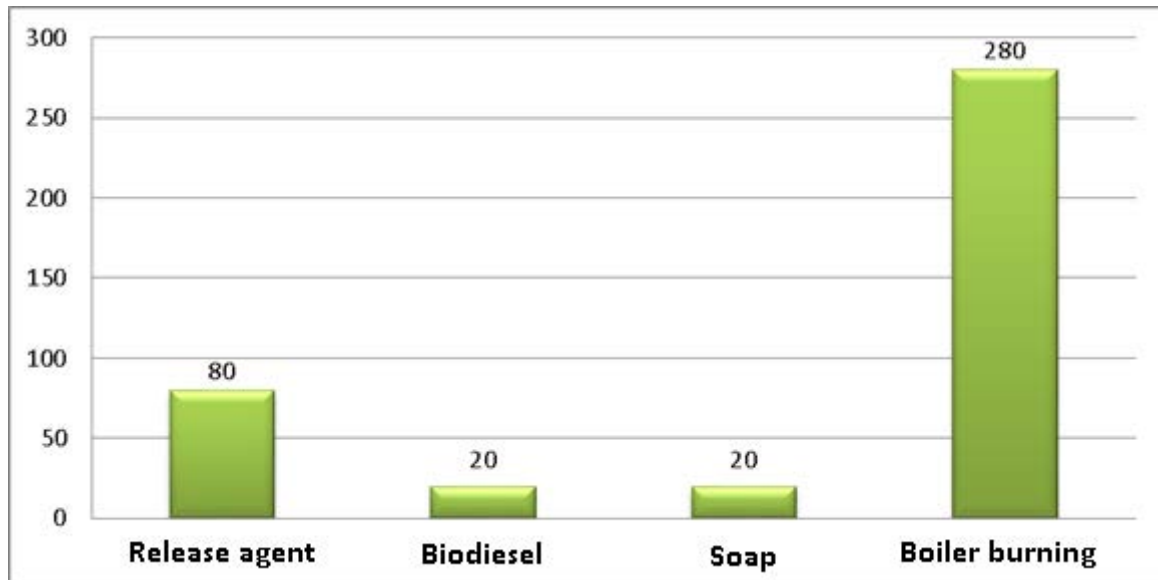
Outside the mall, a 3,000-liter vacuum tanker truck sucks up the oil contained in the drums. From that moment on, the drums are empty for the destination company, where they will be washed to clean the next replacement.

The waste collected from companies, restaurants and snack bars, arriving at the treatment site, will be filtered again to remove solid waste that may still be contained in the oil. From this stage onwards, it will proceed to decantation drums, where the separation of water from oil will occur, as it is harmful to the product. To speed up the process, the settling tanks are heated. When the oil is free of all water and solid waste, it is ready to be marketed as a product [14].

The companies that use frying oil as a product are: factories that have boilers, and replace diesel as fuel

with purified oil; construction companies that use as release agents for concrete forms and soap factories. For weekly collection of 400 liters of used frying oil after discarding the removal of water and solid waste, it is possible to generate approximately 280 liters of boiler burning oil, 80 liters of concrete mold release oil, 20 liters of oil for biodiesel manufacturing and another 20 liters for soap making (Figure 4).

Figure 4 - Products generated after purification of 400 liters treated residual oil.



Source: Own authorship, 2019.

In processing part of the purified oil into biofuel, the most used form in the capital of Amazonas, through its biodiesel plant, has a monthly production of less than 10,000 liters, being the consumption made by the company's truck fleet, with no commercialization of this fuel by part of the treatment company, only for the use of its fleet.

According to paragraph 2 of article 1 [15], prior approval by the ANP is not required for experimental or specific use that covers the caput, if monthly consumption of fuel to be tested is less than 10,000 liters.

#### 4. Conclusion

The results obtained in the feasibility study of the frying oil used for the production of biodiesel, concrete mold release agent, soap or boiler burning, by countless other companies in the Metropolitan Region of Amazonas, showed the importance of reverse logistics. An economic and social instrument that enables the collection and the return of solid waste, in our case the used frying oil, to the industrial sector, returning to the production cycle.

Reverse logistics, besides preserving the environment, enables the reuse of this waste, turning it into a product, which will generate jobs and benefits to society and nature in general.

Finally, the results of this study demonstrated the importance of the correct disposal of oil residues. From a dangerous environmental liability, turned into a product of extreme utility for various segments of industry and construction. Since the greatest legacy provided by reverse logistics is the reduction of the polluting load on the environment.

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## **5G Technology Analysis in Relation to Electromagnetic Waves**

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### **Abstract**

*Electromagnetic waves are present in most of the main equipment used by humans. The advancement of 5G mobile network technology has been gaining ground in the telecommunications market and with it both positive and potentially negative consequences as it is used. Fundamental research has been conducted to gain knowledge and familiarity with 5G technology, how it works and its millimeter waves, which is a new range of the electromagnetic spectrum, which works with this new very high frequency and the first time used in technology. mobile network, as well as exploratory research through techniques such as bibliographic surveys in search of data such as frequency, related to 5G and the equipment transmitting electromagnetic waves, and conducting a comparative study to determine through the data collected from both , pointing out studies that present the evils that may cause the human being due to the use of high frequency. According to the results obtained on the 5G, the use of mobile network frequency presents no risks compared to other equipment that humans have been using.*

*Therefore, despite the research results, it is still too early to point out possible damage over the years with the use of this technology, not ruling out possible consequences.*

**Keywords:** 5G; Electromagnetic waves; Millimeter waves; Mobile Network;

## 1. Introduction

Although we cannot see them, electromagnetic waves are part of our daily lives, either in a natural way, such as light from the sun's rays, but also electronics such as microwaves, Wi-Fi networks, television, smartphones. Like the other examples cited, mobile technology also ensures the propagation of these waves. In recent years 5G technology has gained more and more shape and name in the telecommunication market, providing benefits and improvements of use, as well as integrating new technologies and equipment.

Like previous mobile technologies, 5G relies on signals carried by radio waves across the electromagnetic spectrum transmitted from an antenna to the cell phone. The 5G uses higher frequency waves than previous mobile networks, ensuring a much faster speed as well as allowing devices to access the internet simultaneously.

However, data indicate that this technology could cause serious problems for those exposed to this type of wave propagated by it, and could affect nearby animals, according to the "alternative" medicine site Health Nut News, reporting the alleged deaths of hundreds of birds in tests conducted in a city in the Netherlands, as well as other animals subject to such consequences, such as bees, or even humans, according to the International Cancer Research Agency, linked to the World Health Organization (WHO). , has since 2011 classified electromagnetic fields of radiofrequency as "possibly carcinogenic to humans", with long-term damage to cells, causing modification of their DNA.

In Brazil, although it does not currently have 5G facilities, and with its forecast only for the year 2020, tests are already planned and some have already been conducted through the Chinese company Huawei, with local operators in some cities like: Sao Paulo, Rio de Janeiro, Fortaleza, among others. However, in the state of Santa Catarina a bill has already been made to prevent testing in the capital, Florianópolis, being the same being under analysis, alleging the possible consequences that both inhabitants and animals may have when exposed. waves from fifth generation mobile technology.

From another point of view, in the international scenario, in first world countries like China and the United States, they are a few steps to introduce the 5G once and for all. However, in another, as in South Korea, it is already a reality where the benefits that this technology brings to the social environment and technological development are clear, guaranteeing the exclusion of any consequences to those that are subject to the use of 5G until the moment.

However, studies will be presented on 5G technology, as well as comparing it with other means that propagate electromagnetic waves in relation to their frequencies and showing the amount of radiation expelled by each one, demonstrating the load that a body can carry through them without there being. consequences and, finally, to present the results regarding the possible damages, or not, that it can cause in certain environments and who is in them.

## 2. Methodology

The nature of the research will be, at first, done in a fundamental way, seeking more knowledge about the recent 5G technology, since there are many doubts present about this subject, thus obtaining familiarity and understanding of how it works, as well as respect to electromagnetic waves.

Regarding the research, an exploratory study was performed in which the necessary data were collected to obtain results through technical procedures. For this, a literature review was carried out through theorists and scientific-based documents about this technology, specifically seeking data on: frequency, range and amplitude of the wave, as well as data from the following equipment: microwave, radio, television and mobile network.

In the procedure of data analysis, comparisons will be made with other emitting equipment that are part of the social quoted above.

These comparisons used in studies already carried out will demonstrate if this equipment can have a more or equivalent influence with the 5G technology, regarding the radiation levels expelled by them.

According to the results obtained, the approach used will be quantitative, both in the comparison of 5G with the mentioned equipment and in the sampling of the acquired results, which will be presented through paired graphs according to their data, determining to what point and frequency level can be supported or not by a living being, and conclude whether 5G technology is harmful or not.

### 2.1 Methodological Materials

The materials used: research and official tests already done with 5G and the following equipment, such as microwave, radio, television and mobile network. The procedure will be used to show the comparison of technology as this electromagnetic wave emitting equipment, gathering the different data found in our consultation sources and listing the main characteristic factors about them.

## 3. Theoretical Reference

### 3.1 Electromagnetic Waves

Electromagnetic waves are waves formed from the combination of magnetic and electric fields that propagate in space carrying energy. This concept began with Scottish physicist James C. Maxwell, who drew on equations from scientists Coulomb, Ampere, Gauss, and Faraday, giving them a new view and forming a set of four equations that demonstrate the interaction between the electric field and magnetic field and its relationship to voltage and electric current. [16]

There are seven types of electromagnetic waves which are radio waves, microwaves, infrared, visible light, ultraviolet, x-rays and gamma rays. Each of these wave types is classified according to their frequency and oscillation with which they are emitted. [18]

That is, the higher the frequency, the shorter the length of a gravitational wave. These waves are measured by the so-called electromagnetic spectrum. Through this range you can check the distribution of its intensity. [16], [17]

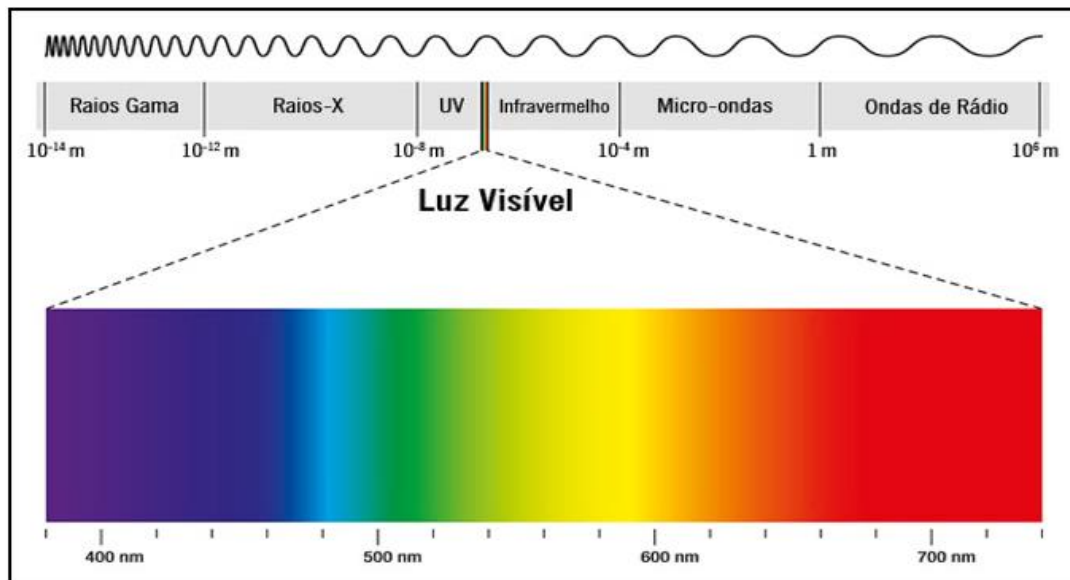


Figure 1 - Electromagnetic Spectrum Source: [18]

Wireless communication technology and mobile networks are increasingly developing with technological advances, bringing improvements in everyday communication, making it common to communicate through various modes, without the need for connected cables. Therefore, since the beginning of wireless communication, there were several ways of signal propagation of mobile network generations, where it began in 1896, developed by the scientist Guglielmo Marconi, who created the first wireless telegraph, that is, sent Airborne messages, better known as radio waves, which are a type of energy that carries electrical signals through the air, thus initiated communication through the air through these waves. [8]

With all this, from there emerged studies and new forms of transmission and creation of mobile networks, these advances also had an impact on society as well as in the health area, affecting the mode of relationship of human beings in their daily lives.

Given the beginning of this wireless communication, generations of mobile networks were created. In the following, we will present a brief explanation according to the arrival of the generations and their main characteristics to the present day.

### 3.1.1 Zero Generation (0G)

0G refers to pre-cellular mobile phone technology beginning in 1970. These phones were generally mounted on cars or trucks, although their installation was in the trunk of vehicles and connected to the interior of the car, having the function of transceiver. (transmitter and receiver), although case models were also made. [9]

The cordless phone started with what might be called 0G if you can remember it back so far. In that decade, before cell phones, there were few mobile operators to set up calls and there were only a few channels available. The technologies used for the 0G system to operate were: PTT (Push to talk), MTS (Mobile Phone System), IMTS (Enhanced Mobile Phone System), AMTS (Advanced Mobile Phone System). [10]

### 3.1.2 First Generation (1G)

The first generation of mobile telephony was characterized by the use of analog signal in its communication form. It was popularized in the 1980s, but only voice communication was employed and has a very poor call quality due to interference with its propagation. [10], [11].

The communication system for its use was called AMPS (Mobile Telephone System), standard used in North America and Australia, around 1983, where the technique of frequency division multiple access (FDMA) was used. Frequency Division), in 284-MHz-894MHz bands and a 30 KHz band frequency modulated channel. [12]

### 3.1.3 Second Generation (2G)

Its implementation began in the 1990s, with the implementation of the digital signal, converting the old analog voice signal to the digital one. Its main standard used was GSM (Global System for Mobile Communication), and was established as the main conversation feature due to offering all the necessary tools to the operators.

This shift to digital technology has influenced the fact that it supports a larger number of users with a much higher quality of communication in the same coverage area. [8], [13].

The main technologies for using 2G were: GSM, GPRS and EDGE [15]. The average download speed provided to users for using each technology was:

Table 1: 2G Downlink Data Rate

Technology	Average Downlink Rate
<b>GSM</b>	10-40 Kbps
<b>GPRS</b>	40-50 Kbps
<b>EDGE</b>	100-130 Kbps

Source: Adapted from [15]

### 3.1.4 Third Generation (3G)

In 1995, the International Telecommunication Union (ITU) defined the third generation (3G) of IMT 2000 mobile phone standards to facilitate growth, increase bandwidth and support more diverse applications. [8], [15]

The main feature of 3G was to offer not only voice services but also data transfer through images, videos and audio.

This generation of mobile network is currently still used by most mobile internet users, including Brazil, the main technologies used for its use were WCDMA, HSPA and HSPA +. [15] The average download speed used by users according to the technologies used were:

Table 2: 3G Downlink Data Rate

Technology	Average Downlink Rate
<b>WCDMA</b>	128-384 Kbps
<b>HSPA</b>	0,3-1 Mbps
<b>HSPA+</b>	3-6 Mbps

Source: Adapted from [15]



### 3.1.5 Fourth Generation (4G)

The fourth generation of mobile network technology has advanced with many qualities over its previous generations, one of its new features being the composition of working via IP networks. This protocol allowed multiple users to access the Internet simultaneously for the use of data, photo and video services and to improve their quality calls from wherever they were. [13]

Its main technologies of use are: LTE, LTE Advanced and LTE Advanced PRO.

Table 3: 3G Download Data Rate

Technology	Average Download Rate
LTE	5-12 Mbps
LTE ADVANCED	Undefined
LTE ADVANCED PRO	Undefined

Source: Adapted from [15]

### 3.2 5G Network and Its Operation

With the arrival of the fifth generation (5G), all its infrastructure will be adapted and expanded for the operation of the new generation, that is, already being coupled to existing antennas, because the 5G technology still depends on 4G.

The 5G will be a more powerful, faster, smarter and more efficient mobile phone network. One of its main features will be broader coverage for users, able to control connected devices such as smartphones, appliances, cars, presence sensors, security and lighting, supermarket cashiers, restaurants, among others.

It will also enable higher throughput (greater than 10 Gbit / s), lower latency (under 1 ms), high reliability, higher connectivity density and greater mobility than previous technologies. To support a wide range of services with varying performance requirements, 5G networks require a scalable, adaptable, and programmable mobile network architecture.

As in previous versions, 5G will be propagated by electromagnetic waves, being differentiated by increasing the fourth generation (4G) band frequency.

In 4G, the bandwidth was approximately 2 - 8 GHz. Serving dynamic information services, HD broadcasts, simultaneous accesses, video calls, among others. 4G now has its core network by IP, different from 3G, which worked by packet network.

With 5G technology, in turn, it will have a very significant increase compared to previous versions, and its frequency will be approximately between 600 and 700 MHz, 26 and 28 GHz and 38 and 42 GHz, working via network over IP and 5G interface. network (5G-NI) to serve millions of simultaneous accesses.

#### 5G network interface

For an adaptation of the 5G network, it will be necessary to use new technologies capable of supporting all the necessary requirements of access to the great demand of services, aiming at the improvement of higher speed, lower latency, increased transmission frequency, thus demonstrating better efficiency.

regarding the use of previous technologies. Below are the technology standards created and used for 5G:

### **3.2.1 New Radio NR (5G NR)**

A standard mobile network access technology called 5G NR (NEW RADIO) was created, this new technology was created by 3GPP to become standard in the use of 5G mobile network technology. It is currently improving, making use of other technologies, with new features, modulation, architectures and spectrum.

Here is the flexibility to support multiple bands, including two frequency bands, which are: FR1 which will operate below 6GHz, and FR2 which includes frequency bands between 20 to 60 GHz.

These frequencies include mmWaves bands (millimeter waves) for the first time that will be implemented with massive pampering technology infrastructure that will produce much larger bandwidth, facilitating the formation and direction of the radio beam.

With the new frequency ranges, the range is limited to a certain transmission power, ie, health, safety and environment will be tightened. For this, the 5G NR will use the beamforming concept, manipulate the signals fed and received from antennas, and focus the energy in a specific direction where use is required. This serves to control the channels, increasing accuracy and overall adaptation to different climatic and structural conditions.

The use of this technology facilitates in: [1] [2] [3]

Improves and increases signal coverage for devices that need instantaneous and simultaneous signaling;

Reduces dead spots by avoiding sending signal to places where there is no need;

Improves download / upload throughput.

Massive treat

Infrastructure pampering has drawn attention to addressing 5G technology, as previously mentioned, 5G wants to cater for the higher capacity of higher speed devices, benefiting users with more reliable and faster network services.

MIMO MASSIVE (Multiple Input, Multiple Output), also known as large-scale antenna systems, tends to be the evolution to wireless communication, compared to current 4G technology, which only allows the placement of 8 antennas (transmitter). + receiver) at its base, which would not sufficiently meet the capacity of millions of users connected to 5G technology, resulting in slow access, delayed transmission and reception of information.

Using this technology, the 5G network would use two or more simultaneous transmitters and receivers, allowing data exchange at least one radio channel.

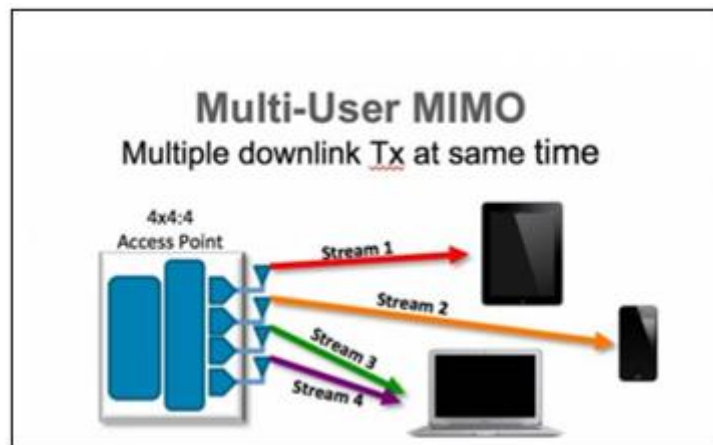


Figure 2 - Scheme of using MIMO technology

Source: Authors, (2019).

thus, looking for the best data traffic path for users, leading to higher performance.

As shown in figure 2, the technology tends to serve multiple connected devices at the same time, which is the equivalent of 4x4: 4, with 4 dedicated transmission, 4 receive and 4 special antennas, maintaining performance and a better flow to connected devices.

Imagine that in a house there are 3 devices capturing 5G signal, targeting access Tablet, Smartphone and Notebook.

Stream 1: Tablet is on a YouTube access.

Stream 2: Smartphone in an online game.

Stream 3: Notebook with access to Netflix.

With the MIMO system in place, the access of each stream would be dedicated to each antenna present in the access point. Thus, there would be no decrease in speed, accesses would be simultaneously unstable. [5]

### 3.3 MIMO System Advantages

As for the advantages of the MIMO System, the 5G has been aiming for higher simultaneous connections, speed and latency reduction, but this will increase the frequency, so the MIMO system will take care of this mobile broadband capacity. propagate your signal over different paths until your end users receive it. Signal receivers gain according to the combination of MIMO system antennas, the composition of these elements offers superior quality to previous generations, thus transmitting higher frequencies of different points mounted according to the signal path, leading to higher reliability. in its transmission. [7]

### 3.4 Millimeter Waves (mmWaves)

Millimeter waves are waves that belong to a part of the electromagnetic spectrum between microwaves and infrared waves, with their wavelengths of 1 to 10 millimeters. They will have to work at very high frequencies in the 24 and 60 GHz bands.

However, we know that the lower the frequency, the greater the range of the signal that will be transmitted, which in this case is contrary to the millimeter waves that operate at these higher

frequencies, which present difficulties in penetration through objects, walls and even the hand in the Signal reception on the mobile phone, to improve this transmission problem, will be made an analysis of the installation infrastructure of the 5G mobile network.

Some of the alternatives designed to deal with these indoor restrictions would be to use signal pickups on the outside and relay internally, which may present a solution to deal with the difficulty of reception indoors with signal barriers.

### **3.5 Interferences**

We already know that the use of this frequency will be used for the first time in mobile network, however, there are consequences that may influence the use in existing equipment and devices, as in the case of weather forecast. This is because the frequency is near and used by satellites that observe water vapor and predict changes in weather, with this influence, it would affect the discovery of more extreme events, because their use is observed to alert people about storms, hurricanes etc. [4]

### **3.6 5G Use Requirements**

According to Ekram Hossain and colleagues in the article “Evolution Towards 5G Multi-tier Cellular Wireless Networks: An Interference Management Perspective” (2014) [7], with the arrival of the new 5G technology, we will have a set of different systems to increase efficiency, but for this to occur there are necessary requirements for its use:

**Latency Data Rate:** The forecast for dense urban areas with 5G networks is that the data rate will be 300 Mbps downlink and 60 Mbps uplink, 95% of the sites.

**Machine Communication Type (MTC) and devices:** The number of traditional wireless devices with internet connectivity (smart phones, smartphones and tablets) can be outnumbered by MTC devices that can be used in vehicles, appliances, home devices. surveillance and sensors.

**Millimeter wave communication:** The increase in traffic and different devices, as well as the increase in services, will consequently require a greater spectral area increase than that allocated for the 4G standard. The solution will be to use millimeter wave frequency bands (28 GHz and 38 GHz) to solve the problem of low spectral capability that allows the transmission of larger bands than the conventional 20 MHz band used by the 4G system.

**Multiple RATs (Radio Technology Access):** The purpose of the 5G standard is not to replace existing technology, but to improve existing technologies such as GSM (Global Mobile Communications System), HSPA + (High Speed Packet Access Network). ) and LTE (Long Term Evolution) providing system evolution for better performance.

**Prioritized spectrum access:** Priority access in both traffic and tiers will exist in 5G networks. This restriction is due to different user needs such as reliability, latency requirements, and power restriction. Layer-based priority is to ensure protection for users who have shared access to the spectrum between larger and smaller cells in a two-tier network, as small cells can create downlink “dead zones” for larger cell users. But the user of both larger and smaller cells will play high priority (HPUEs) and low priority (LPUEs) roles.

**Energy capture for efficient communication:** One of the key challenges of the 5G system will be to

improve the energy efficiency of battery-restricted wireless devices and extend battery life, as well as improving energy efficiency, an interesting solution. will be to capture environmental energies (solar and wind energy). In addition, energy can also be captured from ambient radio signals (RF energy). Simultaneous information and power transfer (SWIPT) are a promising technology for 5G wireless networks, but power capture circuits are not yet available for the conventional receiving architecture and are only designed for information transfer, which may not it works for SWIPT. This impasse is due to the fact that both energy and transfer information operate with different receiver sensitivities (-10dBm and -60dBm), so the solution will be to combine different technologies to capture energy.

#### 4. Data Presentation

Many usual equipment is present in our daily lives. To make the necessary comparisons in the results from this stage, a survey will be made to collect data from the main equipment that emits electromagnetic waves, as well as tests or studies already done with them.

Radio Waves, TV and Cell Phones

In this context, radio, television and cellular equipment, although not having the same type of wave within the electromagnetic spectrum as the 5G technology, operate with waves called radio frequency, where it is common to divide these waves into frequency bands ranging from 3KHz to 300 GHz, see Table 1 for information collected.

Table 4 - Radio, television and cell phone frequency waves.

<b>Equipment</b>	<b>AM Broadcast TV (VHS) and</b>	<b>AM Broadcast TV (VHS) and</b>	<b>AM Broadcast TV (VHS) and</b>	<b>AM Broadcast TV (VHS) and</b>
<b>Frequency Ranges (values)</b>	530 KHz a 1600 KHz	30 MHz a 300 MHz	3 GHz a 30 GHz	300 MHz a GHz

Source: Authors (2019)

Studies carried out through its use, through the International Cancer Research Agency (AIPC), linked to the World Health Organization (WHO), classified, in 2013, radiofrequency electromagnetic fields as possibly carcinogenic to humans. long term. [19]

Earlier in 2012, an independent group called “Bio Initiative 2012” was created, made up of scientists and experts from ten countries (Sweden, USA, India, Italy, Greece, Canada, Denmark, Austria, Slovak Republic and Russia). The possible risks of wireless technologies and electromagnetic fields to human health were discussed. The goal was to develop studies of the growing health problems caused by chronic exposure to electromagnetic fields and radio frequency radiation through equipment used in the daily lives of millions of people around the world. [20]

According to the article “Electromagnetic waves and the impact on human health”, based on the study by the group “Bio Initiative 2012”, the risk of generating brain tumors from radiofrequency waves was presented; cause damage to DNA and genes; of negative effects on memory, learning, and behavior, attention; sleep disturbances; cancer and neurological diseases such as Alzheimer's disease. Effects on reproduction and fertility, fetal and child brain development, and effects on classrooms with children and adolescents were also analyzed. The study is detailed, and the conclusions are presented by areas related to the various aspects studied. Specifically, with regard to wireless networks, the final report warns that the continued release of unrestricted commerce wireless technologies and devices puts global public health at risk unless new precautionary warnings for their use are made. implemented. It also warns that safety standards for sensitive populations will need to be set at more specific levels than for healthy adult populations. Sensitive populations include the developing fetus, infants, children, the elderly, those with pre-existing chronic diseases, and those with developed electrical sensitivity (EHS). Electromagnetic hypersensitivity, then, is considered, although not recognized as a disease. [21]

#### Microwave appliance

The microwave appliance, equipment used to heat food and present in almost all kitchens of the world, is classified within the electromagnetic spectrum by presenting waves called microwaves, these waves have a frequency range of 1GHz to 300 GHz. The frequency used in the device itself acts in the range of 2.45 GHz, enough to make the molecules vibrate at the same time, generating heat, releasing it and heating the food. [22]

Studies conducted by WHO (World Health Organization) show that through its internal structure and the material used to inhibit the propagation and reflect the waves generated by the device, the microwave does not pose risks to human health, nor does it allow The radiation used for heating remains in the food, because the heat is generated by the agitation of the water particles present in the food, and not by the absorption of the rays generated by the waves. [23]

According to an article from the “Mundo Boa Forma” website, it shows that a lot of research shows that the microwave cooking process can affect many nutrients present in food, mainly due to the heating that occurs. Some vitamins are sensitive to heat, such as vitamin C, which can be degraded during the process. Proteins are also greatly affected by heat and may decompose.

A study published in the Journal of Agricultural and Food Chemistry showed the effects of microwave heating such as the loss of vitamin B12 in some foods, including raw meat, milk and pork. The results of this study showed a 30% to 40% reduction in this vitamin when food was microwaved, with a vitamin shift to an inactive form.

The truth is that saying that microwave food is bad is a myth, because there is no accumulation of radiation in food, there is only the loss of some nutrients, damaging their nutritional value. That is, the food can be consumed safely and safely, being only with a smaller amount of nutrients, which will be damaged by heat. [24]

## 5. Results

Being located in the magnetic spectrum between infrared waves and microwaves, the millimeter waves

used in 5G, in relation to other equipment cited in the research presents the following data:

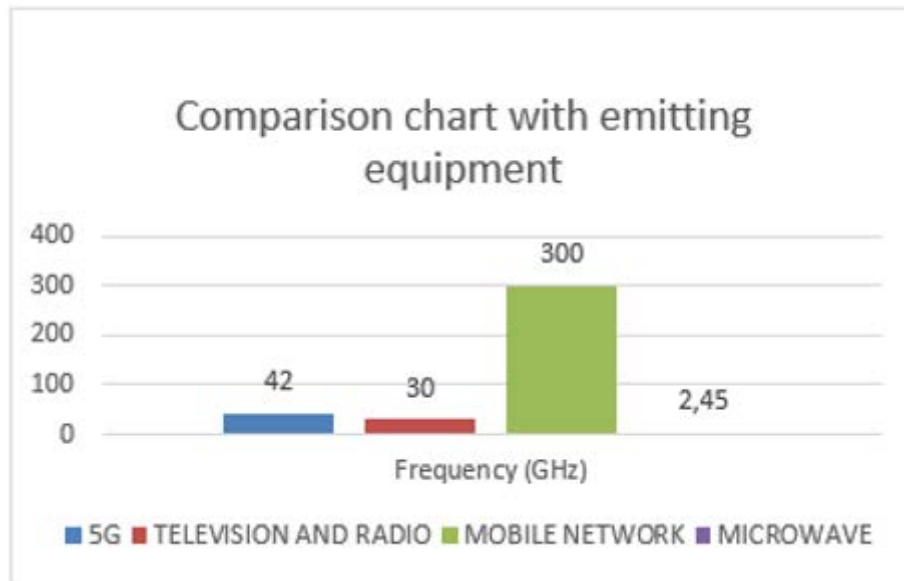


Figure 3 - Comparison with emitting equipment

Source: Authors, (2019).

As the graph above shows maximum frequency values that each element can reach. Indicating higher values that mobile telephony can reach, being 5G besides having individual data in the graph, it is contained within it indirectly.

Compared to the microwave data where they have the minimum values, there is a big difference compared to 5G and even other equipment.

Based on the data collected and studies done during the research, it shows that 5G technology has great potential to cause cellular degenerative diseases in the future, because as shown, the frequency range that a mobile network can reach is quite high in relation to other equipment, besides studies by international organizations show that this type of wave, which is constant in the daily lives of humans, showed possible significant results in the area of medicine and causes of cancerous diseases.

## 6. Final Considerations

The benefits of this generation of mobile networking in all areas of society are notorious, as well as opening up to new technologies, possibilities, ideas or projects, and existing process improvements. But one should be wary of the possible negative consequences it may have on those subjects to exposure over the years.

It is concluded, therefore, that based on the results obtained through comparisons made with other equipment, 5G technology does not present risks to humans, depending on the frequency variation to be used, cited during the research. However, as it is a very recent technology and still does not have a worldwide coverage area, in some countries only, it is still too early to reach conclusions of possible long term consequences, and the possibility of presenting risks during constant periods is not ruled out. exposure periods in the future.

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## Editorial

### Dear authors, reviewers, and readers

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to **THE VOL-7, ISSUE-11 of IJIER** which is scheduled to be published on **30<sup>th</sup> November 2019**.

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We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

Thanks,

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# **Mobile Android APP Proposal Using an Inventor Platform Applied to Energy Efficiency and Sustainability**

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## **Abstract**

*This paper reports on the implementation of the efficient Manaus project, with the objective of developing a mobile application that expires on energy saving, related to environmental issues, since energy production, advanced natural resources. This application is designed to be used in a residential unit to provide residents with information on formula applications that explain the generation and energy expenditure of household electrical appliances, use or usage tests, and usage of the device. lowering values and minimizing the use of environmental resources. Thus, through a process of raising awareness of the knowledge gained from research in recent years, as well as providing quality content and ease of access, use the Google platform "APP INVENTOR" as a framework for testing results. Therefore, compile information on the best use of energy from a variety of information, including the elaboration of a Quiz, which addresses questions such as: where does electricity come from; tariff flags; efficient equipment; and electricity security, implemented in the application where they were supported by tools such as cartridges, and information from the agencies that reference each of these themes. This mode generates positive expectations for the future, which can create numerous other applications with information that helps to understand products, processes, changes in the sustainability context, to minimize impacts by new technologies.*

**Keywords:** APP INVENTOR; Technological development; Natural resources;

## **1. Introduction**

Human evolution proceeded rapidly, changing the ways of man, who stopped the habit of hunting during the day and sleeping at night soon after discovering fire, the first artificial way to produce lighting and air conditioning systems. However, this mode of illumination has brought great benefits.

Various types of handcrafted inventions that made life easier were hand-held, today they have become complex equipment that works by means of electricity. In this way there was an increase in electricity consumption and to meet the needs there was also an increase in the use of fossil fuels to generate energy, world crises that reduced this consumption and consequently world crises that showed the sensitivity of production and forced to reduce consumption. .

This was only possible with environmental awareness projects, energy efficiency, ABNT NBR standards, and ISO, PROCEL, INMETRO certifications, where without technical and scientific monitoring in the elaboration of such items, it would not be possible to obtain an improvement in the projects, current products and services.

Due to the growing demand of the population for many products and processes even with interventions, the lack of supervision causes urban centers to grow irregularly.

The energy crisis that occurred in 2001 caused the population and the government to look for alternatives that would be beneficial and consequently reduce their expenses in the generation and consumption of electricity. Thus, it seeks to reduce consumption, increase the appreciation of real estate and safety against: shocks, short circuits and bad weather. Therefore, through this information is justified the creation of an application to facilitate access to information, which is often difficult to access or understand, to monitor all consumption of energy use.

Thus, given the current need for effective energy efficiency in the residential sector, proven by the lower investment cost and less polluting when compared to the generation of energy obtained from fossil fuels (current matrix) can be diagnosed and created mechanisms for the planning of power generation and equipment, economically viable in order to collaborate with the environment.

We cannot talk about sustainability without presenting the whole process of change that began in the eighteenth century with the industrial revolution, replacing such crafts with machines. It is currently undergoing new changes, replacing the man who complemented the work, linked to the reduction, indicating a new change of habit.

This change in habit, given sustainability, arose in Stockholm in 1972, at the UN conference on the environment, in which Brazil participated, based on contrary ideas from international demands, for new methods to mitigate the environmental damage caused. However, the scenario of the time was alarming and generated protests and news on journalistic pages, such as the change in the color of the sky, waters outside of potability standards, crisis in public health, damage to fauna and flora (DUARTE, 2015).

Between sustainability and profit the Brazilian industry, the country always aimed at profit without caring about sustainability, indicating a process of returns. However, the population, especially those who lived around the industries, felt harmed and the industry was forced to change its practices, reinforced by the Brundtland report of 1987, which at the time was innovative, thus showing the first signs. of the economic tripod, which characterized the economy, the environment and society, presenting a perfect

symbiosis for industrial evolution as a whole.

With the increase in the life expectancy of the population came the exponential increase in the value of energy, food and environmental impacts, as well as the technological dependency of developed countries, generating indebtedness that keeps underdeveloped countries without credit, reducing investments and innovations, highlighting the chaos in the economy, tending to slow growth. In this context, the world must revise its model of unbridled consumerism habits that generates increase in production and reduction of natural resources (MARTINE; ALVES, 2015).

In the 1950s, research was already being done on the population's consumption habits, mainly coming from the family itself. However, what really influenced and impacted the change in behavior was the massive dissemination in the media, in which there was exposure of products that facilitated manual labor, highlighting the need to obtain that product in past decades, which lasted for years. However, they have been replaced by increasingly less resilient products with a shorter shelf life, forcing society to consume increasingly using limited resources.

This formation of the consumption habit begins in childhood, which regardless of social class, impacted by the media, the society that teaches how to consume and the family that has been influenced by other generations, generating a vicious cycle between different times (PASDIORA; BREI, 2014)

It should be noted that the great and impacting destruction of natural resources is increasingly being done in the same condition in current history and by applying it we will have less than 1% of human history, which is already questioning: if we have the same From time to time, will we be depleted of resources or evolve to positive technological development? Thus, the favorable prospects towards sustainability should be targeted, even if gradually.

The joining of several notable inventors has generally contributed by making a specific technological leap, playing an important role in today's society. This technological impulse has changed the perspective in the social and marketing areas, either through the rush of new development techniques or the change in society's habit associated with products and services, which occurs surprisingly and quickly (LARA, 2017).

Massive industrialization in the nineteenth and twentieth centuries, with still little related research, and the lack of technology in the twenty-first century brought about an unpleasant reality of the inherited impacts of the past two centuries. However, in recent years, with the increase in sustainable technologies and practices that the industry has been adopting including the valorization of companies that use these means, it is possible to critically observe companies that do not follow these standards and that are basically obliged to plan change to reduce impacts, generating expectations of change.

However, many midsize and small businesses fail to follow these environmental practices, due to the cost of implementation, and the reliance on larger companies seeking certification, especially suppliers of raw materials, service providers that are forced to obtain these standards. to enter the international market, indirectly causing the search for standardization to ensure in the market.

Importantly, in order to contribute to competitiveness, as well as to receive economic benefits and favorable results for an efficient environmental management, it is necessary to produce good “eco-innovation” strategies and to list the factors arising from these decisions and organizational objectives (CROTTI; MACANEIRO, 2017).

The main changes evidenced occurred more frequently in large companies, such as standard procedures for systematic quality control, quality management and environmental management (TAHIM; DAMACENO; ARAÚJO, 2019).

Not only has industry been standing out as a sustainable practitioner, but society is aware that it has an important role to play in the changes that have taken place over the last decades, not only by trying to have environmental practices, but by highlighting the possibilities for savings, especially in the electricity sector, one has the biggest expense and one of the biggest technology developers. Today, man is becoming more and more energy-dependent, and able to have good practices and efficient product development to ensure the use of resources for future generations.

However, Brazil suffers major difficulties in research and technology development, making it less and less competitive, weakening the industrial sector in this development process, making the evolutionary and competitive process in the international scenario difficult (LOPES, 2018).

Brazil awoke to the real importance of energy efficiency in the 1980s where exactly in 1981 the CONSERVE program was created and the following year the energy mobilization program; In 1985, the National Electricity Conservation Program was implemented. in 1991 the national program to ration the use of petroleum derivatives and natural gas; and finally, the national energy policy in 1997.

Even with the national energy policy came the 2001 crisis, which originated Law 10295/01 that deals with the conservation and rational use of energy and soon after the decree that indicated the maximum levels of energy consumption and the minimum of efficiency. energetic.

To encourage practice in 2009, commercial, public and service buildings could be certified through the energy efficiency certification program. The electricity sector made a significant advance in 2012, which with the electric power compensation system was able to generate its own clean and renewable energy, releasing a fraction of the system and favoring incentives in micro generation, which through resolution 687, No. 482 , updated in 2015, increased this generation and the duration of the credits.

Almost five decades after the introduction of energy efficiency laws and incentive programs, Brazil is far from being an example to be followed. To avoid the risk of a possible suppression of supply, priority should be given to the development of stricter energy conservation laws, encouraging rational use with a primary focus on industry modernization and policies to combat waste (ALTOE, 2017).

One of the main focuses on reducing environmental impacts, which encompasses a wide range of practices that can be evidenced in modern society, culminates in the process of energy efficiency, becoming one of the most economically viable means for current solutions.

Another reason observed in this process, given that there is an increasing concern about the rational use of electricity, given that government funds are becoming smaller in the electricity sector and that are in opposite flow to population growth, becoming dependent on the means. energy sources (SALVATERRA, 2016).

In a residence, several items can be pointed out so that a good practice of energy efficiency can be worked on, and become solutions for a better efficiency to adapt such measures.

According to COPEL (2019), the three largest consumers of electricity in a residence in 2011 were electric shower, lighting and the refrigerator, highlighting these items, comparing them with the changes that occurred from this period to the current one. such as air conditioners, which relatively have a

significant portion in a residence.

Current data provided by the Climate Observatory website (2019); it is noted that air conditioners currently top the list of the largest consumers. With warmer summers, the use of this device is increasing, its demand is expected to triple by 2050 as well as the use of new technologies such as computers, video games, SMART TVs, facilitating the use and installation of these devices, adding more and more load. in domestic demand.

What can be changed quickly and safely without any third-party workmanship are LED bulbs, which are increasingly present in the market, and where most come with socket pattern E27 that can be easily replaced by removing the higher consumption value, such as incandescent and fluorescent, as stated by Santos et al. (2015). The LED provides an absolutely cost effective duration, lasting in hours that can reach 50 thousand hours, and a consumption of up to 82%, greater than an incandescent one.

Currently LED lamps are becoming more and more viable, a few years ago a lamp with a poor lighting was around 150 reais, currently a lamp with a very good efficiency around 810 lumens costs an average of 10 reais (free market). , 2019), this is positively beneficial, as increases in the brands that make the lamps generate competition and low prices, thus helping ease of purchase, contributing to the energy efficiency of a home.

Another highlight, due to the increasing artificial demands, are the air conditioners, which obtained an exponential increase due to the high temperatures, mainly due to the heat islands as evidenced by Correa (2016) in studies that report the temperature differences in urban environments. , contributing to the increased use of these devices.

Demand for artificially acclimatized environments causes a large external impact that due to heat exchanges increases the volume of temperatures outside controlled environments (Kruger and Drach, 2017), this increase decreases energy efficiency in less efficient environments around them, because as stated by Brugnera (2019), depending on the variation of external temperature, high indices, and an increase in energy consumption.

Evidencing this fact we can mention several programs, websites and methodologies that help in the assessment of consumption, energy efficiency, methods and habits that reduce the impact on the environment, however often these technological resources are scattered and are hardly in one model, in this In this context, we sought to create from the "APP inventor" a web platform that creates applications via android (ANDROIDPRO, 2019), which reports on the ease of producing applications that help people's lives, knowledge about energy efficiency and their understanding. from the environmental need, where it can be predicted expenses.

## **2. Materials and Method**

An exploratory analysis was used to elaborate an application, where from the data collection, mechanisms were created for the use of energy production information, characterizing the quality of electric energy per device, addressing the themes of energy efficiency. , power generation, interactive quiz, safety tips.

We used the program "APP inventor", a platform from Google, which compares an irregular residence

with one that follows the efficiency standards, addressed in the mobile application.

The choice of the “inventor APP” was due to the ease of programming, where you do not need to have experience with programming language, because it works with assembly of blocks, including the option of interaction of assembly in real time, with the Smartphone via USB or QR-code, for easy layout of the application interface.

Information has been implemented based on regulatory standards that may highlight the real importance of installations in ABNT NBR 5410 standards and the correct management of energy using ISO 50001 energy efficiency and booklets.

### **3. Results and Discussion**

To create in the "inventor APP" there are four main tabs that showed you step by step: the first is the main palette, where you can find all the content that can be added to a screen: how to insert screen image, subtitles, lists, buttons, among others; All of these items are attached on the viewer tab, where you have a simulating screen, on a smartphone. All created content stays on this screen to make adjustments. As needed, the remaining two tabs correspond to components and properties, where you can insert the images contained in your gallery, change letters, colors and sizes of the selected items.

The programmable main part is in the block part, where clicking on it changes the screen layout, without this part you cannot “run” the application on an android system. In computing several commands are used to program, however in the "APP inventor" to be didactically effective separates the main content, control, logic, math, text, lists, colors, variables and procedures, where the entire application revolves around these items.

For the creation of the application, the main items will be the organizers, images, captions, buttons, creating several screens with educational and technical content, and in the programmable part, will be used a set of controls and texts, in which the main controls will be the buttons where clicking will direct the user to other content screens, and the text to specify the selected screens. All content will be programmed automatically with the help of logic blocks.

Finally, upon application completion, what will be learned from the information available when using the application from a quiz with questions related to energy efficiency to know if the application will have a positive effect on the social and environmental.

The present generation lives immersed in the technological world, and increasingly moves away from the physical means of obtaining information. Based on this precept, the creation of digital content focused on a topic of relevant importance, energy efficiency, to indicate the impact on the use of natural resources.

Currently, the energy issue is in the opposite direction of the environmental area, where it is necessary to implement means to educate, aiming at the interests, which seeks the reduction through tools that facilitate the conscious use of this resource, reducing its impacts on the environment (BALLESTEROS-BALLESTEROS; GALLEGU-TOWERS 2019).

To this end, the application entitled “Manaus Efficient” becomes a useful tool for reducing the impact on the environment, where it seeks to guide users to have practices in the digital environment, leading to the physical reality, the relationship of rational use of energy with the environment. use of natural resources



and financial losses if this does not occur (Figure 1).

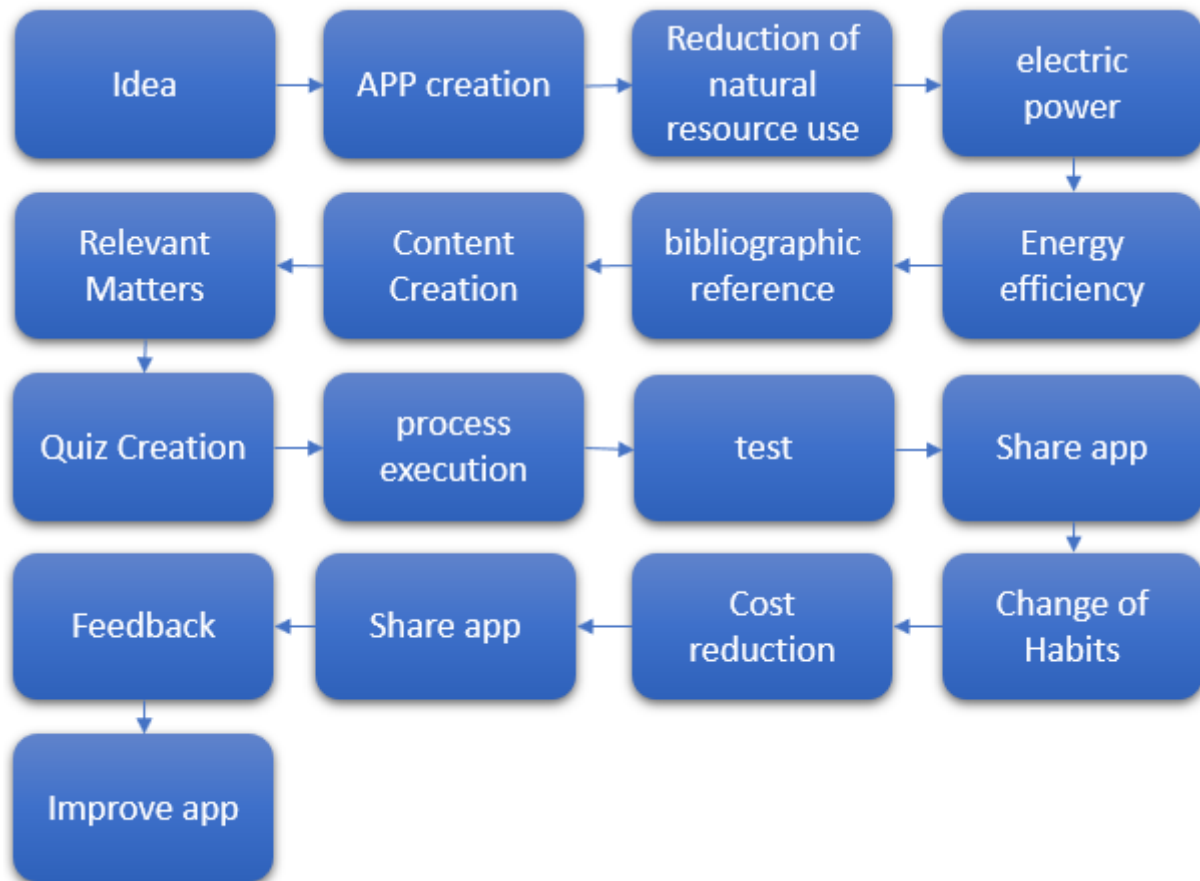


Figure 1. Efficient Manaus APP Creation Flowchart.

SOURCE: CASTRO (2019)

According to Rodriguez-Gomez (2019), the speed with which new technologies are advancing and with an increasingly connected world, where acceleration is faster than our thoughts. We must harness these resources for sustainable development, where we can face the world's high progressivity without impacting resources.

Thus the “Manaus efficient” application was developed in the middle and with digital reference, seeking to benefit its users through the mobile platform, benefiting from the internet of things (IOT), especially given the great use of this medium, which is currently had. as essential.

Increasingly we must look for ways to facilitate the processes, being able to highlight any and all areas, the ease and quantity of platforms that help to put ideas into practice, and each one should develop these practices, especially in the environmental area, where One can highlight the environment of the playstore, which even with few tools that help in the issue of energy efficiency, where the theme is directly related to the use of natural resources, can create new creative tools and make it available in the market quickly. and efficient.

#### 4. Conclusion

The development of the present study made it possible to analyze the different contents about the tools

for using energy efficiency, the facilities and obstacles found in developing this content, and the use of didactic resources to assess its learning. In general, there are many difficulties in addressing important topics, besides the lack of interest and even the difficulty of obtaining these tools contributes to this statement.

The elaboration of this tool facilitates the interest on the subject and adds up to the few contents available in digital media, helping in the development of best practices and collaborating for new ideas that reduce impacts.

Given the importance of these models and / or tools generated, it is necessary to continuously update the theme and other contents, which can guarantee the quality and advances without impairing the efficiency of the model, in accordance with the need for understanding the consumption and energy demand and the use of natural resources, benefiting society.

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## PDCA Cycle Application in the Beer Filtration Process

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### Abstract

*The brewing process requires that the manufacturing of your product be done and controlled in such a way that the entire characteristic of the product is preserved from receipt of raw material to finished product. Thus, this work aims to propose actions that allow identifying possible critical steps of oxygen increases during the beer filtration process. Using the PDCA cycle methodology to analyze possible failures, be it people, management or equipment, and seek improvements through the analysis and monitoring of objective actions capable of identifying and addressing all problems at the process stage, thus ensuring, improving the sensory quality of beer and producing with, lower dissolved oxygen content. The PDCA cycle will be used because it is a sequence of activities that are cyclically performed to improve activities and continuous application and allows a real use of the processes generated in the company, aiming at reducing costs and increasing productivity. Therefore, the scientific problem of this work refers to the evaluation of points of the manufacturing process that causes premature aging and oxidation in the produced beers.*

**Keywords:** PDCA, Process Flow and Process Mapping;

### 1. Introduction

The structure of a company in the brewing process is divided into three major stages: Manufacturing, in order to obtain results that help achieve the main objective of this work, the following actions were defined: Map all the most critical points that are within reach. to do without the investment requirement and identify and budget the others that need to invest to improve the process: Identify the possible

failures in the brewing process by applying auxiliary tools and quality tools with (PDCA): Follow up how often problems occur in the process: Standardize and revise operating procedures and train the entire operation so that everyone can perform the activities in the same way and identify, evaluate and bring effective solutions to each problem if it occurs:

Standardize actions through preventive maintenance procedures and operational standards. The PDCA cycle is defined as a sequence of activities that are cyclically traversed to improve activities and continuous application and that allows a real use of the processes generated in the company, aiming at cost reduction and productivity increase. (planning), Do (check), Check (check) and Act (act) and is related to the philosophy of continuous improvement.

Thus, the general objective of this work is to propose actions that allow to increase the sensory quality of the beer ensuring the production of beers with low dissolved oxygen in the finished product, analyze the possible failures of people, management or equipment and seek the Improvements through analysis and monitoring of objective actions capable of identifying and addressing all problems in the brewing process, thus ensuring the improvement of the sensory quality of the beer and producing with lower dissolved oxygen content.

## **2. Theoretical Reference**

### **2.1 PDCA**

#### **2.1.2 PLAN**

The cycle begins with defining a plan based on company guidelines or policies. At this stage you choose a process or problem to solve, which can be an activity, assembly line, method, etc. This phase, according to Campos (2004), is subdivided into five stages:

Problem identification: This is performed every time the company encounters an undesired outcome (effect) from a process (set of causes). B. Set Goal: The problem will always be the missed goal, the difference between the current result and a desired value called the goal. Every goal to be defined should always consist of three parts - management objective, time frame and value. ç. Phenomenon analysis: detailed analysis of the detected problem and its characteristics, through facts and data collected. d. Process Analysis (Causes): Search for the most important causes that cause the problem by analyzing the important characteristics. and. Action Plan: This is the product of the entire process for the PLAN stage, which contains, in detail, all actions that must be taken to achieve the initially proposed goal.

#### **2.1.3 DO**

Execution of the plan consisting of training those involved in the method to be employed, the execution itself and data collection for further analysis. This stage, according to Campos (2004), is subdivided into two: a. Training: when the plan is disclosed to all involved prior to execution; B. Action Execution: when the plan is executed. During this execution periodic checks should be made to maintain control and eliminate any doubts that may occur throughout the execution. All actions and good or bad results must be recorded to fuel the next step of the PDCA cycle.

#### **2.1.4 CHECK**

It is the analysis or verification of the results achieved and data collected. It may occur concurrently with the realization of the plan when it is verified whether the work is being done properly, or after execution when statistical analysis of the data and verification of control items are performed. In this phase errors or faults may be detected.

#### **2.1.5 ACT**

Characterized by the corrective actions, that is, the correction of the failures found in the previous step and the process of standardization of the actions performed, whose effectiveness was previously verified. It is at this stage that the Cycle begins again leading to the process of continuous improvement.

Therefore, the scientific problem of this work refers to the evaluation of points of the manufacturing process that cause early oxidation in the produced beers.

The Planning step (P) is intended to list the objectives to be achieved in the process, to decide on the methods to be employed to achieve the established goals. ALVES, EAC. PDCA as a routine management tool. In: XI National Congress of Management Excellence. 2015. p. 1-12.

#### **2.1.6 The Diagram of Causes and Effects**

It is the representation of the possible causes that lead to a certain effect. For the authors Paladini (2012) and Carvalho (2012) the diagram which is known as herringbone chart or Ishikawa diagram, reference to the Japanese engineer Kaoru Ishikawa (1915 - 1989) who created this diagram in 1943. The purpose of this tool It is analysis of the operations of the productive processes.

Cause groupings are established by similar categories or observed during the classification process. The cause and effect diagram can be used to verify and identify the factors that will influence a job to be done, as a proactive way to anticipate problems and challenges. It can also be used to identify where project control efforts will provide the most value: what should be measured, when, how, etc. (MULCAHY, 2013). In reactive work, you can help solve the problem quickly and effectively instead of using a contour solution whenever the problem occurs.

BUCHELE, Gustavo Tomaz et al. Analysis of empirical qualitative articles on methods, techniques and tools for innovation. RAM. Mackenzie Administration Journal, v. 16, no. 3, p. 136-170, 2015.

#### **2.1.7 The Flowchart**

It is a graphical representation that allows the easy visualization of the steps of a process. According to Juran (2009) most flowcharts are built from a few symbols. The flowchart begins with an issue / problem / mission / project that needs treatment or care within a team or organization (SHETACH, 2011). Graphically, flowcharts are the heart of business process mapping Barbrow and Hartline (2015). A flowchart where roles are assigned indicates a process map consisting of shapes representing different elements of a workflow.

#### **2.1.8 The Pareto Chart**

It is a bar chart made from a data collection process and can be used when prioritizing a problem or

situations related to a particular subject. The methodological perspective of this research turns, according to Padua (2004), to the solution of problems such as search, inquiry, investigation, reality inquiry.

### **2.1.9 Process Mappings**

A widely used tool for standardizing work steps, identifying opportunities for process improvements, but taking into account the complexity of each structure to be analyzed. Thus its objective is to bring improvements to identify bottlenecks, delimit functions and roles and measure process performance. In a broader approach, Oliveira (2007) defines process as a set of sequential activities that are logically related to each other, with the purpose of meeting and, preferably, supplanting the needs and expectations of the company's external and internal customers. In this sense, Barbrow and Hartline (2015) point out that processes map delays and execution problems, and display information about workflows in a format that allows managers to make evidence-based decisions. To map a process is to make an initial design, observing how a succession of activities are performed and interrelated.

## **3. Tools and Methods**

Using the Process Mapping tool, it was possible to survey the data and identify the most critical stages of the brewing process. Through the flowchart, the evaluation of the criticality of all stages, especially those with the most problems, was broader.

The Pareto Graph showed that the collected data were essential for prioritizing the problem encountered. In this item will be presented the application methods of the PDCA tool as a beer filtration process management system in a brewery, and it is located in the city of Manaus Amazonas. The PDCA cycle lasted five months. The methodology was applied from June to November 2019 and the initial analysis was made taking into account the data from January to May of the same year. To start the application of the PDCA tool it is necessary to have a knowledge about the industrial production process of the brewery in which the methodology was applied. The brewery under study has an engineering area that is responsible for the planning and control management of preventive and corrective maintenance of the other areas, including the brewing process area. The equipment has specific periodic maintenance plans that can be preventive inspection, cleaning, lubrication and retightening of technical level to operational parts. In the brewery studied, the main indicator linked to product analysis is the tasting called sensory analysis. There is also the use of the quality tool Ishikawa Diagram, also known as Cause and Effect Diagram, in order to organize the reasoning in discussion of the problem addressed in production, to survey and visualize the root causes of the problem and to identify possible corrective and preventive solutions. . The flowchart tool aimed to show the stages of the manufacturing process defining each activity and its importance in the increment. The planning stage was divided into problem identification, observation and analysis.

## **4. Study Application**

### **4.1 Check**

Through the survey in all procedures of beer filtration, especially in the stages of dosing of inputs or

some inputs during the process. At first it was identified that we had failures in the functional part of the equipment called Deaerator, where these failures were responsible for the high oxygen content to the storage tank from which it was dosed during beer production and filtration and in the period. From January and February the results were well above target, and ideal for production use.

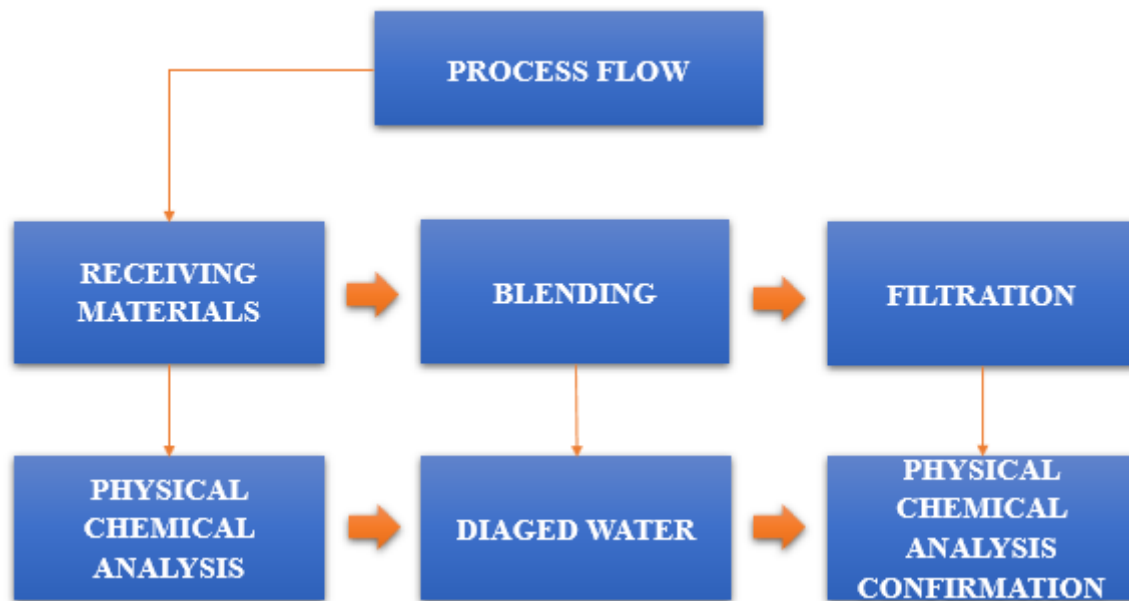


Figure 01- Old beer filtration flow.

Source: Adapted from AMBEV (2019).

The problem was identified through a tasting sensory analysis where it was found the presence of high oxidation in the product, the high oxygen content in the product is one of the main causes for the early aging of beers, thus not reaching its stability in the market. These same defects were also identified by the brewer's internal tasters not only oxidation but at least two more, but the focus for elimination was all on incorporating oxygen content into the process from maturing beer transfer, receiving, filtration, blending and storage. shipping to production lines. As first steps of the improvement work, several analyzes were carried out in the field with the aid of equipment available from engineering, analyzes carried out since receipt, filtration inlet and especially after blending with deaerated water, the main focal point of oxygen incorporation. During this stage it was also identified that there were many leaks in the equipment heat exchanger plates due to failure of preventive maintenance, problems that would be crucial for contamination during water production and its use during the beer blending process. The following table shows the accumulated average of the week, where the ideal would be a maximum of 12.00.



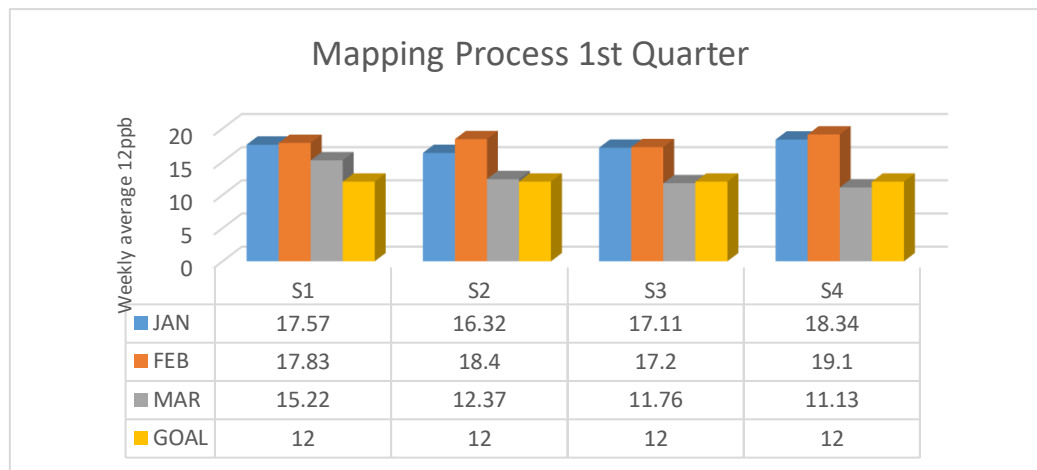


Figure 02: Identification of old process results

Source: Adapted from AMBEV (2019).

## 4.2 Improvement Proposals

### 4.2.1 Act

At this stage of analysis, the keyword will be Why. The challenge was to find out why the problems are happening in those foci identified in the observation phase that are the root causes. And for that it was necessary to know the process flowchart to understand the impact caused on the final product produced. This phase of the PDCA is characterized by the corrective actions, ie, the correction of the failures found in the previous step and the process of standardization of the actions performed, whose effectiveness was previously verified. It is at this stage that the Cycle begins again leading to the process of continuous improvement. ALVES, E. (2015). PDCA as a routine management tool. In XI National Congress of Management Excellence (pp. 1-12).

The planning proposal for the solution of the problem was to survey all the material needed to perform a general maintenance of the equipment. For this, the technical part of the engineering involved the identification and urgent purchase of the parts that had not been available in the warehouse.

Schedule a break of at least 48 hours for maintenance of the equipment.

### 4.2.2 Plan

The planning step was based on the hidden risks of the equipment, evaluation of the possible problems to be encountered during long equipment shutdown, this involves the risks of not coming back in good efficiency, not delivering volume to the lines, breaking any parts. at the time of disassembly of equipment to remedy the leaks. Assessment of the best form of execution of the actions and their distributions during the maintenance and the actions directed to each owner with deadline for execution.

### 4.2.3 DO

Polacinski, et al (2012) describe that the tool consists of an action plan for pre-established activities that need to be developed as clearly as possible and maps them out through the central objective of the 5W2H tool, which is to respond to seven basic questions and organize them.

Nakagawa (2014) states that the tool is useful in its use both to implement simple, everyday company

decisions and to be useful when coupled with other analytical tools or plans that require action, as well as in situations involving the implementation of several decisions.

For Candeloro (2008), the 5W2H tool is a kind of checklist used to ensure that the operation is conducted without doubt by managers and employees. The 5W corresponds to the following English words: What (what); Who (who); Where; When and why. The 2H are: How (how) and How Much (how much). When defining an action that should be taken, a simple table is developed applying 5W2H, according to table 4, where questions are arranged and what is expected of each one. DE AVILA NETO, Clovis Antunes et al. Application of 5W2H for the creation of the internal work safety manual. SPACIOS Magazine | Vol. 37 (No. 20) Year 2016, 2016.

For the organization of the actions generated from the 5 Whys done in the previous step, a technique called 5W2H was used. In addition to organizing the actions, it also defined the owners or those responsible for them, the end time, who was trained, the place of training and the financial cost. Basically it was to implement all actions generated from the action plan in a short term of 4 months and as effectively as possible. So it was important to prioritize the treatment of risks, ie prioritize actions.

Table 1: Generated Planning Action Plan

<b>Action Plan Generated in Planning</b>				
<b>Action</b>	<b>Who</b>	<b>When</b>	<b>Where</b>	<b>Cost</b>
<b>Include components in the equipment maintenance plan checklist.</b>	Intern	July	Filtration Process	-
<b>Use the technical drawing for the correct assembly of the plates and grease fittings.</b>	Intern	May	Filtration Process	-
<b>Buy Grease Plates &amp; Plates</b>	Engineering Technician	February	Filtration Process	R\$ 12.000,00
<b>Set periodicity for cleaning and retightening of equipment.</b>	Filtration Supervisor	March	Filtration Process	-
<b>Include Oxygen incorporation site mapping in the heat exchanger in the Operational Standard.</b>	Operation	May	Deaerator Equipment	-
<b>Revision of Deaerator heat exchanger maintenance plan.</b>	Operation	June	Deaerator Equipment	-
<b>Replace gaskets and place them as stock item in the warehouse.</b>	Engineering Technician	March	Heat exchanger	R\$ 9.530,00
<b>Replace oxygen sensor In line.</b>	Engineering Technician	June	Deaerator Equipment	R\$ 4.122,34
<b>Include in the standard the deaeration system CIP step, which during CIP the inline must be in module off.</b>	Filtration Supervisor	June	Operational Standard	-
<b>Create monthly cleaning procedures for the equipment.</b>	Intern	July	Deaerator Equipment	-
<b>Define and train one equipment owner in each shift.</b>	Intern	July	Deaerator Equipment	-

Source: Adapted from AMBEV (2018).

The execution of one of the main actions that directly influenced the results was the cleaning and inspection of the centrifuge and water deaerator heat exchangers that were carried out at the end of

March. The activity involved disassembly, opening and internal and external cleaning. centrifuge changer that took place late May in addition to the exchange of critical components: gaskets and plates. The equipment was mapped in the Ishikawa diagram because of the leakage by the plate that accumulated dirt shown in the following figure, but despite the maintenance performed the problem persisted, being solved with the analysis of 5 Whys pointing to the fundamental cause that was the plates. small holes identified in a second attempt to close the heat exchanger. After the cleaning activity was completed, all components were mapped and a component checklist for biweekly and monthly frequency cleaning was created, as well as the annual cleaning procedure describing each activity step as stipulated by the brewery. The lessons learned during the implementation of the Action Plan were standardized through the various tools provided by the company such as standards, checklist, cleaning maintenance procedure and inspection, among others.

The main objective of this step is to make the actions that improve the results can be performed again, perpetuating the good practices regardless of the brewery management or the people who hold positions and perform functions.

Standardization was developed by creating a document that describes in detail the cleanliness maintenance action of heat exchangers describing who, when and how it should be done. This document is company standard and classified as controlled documents, and all involved, supervisors or operators, should be trained in this new cleaning and inspection procedure. Also, in the operating standard “Enable Aldox or Unpowered Water System” where there was an opportunity to include the step in which during the CIP the inline must be in module off. The procedures and patterns generated at this stage come naturally if the cycle has been assertive in addressing the problem.

## 5. Results

The results achieved showed that the improvement tools especially the PDCA Cycle are of great importance for handling process bottlenecks. However, as found by Correa (2017) and Neto and Paes (2010), care in the planning stage, especially in the correct identification of the problem, in the analysis of the problem and in-depth knowledge about the process to be analyzed are fundamental in the elaboration of the Plan. Action and, consequently, the reflection of the process performance is shown: the new Process Mapping and the graph with the comparative results to the months after the maintenance and application of the new plan in the equipment where it was identified as the main cause of beer oxidation.

### 5.1 New *PLAN*

The results achieved showed that the improvement tools especially the PDCA Cycle are of great importance for handling process bottlenecks.

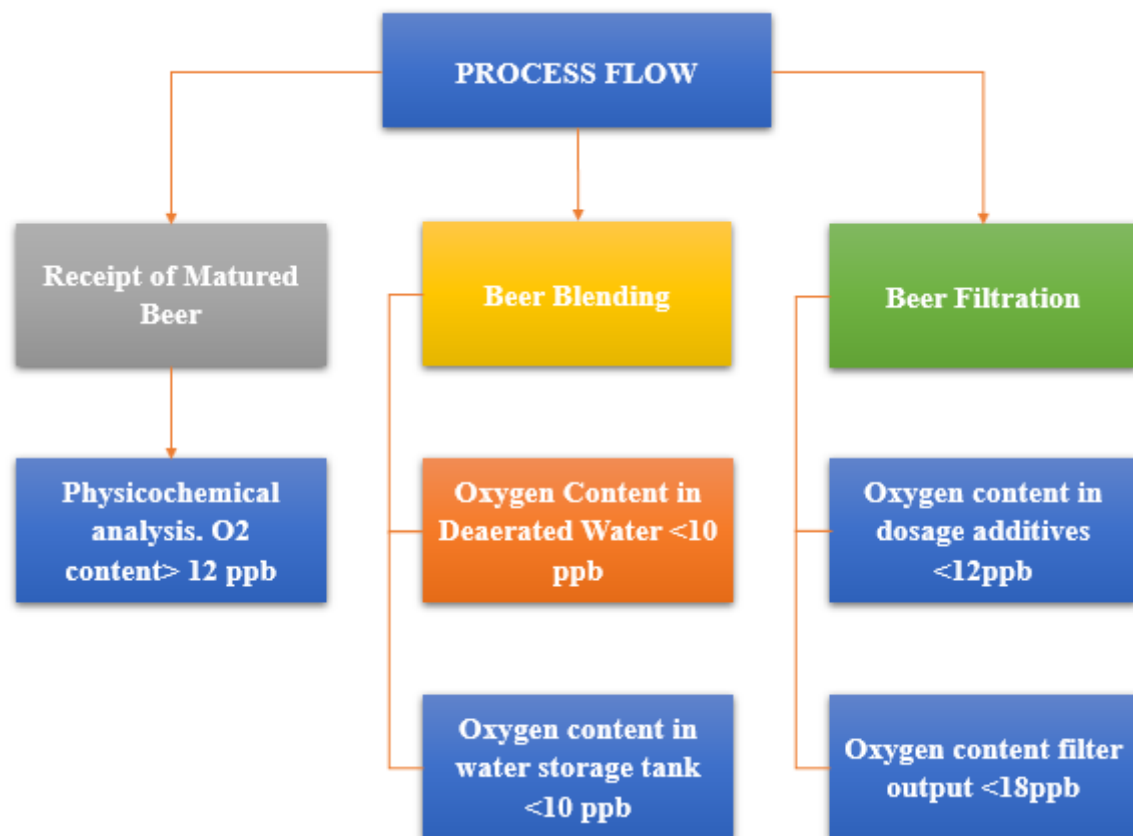


Figure 3: New Process Flow for Beer Filtration

Source: Adapted from AMBEV (2018).

However, as found by Correa (2017) and Neto and Paes (2010), care in the planning stage, especially in the correct identification of the problem, in the problem analysis and in-depth knowledge about the process to be analyzed are fundamental in the elaboration of the Plan. Action and, consequently, in the reflection of the process performance.

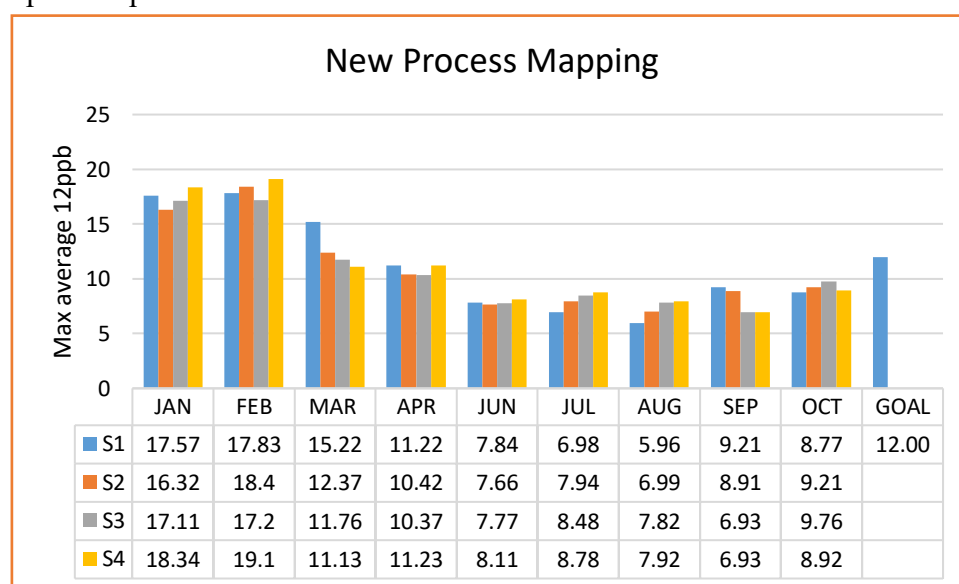


Figure 4: Comparison after equipment maintenance

Source: Adapted from AMBEV (2018).

It was possible to confirm that one of the advantages of the application of the method was the high level of organization promoted by the cycle allowing the search for continuous improvement (a fact evidenced at the operational level, where the practice reduced the incorporation of oxygen in the process), the maturation of people. involved in troubleshooting and troubleshooting; and the feedback promoted by the cycle, since actions whose proven efficiencies can be used to solve other problems of the same nature as found in the studies by Andrade (2013).

## 6. Conclusion

The present work shows after a deep analysis through the PDCA continuous improvement methodology that the improper incorporation of oxygen in the beer during the manufacturing process is extremely harmful to the sensory quality of the product, thus compromising the reach of the sensory indicator target. . According to the specific conclusions the results were satisfactory for the performance of the results and less overload for the operational team besides: The methodology made it possible to find the main points of incorporation of oxygen in the process that were leaks in the heat exchanger in the filtration area. ; Mainly using the Ishikawa Diagram with the participation of employees from different areas of the brewery studied through the application of Brainstorming and the 5 Whys auxiliary tools were analyzed and found the causes: high oxygen high water at the exit of the heat exchanger. deaerator, failure to perform maintenance quality and incorporation of oxygen into the filtration inlet; The realization of a PDCA cycle allowed the Company to propose actions at no financial or reasonable cost to the brewery which, by complying with 90% of this action plan, resulted in the evolution of the result performance in the finished product; In the course of the work it was evident that most of the actions were aimed at the maintenance, modification or alteration of procedures and not the structural physical projects or parameterization of variables, but the application of the PDCA methodology allowed the standardization of actions during the period. work may even be criticized later because the methodology has a philosophy of continuous process improvement.

It was concluded that this work fulfilled all its general and specific objectives, assisting in the process management system, identifying and standardizing improvements and improving the tools, as well as developing the analytical sense in a complex process.

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# **Adaptation of Leopold Matrix for Assessment of Environmental Impacts Caused by the Flower Avenue Project in Manaus City - Amazonas**

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## **Abstract**

*This study aims to describe the effects generated by the construction of Avenida das Flores, has the objective of evaluating the effects caused by an urban mobility project, located in Manaus-AM, and the use of some neighborhoods of the city is prohibited. . Through this process of urban expansion, it is necessary to search for alternatives to urban problems, in addition to seeking solutions for the traffic disorder, a lack of urban mobility due to the difficulty of movement of people living in the more remote neighborhoods of central Manaus. . In this context, formulate the Matrix method of use based and adapted in the Leopold Interaction, which par excellence is dedicated to making relationships, noting the most relevant impacts. The survey allowed to obtain results that could indicate the negative effects caused by the environment in compartments such as: alteration (soil quality, area and microclimate), biotic reduction (reduction of endemic species and forest areas) and social (increase of vehicle circulation, attraction of new constructions and services, serving as a source of decision making, allowing to identify the most relevant effects for the use of instrument in decision making.*

**Keywords:** Urban Expansion, Urban Mobility, EIA.

## **1. Introduction**

With the installation of the automobile industry in Brazil, in 1956 there was an increase in the number of vehicles in cities caused by urban expansion and changes in travel patterns and traffic. Given this, there

was a need for public managers to implement urban expansion projects, through the construction of new streets, roads, avenues, etc., seeking measures to prevent or minimize the negative impacts caused by buildings regardless of type, purpose or size [1].

The construction of avenues, roads, highways, roads is one of the alternatives found to reduce the problems of urbanism, which in turn causes impacts on the environment, where it can often be irreversible. Such expansions and / or constructions should be made by planning so that environmental degradation does not occur in the construction space. From this arise many discussions about the environmental impacts caused by anthropic activities, which are of fundamental importance to the population. Thus, the environmental issue has complexity that encompasses social, economic and natural aspects [2].

The significant increase in urban sprawl causes high levels of socioenvironmental vulnerability, in which several social problems arise, such as: irregular allotments and slums in risk areas, and even in areas protected by environmental legislation. One of the consequences of the constructions is the environmental impacts generated in green areas, which give space to these access roads, besides the other constructions that help the population. The preservation of green areas is related to the quality of the environment, as well as having a direct influence on the spheres: aesthetic, environmental and psychological [3].

Environmental impact according to art. 1 [4], cites as “any change in the physical, chemical and biological properties of the environment, which, directly or indirectly, may interfere with the health, welfare of the population, social and economic activities, as well as environmental resources. . These must be evaluated, controlled, and reduced with a focus on minimizing numerous social, economic and ecological problems that can be remedied by numerous processes such as environmental management.

From the urban problems of the municipality, one of the alternatives for administrations that seek solutions to these problems is the Master Plan, a basic instrument of urban development and expansion policy, and important legal support. Complementary Law No. 2 [5], which provides for the Urban and Environmental Director Plan of the Municipality of Manaus, which is noted in Chapter II, art. 6th, that the strategy of environmental qualification should value the municipality's natural heritage, prioritizing the maintenance of protected spaces, remedy conflicts, in addition to mitigating environmental degradation processes and sanitation deficiencies.

The Avenida das Flores project generated a lot of environmental controversy, since the avenue passes through a part of the State Conservation Unit (Sumaúma State Park), according to the Manaus / AM Master Plan. In addition, it can affect the habitat of an endemic species - *Saguinus bicolor*, which is endangered [6], causing social and environmental impacts, such as the emergence of irregular occupations of the environment on fauna and flora.

Manaus, not unlike other major cities, has been growing uncontrollably, thus bringing a series of problems, such as traffic congestion, exhaust gas emissions, especially by public transport, being one of the main causes of environmental problems.

The relevance of this study is shown given the environmental impacts that occurred in the extension of Avenida das Torres, involving endangered animals, forest fragments, conservation unit, irregular occupations, congestion and the emergence of new buildings.



The Federal Constitution of 1988 states that all cities with more than 20,000 inhabitants are required to draw up the Master Plan, which is an integral part of the municipal planning process [7].

According to [8], in its Art. 17, by the evaluated follow-up the Avenida das Torres corridor, analyzed based on chapter II, in the area of the northern segment, encourages residential use and commerce and service activities.

Due to the repercussions of environmental degradation, it is necessary to propose measures capable of analyzing the environmental impacts resulting from anthropic activities [9].

Thus, the interaction matrix relates the indicators of environmental impacts, based on the listing of human actions in certain phases of the project, which is important for communication, for an environmental assessment, having qualitative and quantitative data, allowing easy understanding of the population about social factors [10].

However, it is necessary to evaluate the social and environmental impacts caused by the avenue of flowers project, analyzing the existence of mitigation and compensation measures, as well as considering the environmental impacts from the matrix [11], describing the magnitude of the importance of each one. impact generated by the project.

## 2. Materials and Method

### 2.1 Study area

The focus of the study is located at Avenida das Flores, in the city of Manaus / AM (Figure 01), a road built to give greater accessibility to different areas of the city.



Figure 01 - Location of Avenida das Flores, Manaus-AM

Source: Thiago Barbosa Fernandes, 2019.

According to data from IBGE (2010) [12], the capital of Manaus had an estimated population of 2,182,763 people, a demographic density of 158.06 inhab / km<sup>2</sup>, and because it is an urban mobility

project, it presents a little half of 718 people. thousand vehicles - DENATRAM (2018) (Table 1).

Table 1 - Vehicle Fleet, by type in Manaus City

Type	Nº of Vehicles
Car	372.803
Truck	16.421
Micro bus	2.998
Motorcycle	172.173
Motor scooter	17.192
Bus	7.831
Others	72

Source: National Traffic Department, 2018

The Avenida das Flores project, extending Avenida das Torres, is approximately 11.1 km long, starting at Avenida Timbiras, in the Cidade Nova neighborhood, North Zone, ending at the beginning of AM-010, the road that connects the capital to the municipality. from Itacoatiara / AM, covering the following neighborhoods: Cidade Nova, Monte das Oliveiras, Joao Paulo Complex, Santa Etelvina, Col. Terra Nova and Lago Azul.

The housing complexes present in the area, causes the growth of Peri - urban areas and the emergence of irregular occupations, which in turn implies the absence of infrastructure, such as basic sanitation, sewage system, and consequent increase in sanitation. pollution of streams, soil, air, and besides caused deforestation, even focusing and changing permanent preservation areas (APP).

## 2.2 Data collect

The methodology used was exploratory research, through case study, using bibliographic research, on-site visit and data collection.

The method applied in the environmental impact assessment process was developed through the characterization of the collected, adapted and corrected data for interaction matrix [11]. The most relevant impacts on the physical environment, biotic environment and anthropic characteristics were described. In the project.

## 2.3 Impact Matrix Characterization

The interaction matrix developed by [11] used in this study was adapted given some characteristics, since the matrix has 88 environmental characteristics (factors) in the table rows and 100 projects actions in the column, being satisfactory for use in most projects ( MMA, 1995). Considering this matrix, 8,800 interactions between them are possible, so the Leopold matrix has been and continues to be widely adapted, giving rise to a number of other matrices.

After the preparation of the document, the theoretical explanation of the factors addressed in the project was described. From this, the data were crossed to evaluate the impacts generated by the project.

The last step is the sum of the values obtained by crossing the impacts and the subgroup components resulting in the value of importance, obtaining the result with the possibility of identifying the most

representative impacts to the environment, adapted from the physical environment, environment. biotic and anthropic characteristics.

### 3. Results and Discussion

The socio-environmental issue has taken great proportions in recent years, where the theme has sought to deepen knowledge in the areas of social, environmental and health sciences, as well as to consolidate public policies [13]. Also, according to [13] environmental problems spread in the larger territories, bringing medium and long term consequences. Thus, it is noted the involvement of the distribution of the population causing the attraction, expulsion or retention of people and as a consequence change in the transport system and the pattern of urban mobility.

With the urban mobility project (extension of Avenida das Torres) there was a reduction in traffic jams and the impact assessment results were positive for the social environment, but negative for the environment.

With the characterization of the impact matrix, the consequences of the identified and quantified environmental impacts after the project implementation were determined.

The existing aspects were distributed into three (3) subgroups, given the place where the action took place. Where the conditions attached to the groups were described, described in the Impact Matrix (Table 3). The columns of the matrix correspond to the interactions between components and the impacts generated, then the results were valued from 0 to 5, where in the end added the importance.

The number 0 (zero) corresponds to the lowest (minimum significance of the action on the environmental component considered) and the number 5 (five) corresponds to the values of highest significance for the attributes (Table 2).

Table 2: Rank on the importance of impact.

0	No Impact
1	Very Low
2	Bass
3	Intermediate
4	High
5	Very High

The total achieved corresponds to the sum of the score, as to the degree of importance of each impact evaluated. At the end, summing all the interactions between the rows and columns elaborated and described in the spreadsheet, one can visualize the impacts, when aggregated the highest scores (Table 3).

Table 3 - Impact / Interaction Matrix

IMPACT / INTERACTION OF FLOWER AVENUE DESIGN INTERACTION										
Components	Physical Medium				Biotic Medium		Anthropic Characteristics			IMPORTANCE (TOTAL)
Impacts	Air	Water	Climate	Soil	Flora	Fauna	Developments	Tax Generation	Devaluation Real Estate	
Soil compaction	0	4	0	5	4	4	5	0	0	22
Deforestation	5	5	5	5	5	4	5	0	1	35
Leaching	0	5	3	5	5	3	2	2	2	27
Loss of Diversity	2	2	2	4	4	5	1	1	1	22
Pollutants	4	5	4	5	5	5	4	3	2	37
Asphalt	4	0	4	5	4	3	0	3	0	23
Visual Impact	0	0	0	0	4	5	3	0	2	14
Soil Removal	0	4	0	5	5	4	2	0	3	23
Wildlife Habitat	0	0	0	0	3	5	4	0	2	14
Tree felling	5	0	4	5	5	5	4	0	0	28
Noise	0	0	0	0	3	5	4	0	0	12
Forest Fragment	5	1	5	5	5	5	3	0	3	32
Waste generation	4	5	3	4	2	5	4	3	1	31
Vehicle Traffic	5	3	5	5	4	4	0	4	0	30
<b>TOTAL</b>	<b>122</b>				<b>105</b>		<b>62</b>			<b>289</b>
<b>Legend</b>	0 - No Impact		1 - Very Low		2 - Low		3 - Intermediate	4 - High	5 - Very High	

Source: Prepared by the authors, 2019

### 3.1 In the physical environment

the quality of air, water, microclimate and soil was evaluated. From the implementation phase to the operation phase, the visual impact caused by the removal of part of the native vegetation and buildings (housing developments, new developments) in the region is observed. Therefore, the process of urban expansion is one of the most relevant transforming agents of landscape and the environment, which can lead to important losses, such as historical, natural, affective and defining loss of an area [14].

The consequence of soil impacts was given by the loss of nutrients and microorganisms, which are essential for land productivity, thus harmed the environment given some suppressed soil ecological characteristics, leaving it unprotected and vulnerable to wind, which carries microparticles, to distant areas.

The soil has the function of generating natural resources, in addition to reserving nutrients and minerals important for renewal and support of living beings, microorganisms and vegetation, being extremely important for the life cycle [15]. The soil compaction caused by the generating actions (deforestation, movement of machines) favored the superficial runoff and the emergence of erosive processes.

During the implementation phase there was a change in air quality by moving heavy machinery, altering the microclimate of the region. Then there was an increase in the emission of vehicle pollutants, due to

the pace of vehicles on Avenida. Given the relationship between pollutant gases and the atmosphere, there was interference in air quality, where we have: that the higher the concentration of pollutants in the atmosphere, the worse the effects under the atmosphere, also helping to decrease the quality of the air. According to [16] the dispersion of pollutants depends on the built environment, larger roads with high vehicle flow present higher levels of concentration of pollutant emissions.

### **3.2 In the biotic environment**

with the removal of native forest, there was a reduction of preserved forest, including sometimes suppression of ciliary forest, in which there was visual impact, loss of fauna species, decreased microclimate, changes in the macro and soil microbiota. , besides promoting other losses, while the species that, due to the scaring process, could not adapt to the new habitat, mainly in the project implementation phase, which through noise of the machines and many equipments operating, many ecological niches were affected. , causing species extinction in the local condition.

For [17] the first phase for conservation and rational use of an enterprise, is the survey of species that make up the flora and fauna.

Animal migration is triggered by some factors such as temperature, lighting, feeding. However, animals excluded from the affected areas cause problems in the territories where they take refuge, as they are occupied by other animals, and the arrival of "intruders" unbalances the environment, given the competition for numerous survival conditions. Moreover, food may not be sufficient for everyone, increasing competition and mortality rates of different species in search of new habitats [14].

Sauim-de-coleira, as an endemic species in the region, has been suffering more and more individual losses due to the occupation of areas. Thus, with the disappearance of forests, the impact becomes increasingly potentially harmful to the species.

For [18] there is a huge possibility of attracting the species of collar sauins, which can be explained by the cultivation of fruit trees of the resident population near the forest fragments, corroborating this study, since the foods mark the habitat of the species in productive backyards.

### **3.3 Anthropic characteristics**

There was the generation of noise from the horns, caused by vehicles, in addition to the flow of cars and people, which has been increasing; maximizing waste generation given the addition of the community; constant emergence of new buildings, such as housing developments, trades and others.

With positive impact, there was hiring labor during the construction phase, thus contributing to the reduction of unemployment that affects the country, in addition to the appreciation of real estate, with the increasing demand for new properties, given the ease of access.

According to [15], the anthropic actions in fact, is the flagship for land use changes and urban sprawl, causing numerous problems, increasing the process of degradation.

### **3.4 Mitigation measures**

Mitigation measures can easily reverse, minimize or compensate for environmental impacts. Therefore, the following mitigation measures are suggested:

### **3.5 For the physical environment**

Promote techniques for managing native species, so that the environment continues to maintain species with characteristics of the region and the Amazon rainforest in the central region; soil recompositing by means of drainage system implantation; development and implementation of hydrological and meteorological monitoring in the area to assess changes in standards.

### **3.6 For biotic environment**

Preserve the remaining forest areas, especially in permanent preservation areas; recovery of affected areas through the cultivation of native species, avoiding erosive processes; evaluation of the establishment of new protected areas, considering the diversity of the present ecosystems; avoid opening new access routes, prioritizing those already consolidated.

### **3.7 For anthropogenic characteristics**

Guide nearby communities on the conservation of trees that attract saúns and other animals of the local fauna, and on the prohibition of hunting; have information signs on the Avenue to alert vehicle drivers of the risk of animals being run over; and implement a fauna and flora monitoring program; beyond the monitoring control for use of areas, for purposes of open dumps, or simply new areas of invasion.

## **4. Conclusions**

Given the study, it is noted that Avenida das Flores was an important alternative to reduce vehicle congestion and interconnection between various neighborhoods of the city, given the conditions of urban mobility of the city of Manaus, but that enhanced the environmental impacts.

In the implementation phase, one of the major impacts was on the physical environment, such as visual impact, change in air quality, process associated with the removal of vegetation, the intense use of vehicles, machinery and equipment, the impact on local soil, deconfiguration of the local landscape, transforming the area.

The project implies in the increase of the emission of gases and particulates to the atmosphere, through the circulation of vehicles, consequently, the variation of the air quality.

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# **Application of Swot Analysis in the Distributor Company and Commercial Market Souza Cruz**

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## **Abstract**

*This article focuses on the SWOT analysis, which deals with content related to strategic planning in which the research object is the commercial company Comercial Souza Cruz, located in the city of Manaus / AM, active in the wholesale and retail business. With the general objective of this work was to analyze and identify growth strategies, through SWOT analysis, with the purpose of increasing the profitability of the company in question. During the elaboration of this scientific study, the bibliographic basis was used as a methodology, where it is characterized in a case study of descriptive analysis, through which data collection took place through a documental analysis and semi-structured interview. As a result, it was observed that the company has a favorable location, differentiated service hours and customer loyalty. However, there are still variables to be improved in the company, such as low financial resources, non-standardization of financial data analysis and 50% of its physical structure depends on a lease agreement.*

**Keywords:** SWOT analysis; Strategic planning; External environment; Internal environment.

## **1. Introduction**

Due to the economic changes that Brazil has been going through in the last decades until the present state of the crisis, mass layoffs, dollar increase among others, the companies in general needed new adaptations in the economic scenario so as not to go bankrupt. According to data from the Brazilian



Institute of Geography and Statistics, (2017) quoted by Silveira and Cavalline, (2017), from the first quarter of 2014 to the first quarter of 2017, Brazil lost about 3 million jobs with a formal contract. In the first quarter of 2017 was registered high of 13.7% or 14.2 million unemployment, this was the highest rate ever recorded in the country.

According to Lima (2017), with the crisis, some companies eventually went bankrupt, where there was a 28.5% increase in bankruptcy filings from May 2016 to May 2017, the crisis also affected the beverage distribution company. Commercial Souza Cruz who, through resilience, changed his field of activity to remain active in the market.

According to Martins et al. (2012), resilience in the business sector is characterized by the ease of adaptation of companies in the face of environmental adversities, and organizations must evolve and adapt quickly to changes.

This study was carried out in a wholesale and retail company located in Manaus / AM, acting as a beverage and market distributor. Initially, it began its activities only with beverage deliveries to third parties, but due to the economic changes of the country and will intensify a potential competitor, the owner changed segments and inaugurated a distributor and mini market. Souza Cruz is a small wholesale and retail company located in the north of Manaus.

The company works with the resale of general drinks and food products.

This study addressed as problematic: how to contribute to the growth of a distributor and mini market, located in Manaus / AM?

Formalizing the analysis of the organization's strategies is extremely important, because when the company has controlled and aligned strategies, it is possible to objectify the company's strengths and weaknesses. In view of this, the overall objective was to identify growth strategies that aim to increase profitability and rise. Souza Cruz distributor and commercial market, located in Manaus / AM, through SWOT analysis.

With the intention of expanding the knowledge of the company's strategic area, the specific objectives were elaborated for the present research aiming at: a) identifying opportunities and difficulties found by the company from the SWOT analysis; b) analyze the strategies and attitudes taken by the company to attract new customers and; c) propose improvements in the company through SWOT analysis.

The justification of this study is given the opportunities and difficulties encountered by the company, its entry into the market today. This research also contributes to the company's management improvement, thus applying a SWOT analysis, addressing the points to improve its growth, verifying variables that can attract and retain new customers.

## **2. Theoretical Reference**

### **2.1 Strategic Planning**

According to Schreiber (2012) believed that strategic planning allows the difficulties and problems of an organization to be studied, analyzed to look for attitudes that tend to reduce or correct the points where the company has the most problems.

Fernandes et al. (2013) Strategic Planning seeks to put the available resources into practice effectively to achieve the objectives, strategic planning is not done as a simple schedule, it must be applied in action,

and adjusted daily business adjustment, must regularize the changes needed to meet the needs of the business.

According to Sebrae Nacional (2016), Strategic planning is a great opportunity to build, review or develop the reading of an organization's reality, where reading should be critical, coherent, complete, whole, systematic and understandable, and should also generate confidence, security and clarity to the role that the company wants to assume in the market.

Companies must adopt strategic planning to implement organization, direction and control; maximize your goals; minimize their shortcomings and provide efficiency.

## **2.2 Analysis S.W.O.T.**

SWOT analysis which is the analysis of the company's strengths and weaknesses, opportunities and market threats. This model addresses the internal and external environment of the organization. Taking this information into account, it will be possible to have a better detail of which part of the company should improve where the positive points of the company will be exposed, in which it will maintain the quality.

For Schreiber (2012) the SWOT analysis has been a widely used tool since the 1960s. With the application of this analysis in a business environment, it is possible to identify possible markets and trends, allowing the creation of new strategies that are more coherent for the current situation. by surveying the internal and external environment of the business.

Created by Kenneth Andrews and Roland Cristensen, professors at Harvard BusinessSchool, and later applied by a number of academics, SWOT analyzes the organization's competitiveness in four variables: Strengths, Weaknesses, Opportunities, and Threats. ). Through these four variables, the strengths and weaknesses of the company, the opportunities and threats of the environment in which the company operates can be inventoried. When an organization's strengths are aligned with the critical success factors to meet market opportunities, the company will certainly be competitive in the long run (RODRIGUES, et al., 2005).

## **2.3 Internal Environment and External Environment**

In SWOT analysis the internal environment according to Chiavenato (2006) is the evaluation of the strengths and weaknesses of the organization being analyzed the financial resources, competence and business structure.

Certo et al. (2005) The internal environment is the analysis from the inside of the company, its variables are easily found and controlled differently from the external environment.

Dornelas (2011) the external environment is composed of opportunities and threats, company managers must always be aware of new trends that may affect their business, and detect market opportunities, and the opportunities should be classified according to their attractiveness and likelihood of being. a success, but not only does it depend on the company's dedication, it needs to meet the market needs to succeed with its target market, the company must have the competency to outperform its competitors, the business that can build the most value for its The target audience will be the best at an opportunity.

According to Silva (2015) the external environment is not possible to perform effective evaluations,

because it is dynamic, competitive and aggressive. For evolutionists who decide whether the company will survive in the market are the external factors, and for the manager to succeed must always be aware of changes and seek to adapt to market demands.

### **3. Tools and Methods**

The present case study was conceived at Comercial Souza Cruz, located in Manaus / AM. The research was carried out in a micro company bringing a detailed and individual analysis, where it studied a single case being described in a complex way.

The company Comercial Souza Cruz is located in Manaus / AM Brazil, mainly in wholesale and retail, characterized as a small company.

For detailed knowledge of the company, a documentary analysis was applied in order to identify data for the SWOT matrix. This being applied in the first half of 2019 described qualitatively.

In the methodology studies one can count on several possibilities regarding techniques for data collection. A documental analysis was performed for greater understanding through data collection, verifying company records that contributed to the formulation of the SWOT analysis, verifying the veracity of the key points.

By non-participant observation, the company's opening hours were observed to survey some of its strengths and weaknesses.

According to Marconi and Lakatos (2010), by non-participant observation the researcher is a spectator, he participates in the fact with the group, community or area most studied without having involvement. The use of such points in the research brought to the article a theoretical basis with greater understanding regarding the applied strategic themes.

### **4. Application of Study**

In order to build the SWOT analysis of the company SOUZA CRUZ, observations were made of the internal and external environment of the company, identified by the documentary analysis verifying the veracity found in the SWOT analysis and non-participant observation for the survey of weaknesses and strengths, opportunities. and threats of the business, thus being able to analyze the scenario and the strategic positioning, it was also possible to know the difficulties and opportunities of the company.

It was possible to achieve the specific objectives with the collection of information, which this article proposes.

From SWOT analysis it is possible to identify and analyze problems encountered by the company pointing out the strengths, opportunities, weaknesses and threats mentioned below:

#### **4.1 Forces**

- a) Possibility to offer personalized services
- b) Ability to maintain local weekly promotions
- c) Location
- d) Flexible hours

- e) Low prices
- f) Good quality products
- g) Regular stock control

#### 4.2 Opportunities

- a) Customer loyalty
- b) Expanding market, with great demand in the locality.

#### 4.3 Weaknesses

- a) low financial resources
- b) Lack of standardization in the analysis of financial data of inputs and outputs
- c) 50% of its physical structure depends on rental agreement.

#### 4.4 Threats

- a) likely entry of new competitors in the locality
- b) 24 hour assault vulnerability.

### 5. Improvement Proposals

The necessary improvements to the company through SWOT analysis based on documentary collections and systematic visits through non-participant observation provided the company to objectively survey important information for the promotion of the company where being well executed can be used. Forces leveraging opportunities and defending threats, the table below presents the relevant points for the creation of the SWOT analysis and its results.

Table 01 - SWOT matrix of Comercial Souza Cruz.

<b>FORCES:</b> a) Possibility to offer personalized services. b) Ability to maintain local weekly promotions. c) Location. d) Flexible hours. e) Low prices. f) Good quality products g) Regular stock control.	<b>WEAKNESSES:</b> a) low financial resources. b) Lack of standardization in the analysis of financial data of inputs and outputs. C) 50% of its physical structure depends on rental agreement.
<b>OPPORTUNITIES:</b> a) Customer loyalty. b) Expanding market, with great demand in the locality.	<b>Threats:</b> a) likely entry of new competitors in the locality b) 24 hour assault vulnerability.

Source: Author (2019).

### 6. Results

Taking into consideration the gathering of SWOT analysis information, the manager can know his

strengths, weaknesses, threats and opportunities. With this study, the company can strategically position itself seeking improvements to its weak points and maintaining its strengths, already in the strong points. From the external environment, the company no longer has control and must be aware of the threats it has and that may arise in the future, and the opportunities must be seized in its favor, seeking the growth and development of the business.

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# **Modernization of the Environmental Lighting System of a Manaus City Commercial Business**

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## **Abstract**

This research aimed to present a brightness control system through the Arduino prototype that will adjust the brightness in the workplace according to the Brazilian norms according to the activities performed and through the literature review point its advantages and benefits to the company. To this end, the following research methodologies were adopted: case study, literature review, quantitative and qualitative analysis. Where illuminance samples were collected in a work environment where they are outside the standard of NBR 8995-1, a fact that has been negatively influencing workers performance and company results, a high level of energy consumption was also detected energy. Thus, based on the literature review

on the subject, and the results obtained in the inspection of the illuminance of the work environment, it was possible to present a prototype on the Arduino platform that solved the problem of lighting in the work environment, regarding the quantitative results of the work. Research has proven that with the installation of the prototype in the workplace the energy reduction can vary from 7% to 20% in addition to the reduction of occupational disease costs, and the qualitative results show numerous benefits of adequate lighting in the workplace. minus three spheres: physical; cognitive and operational.

**Keywords:** Lighting. Workplace. Lighting control. Arduino;

## **1. Introduction**

A work environment is the result of a sum of factors, material and subjective, all very important. Environmental working conditions must be appropriate to the psychophysiological characteristics of the workers and the nature of the work to be performed. Thus, in workplaces where activities are performed that require constant intellectual solicitation, such as the office room, brightness is a prime factor in the performance of activities, which is standardized by NR-17 and NBR 8995-1.

In this context, the excess or lack of illumination and even illumination of environments designed outside the normative standards, directly affect negatively in the performance of the activities performed by the employees, favoring the emergence of some problems: physical, because it damages the visual senses of the persons and contributes to the development of physiological and mechanical deficiencies; cognitive, in relation to mental processes and interpersonal relationships in the workplace; and organizational, dealing with rules, communication and organizational structure; and the increased risk of accidents and other work-related illnesses. Scenario consisting of the following problem: How to modernize the lighting system in the workplace according to regulatory standards?

Therefore, this research aims to present a brightness control system through the Arduino prototype that will adjust the brightness in the workplace according to the Brazilian norms according to the activities performed and through the bibliographic review to point out its advantages and benefits. the company and the workers.

Interest in the topic arose from the need to adjust the lighting system of the administration room of a company in the commercial area of Manaus City, where it was made measurement and analysis of the brightness levels of the room and it was found that it is outside. regulatory standards on the subject, resulting in negative results for the company.

With the advancement of automation technology through the Arduino prototype, it is now possible to have automated lighting in the workplace, creating great comfort for workers, relating its functionalities with concepts of occupational safety, improving occupational health and safety. undoubtedly generated huge energy savings.

The idea of controlling brightness levels in the workplace works through computers, microcontrollers and lighting sensors, which gradually increase or decrease artificial lighting, so that the environment is always fit for the job to be. executed.

## 2 Materials and Methods

### 2.1 Area of study

The study was done in a commercial office located in Manaus city center (Figure 1). The room has an area of 25m<sup>2</sup>, where it is divided into eight workstations, each workstation has a computer and a chair, featuring fixed workstations. It is noteworthy that the room has no windows, completely depending on artificial lighting for development of daily work routines.



Figure 1. Place of study

Source: Personal Archive.

To validate the results, we used the literature review on the benefits of a lighting control system. We reviewed books, articles and dissertations published from 2011 made available through google books and academic.

### 2.2 Data Collection Procedure

For inspection of the illuminance levels of the study site, it was based on the parameters of NBR 5382 for verification of interior illuminance in environments, in rectangular spaces with two or more continuous lines of luminaires, which is the subject of this study. With the aid of the digital luxmeter, illuminance levels were collected at four points of the room. Complementing the information on the quantitative aspects of the research, the levels of electricity consumed in a 10-hour workday were also collected.

It was also used a questionnaire with 13 closed questions and 3 multiple choice questions, applied to the room staff, specifically in 9 employees. With this instrument, it was possible to point out some qualitative aspects of the research.

### 2.3 Data Analysis

For data analysis, due to the complexity of the results, we chose the quantitative / qualitative approach to analysis. Divided into two stages, the quantitative data were first analyzed using tables, tables and graphs, the results from the illuminance inspection and the application of the questionnaire. Finally, the second stage deals with the benefits that the Arduino prototype can provide for the environment under study, it deals with physical, cognitive and psychological aspects.



## 2.4 Materials Used

Table 1. Materials used for prototype development

Hardware	Quant.	Software
<b>Jumper Cables</b>	11	Arduíno IDE
<b>1K<math>\Omega</math> Resistor</b>	1	Eclipse
<b>GY-2561 Light Sensor</b>	1	Matlab
<b>ESP8266 ESP-01 Wifi Module</b>	1	C++ Language
<b>Arduíno UNO R3</b>	1	Java Language

Fonte: Próprio autor, 2019.

## 3 Theoretical Reference

### 3.1 Lighting in the workplace

The work environment is composed of a set of interdependent factors that act directly and indirectly on people's quality of life and the results of their work. In this sense, lighting is very important for an adequate level of comfort, health, satisfaction and safety at work (PAIS, 2011).

Workplace lighting, also called service lighting, is the use of light to become an easier activity to perform. It is the ratio between the luminous flux that affects a surface per unit area measured in lux (TREGENZA; LOE, 2015).

The term luminous flux ( $\Phi$ ) is characterized by the amount of light emitted by a light source per second in all directions, having Lumen unit (lm). The ratio of the luminous flux that falls under the square meter of an area is defined by illuminance (E), has Lux unit (lx) (ABNT, 2013).

In this context, the use of artificial lighting is the most common in work environments, is directly related to the use of lamps and luminaires, whether indoors or outdoors. However, for a lighting project a technical analysis is made to determine the most appropriate type of lamp, taking into account the beam angle and the uniform distribution of the distribution (CORRÊA; BOLETTI, 2015).

According to Bakman (2018, p. 9) for project and lighting application and in work environments “three types of artificial lighting are considered: general lighting; spot lighting; artificial lighting”. As illustrated in the following figures.

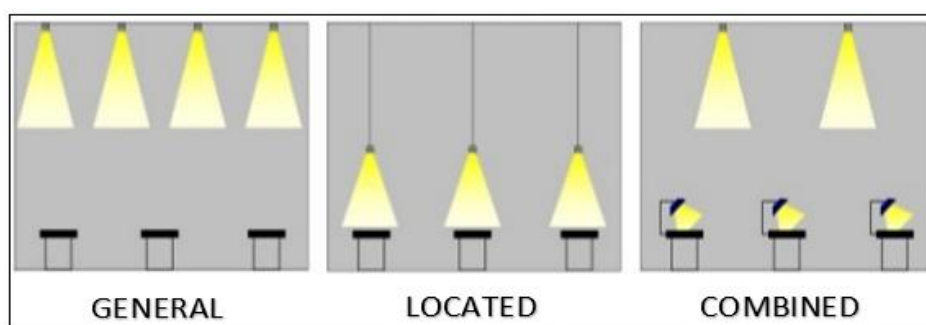


Figure 2. Types of artificial lighting

Source: Bakman, 2018.

Office activities involve a wide range of tasks, including working on display, telephone, scanner,

photocopier and sending equipment, receiving e-mail and faxes, viewing documents, reading texts. , communication with coworkers. To perform their tasks, the worker has to use, among others, the visual system, one of the most important systems of our body (HENRIQUES, 2014).

In environments that require visual tasks such as reading or typing, common office activities, there is often a requirement for uniformity of illuminance standards throughout the area itself, usually including desks or, if work positions are not fixed, the horizontal work plan as a whole, the uniformity required will depend on the particular visual tasks and the situation (TREGENZA; LOE, 2015).

Thus, the study is based on inspection, measurement and suitability of work environments, in specific offices that is the subject of the research, the 2013 NBR 8995-1, which deals with the specifications and requirements for lighting in the workplace. for people who perform visual tasks.

According to NBR 8995-1 (2013, p. 27) the criterion for light level evaluation “is the point-to-point measurement in the different tasks and the comparison with the minimum required values corresponding to the minimum illuminance value for specific tasks”.

Based on the minimum illuminance values specifically in the office that is the object of study research, will be used the NBR 8995-1 with the values of each activity, as detailed in the following table

Table 2. Minimum illumination levels E (Lx)

TASK OR ACTIVITY	OFFICES			COMMENTS
	<i>E (LX)</i>	<i>IRC/RA</i>		
<b>Archiving, copying, circulation etc.</b>	300	80		
<b>Write, type, read and process data</b>	500	80	See note*	
<b>Technical drawing</b>	750	80		
<b>Computer Aided Desing Station</b>	500	80	See note*	
<b>Meeting and conference room</b>	500	80	Controllable	lighting is recommended.
<b>Reception</b>	300	80		
<b>Archive</b>	200	80		

Fonte: Adaptado ABNT, 2013.

For light evaluation after installation, or for technical report issuance, NBR 5382, which deals with the verification of interior lighting, describes how to check the average interior illuminance in rectangular areas on a horizontal plane, this measurement is made by middle of the lux meter, illustrated in the following figure.



Figure 3 - MLM-1020 Digital Luxmeter

Source: Bakman 2018

\* There may be exceptions to the overall reproduction rate for high mount lighting (over 6m) and for outdoor lighting when there are no people working for long periods or when color identification is required for safety.

Currently, the lighting system of a work environment is quite complex and can not take into account only quantitative aspects, it is necessary to promote qualitative aspects so that along the workday, can create stimuli and situations of relaxation and visual comfort (PARIS). , 2011).

In this context, visual comfort is linked to the set of conditions of a given environment, whose individual develops visual tasks with accuracy and precision, with less effort and less risk of injury, including risks and accidents (HENRIQUES, 2014).

Therefore, it is important to pay attention to these aspects of lighting to be most effective for both users and energy savings when it is designed to fit the function and layout of the room and the characteristics of the people who will use it.

One of the tools that has gained prominence in the market is automated lighting systems. This concept has been of fundamental importance in systems that aim to optimize procedures. A lighting system aims to provide adequate lighting, avoiding waste and maximizing the health of people at work (LOPES, 2018).

It is sometimes interesting to offer users ways to adjust the level of illumination over their individual work plans. Individuals can adjust their luminaires if they feel the need to increase or decrease the lighting relative to their surroundings, varying it according to activity. The feeling of being able to control your work environment is important for professional satisfaction and company performance (TREGENZA; LOE, 2015).

A lighting control system is an intelligent network-based solution that incorporates programming language communication between various system inputs and outputs via illuminance control-related sensors using one or more computing devices, one of which is simple and practical with low power consumption and low implementation. and maintenance costs (PARIS, 2011).

### 3.2 Prototype of artificial lighting control system

The design of the lighting control system had its electrical characteristics the 127V circuit, where a power line for the prototype in Arduino was created. This power supply worked from a common source that lowers the voltage from 127V to 12V as per Arduino Uno R3 specifications.

Arduino® is an open source electronic platform based on simple hardware and software. They perform input readings and turn them into output by performing some command. All these commands are executed through a set of instructions sent to the microcontroller on the board, using the programming language and the processing-based Arduino® (IDE) software (OLIVEIRA; ZANETTI, 2015).

The code installation in Arduino is the reading of the C ++ language is done through a server that communicates with Arduino through the ESP8266 ESP-01 WiFi module, powered by a 5V output of Arduino itself. To program Arduino, we use the Arduino IDE itself (Figure 3), a free software program in the Arduino understands language (inspired by C language). The IDE allows you to write a computer program, which is a set of step-by-step instructions that you upload to Arduino. Arduino then executes these instructions, interacting with whatever is connected to it. In the Arduino world, programs are known as sketches (ADAS, 2017).

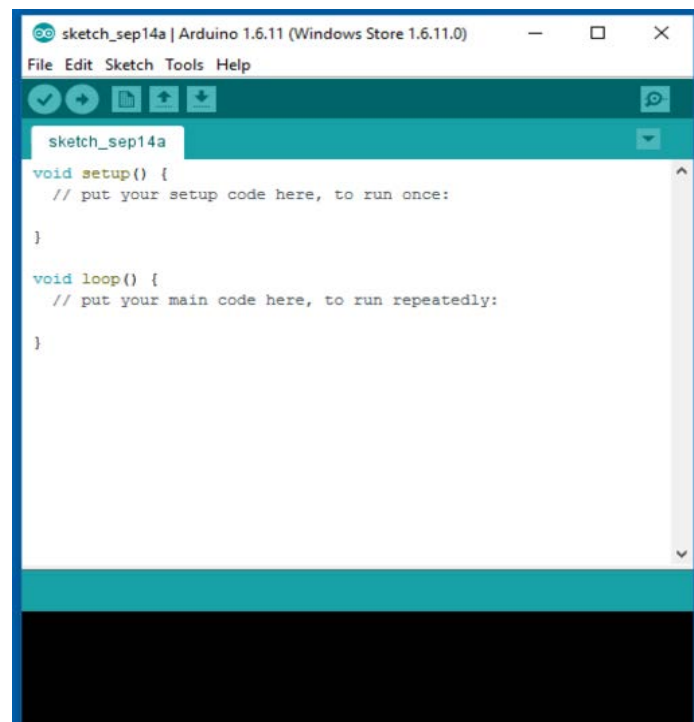


Figure 4. Arduino IDE Interface

Source: Adas, 2017.

The programming language used in Arduino® is very simple, based on C and C ++ languages, it uses a lot of libraries and resources. It has three main parts: structure, values (variables and constants) and functions. The structure is the elements of the Arduino® code, the variables are the constant data types and the functions are to control the Arduino® plate and perform the calculations (KULKARNI, 2017).

The ESP8266 (Figure 4) is a microcontroller developed by Espressif Systems, which has been on the market since 2014. Although recent, it has been gaining prominence with developers and enthusiasts due

to its small size, having a Wi-Fi communication system, standard widely used today, and also for its low cost (ARAÚJO, 2017).



Figure 5 - ESP8266 wifi module

Source: Araújo, 2017.

Protoboards (Figure 6) are one of the most important tools for assembling circuits, because it is possible to assemble numerous circuits without the need to solder components, so if there is no certainty how a particular circuit will behave during Protoboard is the most recommended place to operate this circuit and perform all necessary tests (ADAS, 2017).

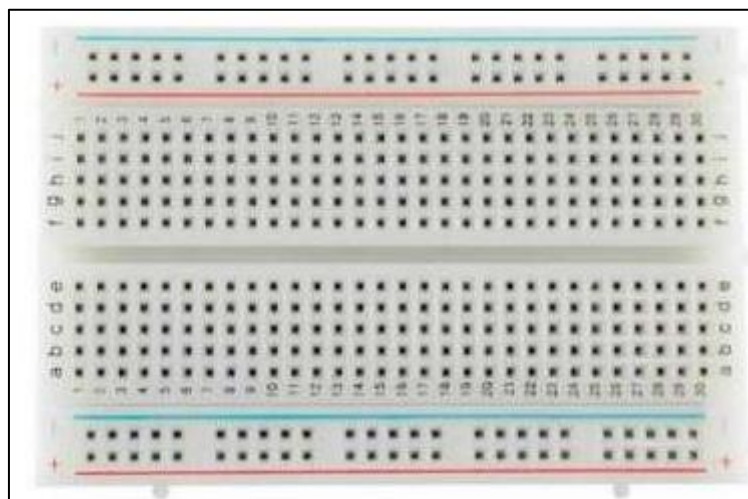


Figure 6. Protoboard

Source: Adas, 2017

The TSL2561 Breakout Light Sensor (Figure 7) is a sophisticated light sensor responsive to most of the visible spectrum. Unlike the simplest sensors, the TSL2561 measures both infrared and visible light to better approximate the response of the human eye (OLIVEIRA; ZANETTI, 2015).

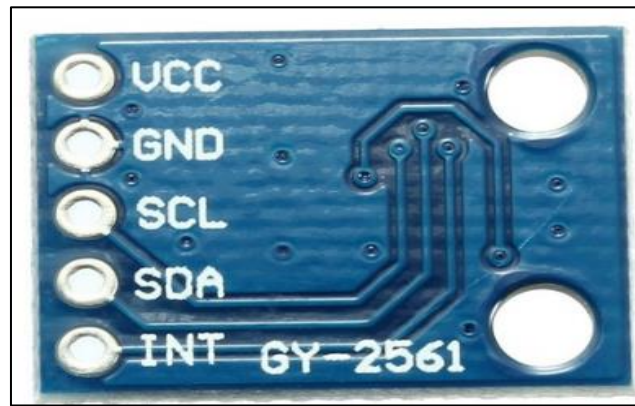


Figure 7. GY-2561 Light Sensor

Source: Oliveira and Zanetti, 2015.

A resistor or resistor (Figure 8) is a widely used electrical device in electronics, sometimes for the purpose of transforming electrical energy into thermal energy through the joule effect, sometimes for the purpose of limiting the electric current in a circuit (ARAÚJO, 2017).



Figura 8. Resistor de 1KΩ

Source: Araújo, 2017.

Jumpers (Figure 9) are electrical cables or wires with ends that are properly prepared to make electrical connections between the components of a circuit enabling the conduction of electricity along it (KULKARNI, 2017).



Figure 9. Male / Female Jumper

Source: Kulkarni, 2017.

In this context, the proposed lighting control prototype is represented as the following figure.



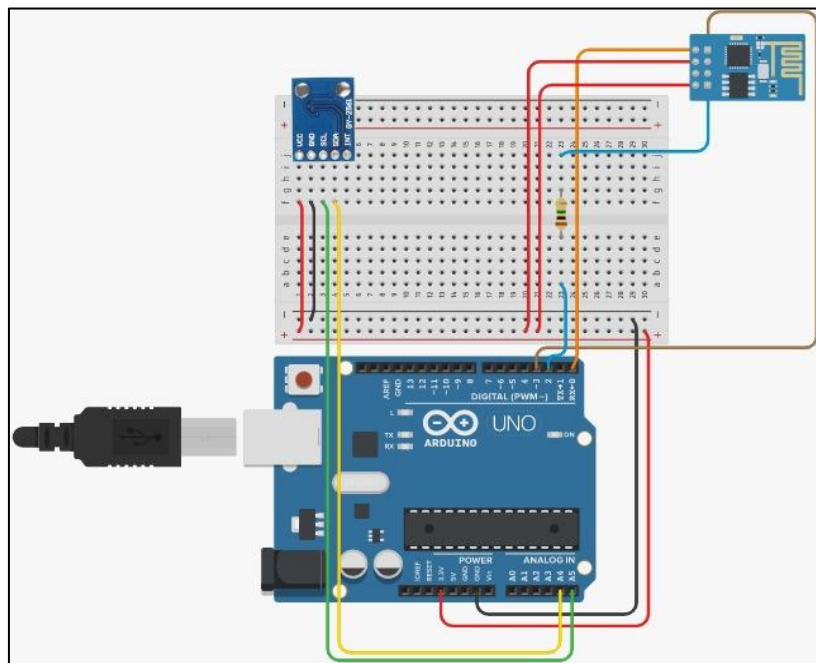


Figure 10. Lighting Control Prototype

Source: Matlab, 2019.

The prototype is very simple to operate, first the GY-2561 light sensor sends the light measurement to the Arduino through the input ports (A4 and A5), in the lux measurement unit, the Arduino then communicates with the module. wifi through its output ports (0, 2 and 3), using the data received by the light sensor, sending this information over the network to the server that will then perform the data recording, as illustrated in the following figure.



Figure 11. Lighting Control Prototype

Source: Personal Archive.

Eclipse software is an IDE for Java development, but it supports several other languages from plugins like C / C ++, PHP, ColdFusion, Python, Scala and Android platform. It was made in Java and follows the open source software development model.

The results obtained by the prototype will be available on the computer screen through the "Web Screen" which uses PHP programming language that allows access through any device with internet access. An outline of what the screen will look like is illustrated by the following figure.

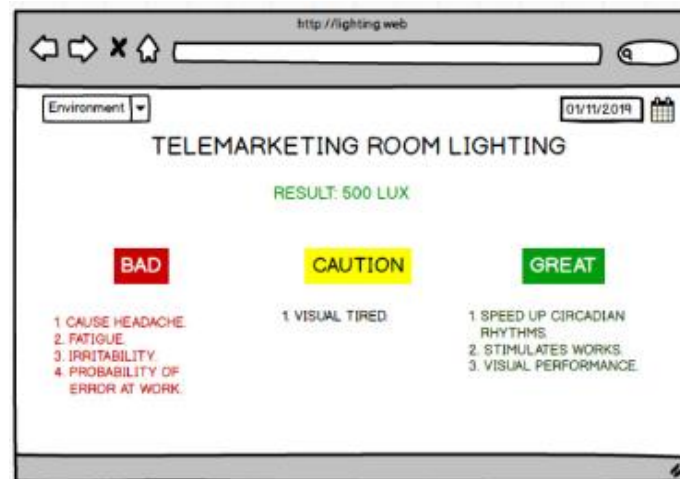


Figure 12. Web screen

Source: Matlab, 2019.

## 4 Results and Discussions

### 4.1 Quantitative Research Data

The results obtained in the illuminance inspection are described according to the following table.

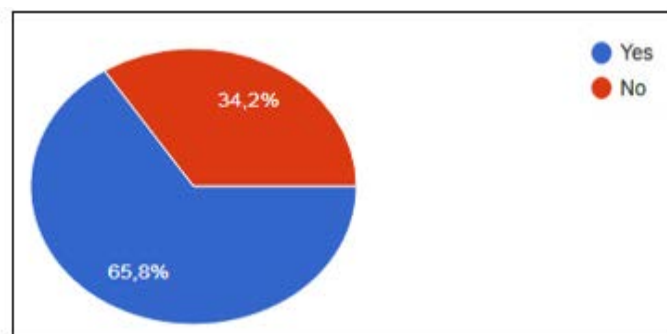
Table 3. Illuminance levels inspection results

Score 1	564 Lux
Score 2	410 Lux
Score 3	389 Lux
Score4	592 Lux

Source: Own author, 2019.

It is observed that the level of illuminance in the workplace studied are outside the standard specified by NBR 8995-1, which was found in the application of the questionnaire assessing workers' satisfaction with lighting in the workplace, as shown by following results.

At first it was asked if the lighting is being evenly distributed in the work environment. The result shows that 65.8% of respondents think yes and 34.5% think no, as shown in the following chart.



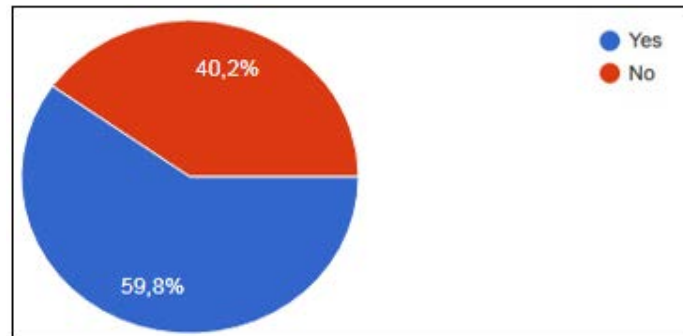
Graph 1. Evaluation of lighting distribution

Source: Own author, 2019.

Another aspect asked was about the lighting presenting some kind of shadow or glare. As illustrated in



the following graphic.

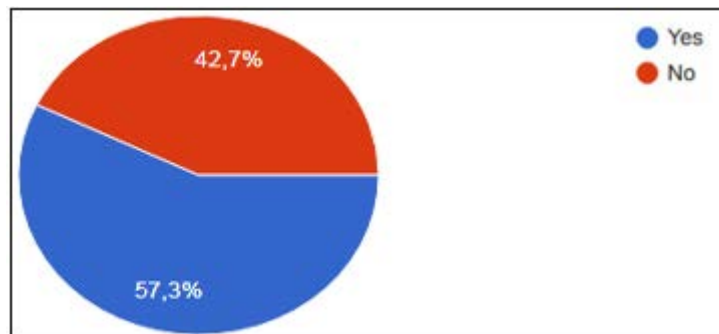


Graphic 2. Illumination with shadows and glare

Source: Own author, 2019.

The graph shows that 59.8% of respondents have some kind of shadow or glare problem at work.

It was also asked if the worker has any symptoms of eye irritation, redness or tearing after the workday, as illustrated in the following graphic.

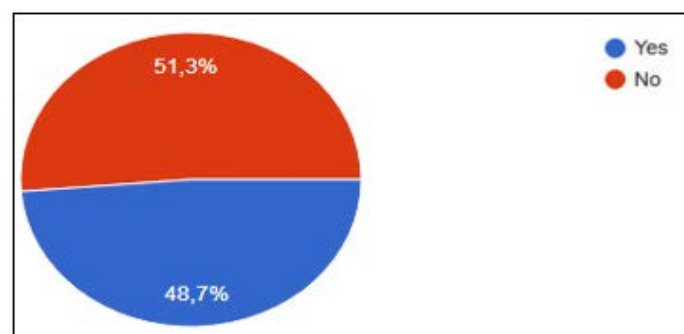


Graphic 3. Symptoms of irritation, redness or tearing

Source: Own author, 2019.

The results showed that 57.3% of respondents have some kind of eye symptoms after the workday and 42.7% do not experience any of these symptoms.

Another important fact of the research was in relation to workplace accidents arising from low lighting, the following graph shows the following results.



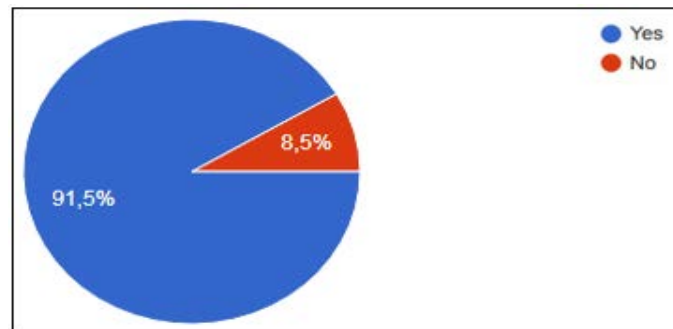
Graph 4. Work accident from low light

Source: Own author, 2019.

The results show that 51.3% of respondents did not suffer accidents from low lighting in the workplace,

and 48.7% already had some type of accident in the workplace from low lighting.

Finally, we were asked about the indication of the implementation of a lighting system in the sector studied, the results are illustrated in the following graph.



Graphic 5. Indication of a luminosity system

Source: Own author, 2019.

The results show that 91.5% of respondents felt positive the implementation of a brightness control system in the workplace, and 8.5% did not consider it important to have this brightness system in the workplace.

Regarding the prototype performance, the energy saving as a function of the lighting control system. Automation is an important factor in reducing energy consumption. Analyzing the performance of the lighting system proposed by the In this research, using it in a 10-hour journey, there is a significant reduction of 7% a.m. in energy consumption, taking into account that the prototype works only in one sector of the company that is the office. By extending this prototype to other sectors, energy savings can reach 20% a.m. on the energy bill.

Another important aspect is the low cost of the prototype presented, detailed according to the following table.

Table 4. Budget for the light control system

EQUIPMENT	QTY	PRICE
Female Jumper Cables	11	R\$ 14,00
1KΩ Resistor	1	R\$ 0,17
GY-2561 Light Sensor	1	R\$ 19,90
ESP8266 ESP-01 Wifi Module	1	R\$ 17,90
Arduíno UNO R3	1	R\$ 27,89
Protoboard 400 holes	1	R\$ 14,45
12V power supply	1	R\$ 9,90
<b>TOTAL</b>		<b>R\$ 104,21</b>

Source: Own author, 2019.

It is noteworthy that no information was obtained on the monthly electricity cost of the company nor access to the electrical panel of the studied sector, therefore, it was not possible to make an analysis of the financial viability of the prototype.

From the point of view of quantitative research results, it is important to highlight that productivity

depends directly on the well-being of the worker in the workplace, which is directly related to adequate illumination that provides good execution of activities without glare, shadows, sparkles. and reflexes, and other anomalies arising from poor lighting (KOVALECHEN, 2012).

#### **4.2 Qualitative Data**

The influence of good lighting is of paramount importance to the good performance of the task. Lighting should be evenly distributed, general and diffused to avoid glare, annoying reflections, shadows and excessive contrasts. With the scope of this research as a commercial office, lighting is a very relevant factor in relation to activities performed in the workplace.

The goal of a good project to control illuminance levels in the workplace is to improve crucial visual differences in brightness and color using lighting and other features (PAIS, 2011).

In this context, the prototype presented for lighting control enables automatic adjustment of illuminance for the most common office activities. Need that arose taking into account aspects related to physiological and psychological effects detected in the study environment.

The need to adapt this space, valuing characteristics such as comfort, health, safety, physical and psychological well-being, in order to make the work environment motivating and favoring the improvement of work performance activities, are factors of good equivalent lighting. the quantity and quality requirements of the resources allocated in a modern lighting control system (HENRIQUES, 2014).

Qualitative classified points correspond to three factors: physical; cognitive and psychological. The physical aspect is easily detected because it deals with the mode of operation, actions, gestures and movements to perform daily work activities. The cognitive aspect concerns reasoning, decision making, memorization, planning, elaboration and control, characterizing the intellectual side of the activity. This is complemented by the psychic aspect that is related to feelings, emotions, behavior and perception of those who perform the activity (LOPES, 2018).

The effects of good lighting according to recent medical and biological research have consistently shown that light entering the human eye has, in addition to a visual effect, also an important non-visual biological effect on the human body. As a result, good lighting has a positive influence on health, well-being, alertness, and even sleep quality. Our better understanding of the diversity of lighting effects teaches us that new rules governing the design of good and healthy lighting installations are necessary (HELIODORO et al., 2017).

Thus, visual comfort is an important factor within a lighting system. Since psychological factors such as behavior and attitudes in the workplace are related to this concept. Another factor is the improvement of visual acuity in activities, without effort and vision impairment, in the long run contributes to quality, productivity and reliability of work environment performance, which indirectly increases workers motivation (BORTOLAN, FERREIRA, TEZZA, 2019 ).

A good lighting system also promotes long term worker health. Some illnesses linked to office activities can be prevented such as stress, mental fatigue, physical injuries, accidents, headache, nervousness and emotional imbalance, drowsiness and other illnesses related to workplace lighting (KOVALECHEN, 2012)..

## 5. Conclusion

The aim of this research was to present a brightness control system through the Arduino prototype that will adjust the brightness in the workplace according to the Brazilian norms according to the activities performed and through the bibliographic review to point out its advantages and benefits to the company and its customers. workers.

Through the data collection results, it was possible to detect some negative aspects of the lighting of the work environment under study, such as: low light levels in relation to the values stipulated by NBR 8995-1; dissatisfaction with ambient lighting and some occupational diseases.

In this scenario, the need to create an automated brightness control system is a prototype-based system in Arduino that sends information to a computer that allows the measurement of brightness in the studied environment in real time, showing the results on the screen. (Figure 10) and automatically adjusting the brightness to the values stipulated in NBR 8995-1.

Due to the complexity that surrounds a lighting control system, prototype experiments were necessary, some programming and language difficulties were very present in the prototype creation. In this context, the prototype function test was successfully performed, the results of this prototype were divided into quantitative and qualitative.

It can be concluded that from the point of view of the quantitative benefits of the prototype, it is emphasized the increase of productivity in the work environment; reduction of disease and energy costs and compliance with current standards, as well as low cost for prototype implementation.

Regarding the qualitative benefits, the importance of visual comfort, a weighting factor in office activities, is emphasized, relating benefits of character: physical; cognitive and psychological, which provides well-being, motivation and quality of life at work.

Thus, the objective proposed by the present research was successfully achieved. It is indicated the use of the material developed for future consultations in new research on the theme addressed or serving as a model for problems related to lighting in the workplace, specifically in offices or rooms based on the use of visual activity in their areas. daily activities.

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## **Irregular Occupations and Environmental Impacts Caused by Fire of the Neighborhood of Educandos in the City of Manaus - Amazonas**

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### **Abstract**

*The paper describes the data of an exploratory research conducted after a fire that occurred in a favela space in the described Educandos neighborhood, located in the South Zone, peripheral area of Manaus. Educandos was formed over 100 years ago, when the first families began housing construction. At first glance, walking through the main streets of the neighborhood, there is no evidence of the irregular situation of the place, because masonry structures cover the stilt houses, installed near the Rio Negro bed, an area affected by the fire. Assuming that irregular occupation contributed to the cause of the fire, the study aimed to carry out the impacts caused by the fire. Tracing a qualitative and quantitative diagnosis of these impacts, it was observed through the Interaction Matrix that the impacts were negative in nature, 85% directly, has as local scale, irreversible for impacts to vegetation and social problems, high magnitude during the action. Of fire.*

**Keywords:** Manaus Free Zone; Rural exodus; Irregular Occupations;

## **1. Introduction**

The increase in industrial and commercial activities of the Manaus Free Zone - ZFM created through Decree-Law No. 288, of 28/02/1967 [1] has created a great demand for manpower, thus having a great interest of the populations from other states and other municipalities, in the process of migration to the Amazonian capital, resulting in rural exodus, in this case causing a new adjustment in economic and social development [2]. However, this hasty migration led to the chaotic growth of unplanned cities, triggering serious environmental problems and social imbalances [3].

Among the main causes of irregular occupations are the lack of concern from the authorities and the absence of public policies directed to city planning, especially in social matters, where the growth of cities is inevitable, with state intervention to guarantee access to housing. for the entire population [4].

The same authors emphasize the importance of urban planning as a continuous tool, where its objectives must be changed, following a chronological order as time goes by. They also emphasize that this urban planning must be linked to an adequate environmental planning, having as its principle the valuation and conservation of the natural goods, in contrast, the sustaining of life and guaranteeing the quality of life of the populations.

Population growth in urban areas in Brazil was at first characterized by poor planning and disorderly growth in large urban centers. The cities grew unbridled and with this the emergence of new neighborhoods, deriving from irregular occupations, bringing risks to the local population. These risks can be attributed to the change of use of buildings, which after the intervention processes began to house commercial and service activities. This indicates that urban areas will continue to grow at a rapid pace, particularly cities in developing countries [5].

In Manaus, given the urban expansion, there was an accelerated and disorderly growth of the population. According to IBGE data in 2010, [6] in the 1950s, Manaus had a count of 139,620 inhabitants, and in 2010, the last count by the agency, the city accounted for 1,792,881 inhabitants in the urban area and 9,133 in the area. totaling 1,802,014, this means an increase of 92.3% in 60 years, indicating major impacts.

In this condition, there are still anthropogenic impacts, caused by this growth and given the condition of invasion the occurrence of fires. The choice of the region for analysis was based on the form of occupation, in which the fight for the right to housing, the great performance and intervention of the public power, the evolution of irregular areas in this region, considered as one of the pioneers in demonstrating irregular occupations in the region. City.

In the city of Manaus, the demographic increase has concentrated in the last thirty years, due to the implementation of the Manaus Free Zone, with the need to hire people for the industrial area. However, the city had neither the capacity nor the infrastructure to absorb all migratory flows. Thus, low-income people have no alternative but to occupy the banks of streams, slopes, preservation areas and areas that are affordable to the reality of the person in need [7].

In Brazil, the urbanization process mostly occurred irregularly, few cities had a planning, characterized by an exclusionary growth. This growth and the lack of effective zoning policies contribute to the emergence of invasions and occupations that form risky areas, often clandestine and irregular, causing

major impacts and polluting the environment [8] and can cause disasters, as observed in recent years. irregular housing contributed to fires, resulting in human and material losses.

In the city of Sao Paulo, where more than one and a half million people live in 1,700 favelas, this type of disaster is so common that some residents experience it more than once. Between 2001 and 2012, registered by the Fire Department, a total of 1648 slum fires; In 2016, there were 202 cases; in 2017, 81 cases, [9].

In this context, fire safety must be part of a fire-fighting plan to manage or counteract disaster risks, as the costs of such an accident are high, globally in the tens of billions, estimated at 1% of annual global GDP [10].

There are countless cases of fires due to irregular occupations, in Brazil recent cases such as the one that occurred in Largo do Paissandu, in which a 24-story building occupied by a Social Movement for the Defense of the Right to Housing, occurred on May 1, 2018 caused the building to collapse, leaving four dead, four missing and countless families homeless, the cause of the fire being a short circuit in a socket that connected TV, refrigerator and microwave [11].

In Manaus, the population came across and experienced chaos in two areas of irregular occupation, taken by fire, being classified as the two largest occurred in this condition, in urban area occurred in the city. According to the Civil Defense of the State of Amazonas was considered the fire that occurred on December 17, 2018, the second largest in the state, with 600 homes consumed by the fire [12].

According to the Civil Defense, the fire was not bigger than in 2012, in the São Jorge neighborhood [13], with a total of 600 homeless families, in the Arthur Bernardes community, where the residents of this community were registered in the Social and Environmental Program of the streams from Manaus - PROSAMIM and awaiting relocation to another location.

The obligation to preserve urban areas makes it indispensable for the dynamics of fire safety, one of the main dangers that threaten these spaces. The occurrence of fires in peripheral areas, in slum areas or even in irregular occupations, has a series of negative consequences that can have a significant emotional and economic impact on the affected community. Immeasurable losses lead to the question of fire protection, the vulnerability of these areas to risks and the need to manage them, as they may affect the sustainable development of the affected area.

The direct and indirect losses resulting from fires are many, namely: standstill, damage to the environment, loss of historical heritage, loss of human life, financial loss, loss of information and damage to local businesses. The losses raise questions about the need to protect this community. It is also noted the need for more effective intervention by the government, considering the recurrent incidences of fire in these areas, with material and human losses [14].

Thus, this study aims to conduct a survey about the impacts caused by the fire in the neighborhood of Educandos, in the city of Manaus - AM, where from a previous diagnosis on the impacts caused by this irregular occupation; a qualitative and qualitative analysis of the impacts generated by the fire is envisaged; the characterization of impacts from the interaction matrix; besides the analysis of the scenario and its environmental losses: soil, water and air.



## 2. Materials and Method

The landmark of the Educandos neighborhood officially begins in 1856, when the establishment of the Educandos Artifices was created, at the time an advanced model of vocational education that was being opened throughout Brazil. At that time, the town was confined to the “Alto da Bela Vista”, a verdant hill whose access was through a single path that began at the “port of catraias”, where the students of the artisans' educators and visitors from other locations.

With a population of 15,857 thousand inhabitants [6], the Educandos neighborhood is located in the south of Manaus, connected to the center by the Padre Antônio Plácido bridge and the Cachoeirinha neighborhood by the Ephigênio Sales and Jucelino Kubistchek bridges (Figure 1).

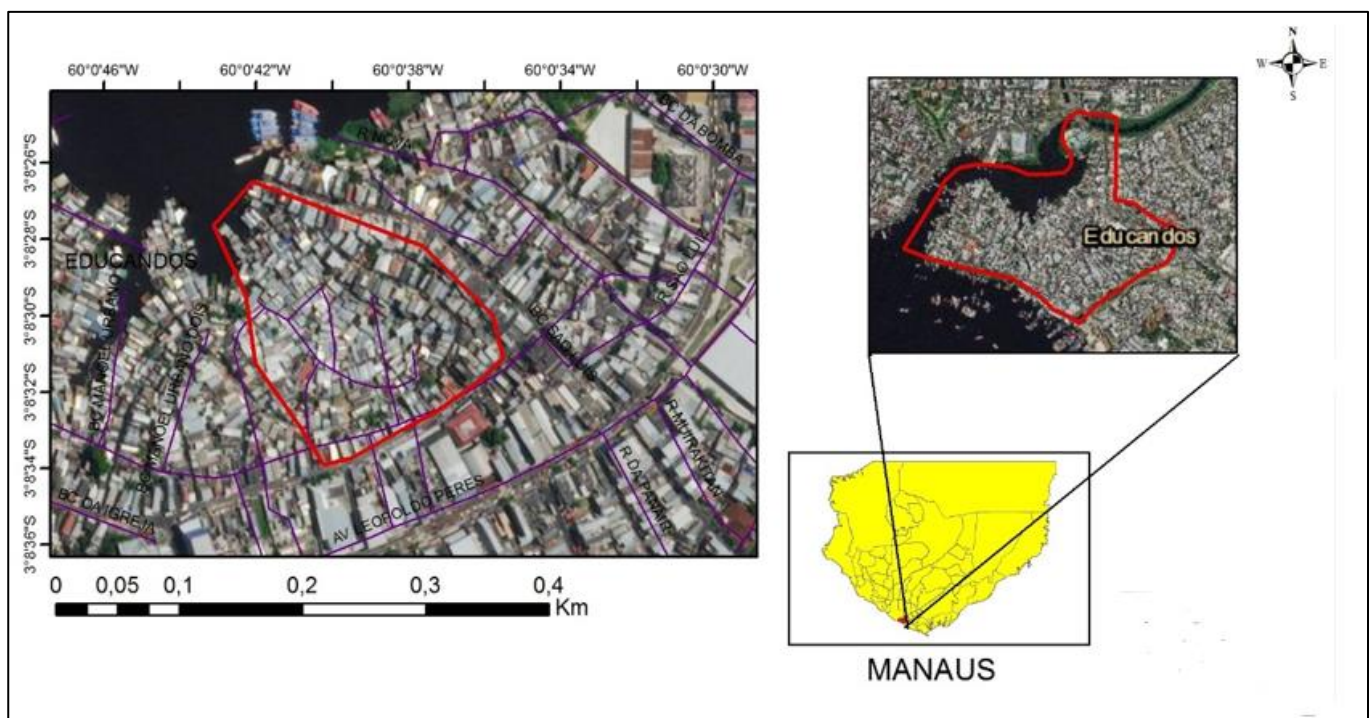


Figure 1. Location of Educandos Neighborhood, Manaus / AM.

Source: Thiago Barbosa Fernandes (2019).

### 2.1 Data collect

For this work we used exploratory research, seeking to describe the fire in the neighborhood of Educandos, which triggered social and environmental impacts on the community. The research approach is qualitative and quantitative, seeking to establish and understand the connection of the fire with the community, in addition to documentary research and on-site visit.

In addition, a checklist for data collection was carried out, observing a matrix of socioenvironmental impact of the area, aiming to demonstrate in a qualitative and quantitative way, the impacts occurred after the fire.

Environmental impact assessment methods and techniques are then structured mechanisms for collecting, analyzing, comparing and organizing information and data on impacts of a proposal. These methods aim to determine the magnitude of impacts [15].

The checklist consists of identifying and enumerating the impacts from the environmental diagnosis of

the physical, biotic and socioeconomic environments, listing the impacts resulting from the implementation and operation phases of the enterprise, categorizing them as positive or negative, according to the type of anthropic modification. to be introduced into the system analyzed, since the fire had already occurred in the study area.

Observing the environmental impacts, object of study the article 1 of the Resolution n° 001/86 of the National Council of the Environment [16], environmental impact is "any alteration of the physical, chemical, biological properties of the environment, caused in any way matter or energy resulting from human activities that directly or indirectly affect: the health, safety and well-being of the population, social and economic activities, biota, environmental aesthetic and sanitary conditions, as well as the quality of environmental resources. "

Therefore, the definition of Environmental Impact is associated with the change or environmental effect considered significant through the project evaluation of a particular project, which may be negative or positive [17].

The methodology used to identify the environmental impacts of fire was the interaction matrix, which refers to a two-dimensional control listing that relates factors to actions [18], commonly applied for impact analysis of operating enterprises, for example. correlate the activities performed with the aspects to be analyzed and the possible impacts caused [19].

According to [18] the interaction matrix method allows easy understanding, addresses social factors, accommodates qualitative and quantitative data, provides good guidance for conducting studies, and introduces multidisciplinary.

The evaluated criteria used in the Interaction Matrix for the fire occurred on December 17, 2018 have two classifications, one qualitative and one quantitative. The qualitative criteria used were:

- Nature: Indicates when the impact has beneficial / positive (POS) or adverse / negative (NEG) effects on the environment.
- Form: Refers to the way in which the impact, ie direct (DIR), arising from a project action, or indirect (IND), arising from another and / or other impacts generated directly or indirectly.
- Scale: Indicates impacts whose effects are felt on the spot (LOC), which may affect wider geographic areas (REG) or even strategic (EST). The local effect is considered to be the restriction of the area of direct influence, which is restricted to the contamination plume, the regional one that affects the Areas of Indirect Influence, the strategic one when relating a chain with boundary extrapolation.
- Temporality: differentiate the impacts, according to the immediate manifestation after the impacting action last in the short term (CP), in the medium term (MP) that is in intermediate situation. Finally, those whose effects are only felt after a period of time in relation to their cause, ie long term (LP).
- Dynamic: is the time of impact, is classified as permanent (PER), ie those whose effects manifest indefinitely and temporarily (TEM), those that occur for a specified period of time and then cease.
- Reversibility: classifies impacts according to those that, after manifesting their effects, are irreversible (IRR), reversible (REV) or cyclic (CIC). It identifies which impacts can be fully avoided or can only be mitigated or compensated.

The quantitative criteria analyzed in environmental impacts are usually assigned with numerical values relating the intensity range, which are:

- **Magnitude:** refers to the degree of incidence of an impact on the environmental factor in relation to the universe of this environmental factor. It can be low (1-3), medium (4-7), high (8-10), depending on the intensity of transformation of the pre-existing situation of the impacted environmental factor. The magnitude of an impact is therefore treated exclusively in relation to the environmental factor in question, regardless of its importance, as it affects other environmental factors.
- **Importance:** refers to the degree of interference of the environmental impact on different environmental factors. May be No importance (<<), Unimportant (<), Important (>), Very Important (>>) to the extent that it has more or less influence on the overall local environmental quality.

### 3. Results and Discussion

In the study an analysis was made of the social and environmental impacts from an urban fire, the fact occurred in the neighborhood of Educandos in the municipality of Manaus, State of Amazonas, the neighborhood began through an irregular occupation.

During the research, it was observed that the population growth of the neighborhood had a direct influence on the impacts caused by the rural exodus of that decade [3] and because of this event, people began to see irregular occupations as the purpose of guaranteeing the right to housing. Another factor to consider is the implementation of Public Policies through the PROSAMIM program, however some families even registered in the program had resistance to leave the place, since they have a whole affective history with their place of origin, thus being at the mercy of an area without infrastructure.

The research exposed a scenario before the fire, the neighborhood of Educandos showed lack in basic sanitation, desirable for a neighborhood, to have effective drinking water supply systems, sewage collection and treatment, public cleaning, a system of rainwater drainage, according to [20] without intervention by the government to regularize, organize and supervise, the State is totally absent and irresponsible, leaving apparent the neglect of slum areas, thus preventing the natural development of social activities. and economical of these places.

Thus we can see the environmental impacts during the fire as point factors, using this concept we point out:

**Soil Degradation** - The site has had an impact since the invasion was implemented, since all vegetation was removed, and it was eutrophied, causing siltation on the Rio Negro riverbed. During the fire process there was an immediate disposal of nutrients by burning material, which could be used for the recovery of degraded areas, however there were toxic elements such as plastics, as well as burning of heavy materials through electro-electronic material. For a better soil verification, chemical analysis and physical analysis through soil compaction are suggested, as there was burning of inorganic materials and not easily decomposed (non-biodegradable). The burning process, in turn, causes soil wear and the emission of toxic gases into the atmosphere [21].

**Social Impact** - The present study also showed that the environmental conflicts in urban centers are problems of past decades, and that the extension of this problem comes with the perception that the work of raising awareness among the population and according to [22] pay attention to projects and improvements in urban spaces, based on environmental monitoring and supervision, educational

practices, with emphasis on environmental education continues, and effective in land use plans and regulation, always seeking a social and environmental set. The event in addition to material losses left an even greater trail of social impact, where even with the existence of implementation of public policies in that area, there is a difference between residents of the neighborhood, with those who actually lived in the favela, the growth in its disorder, it highlighted the differences between housing, access to public services, as well as social inequality, causing spatial segregation. It is not possible to say which is the best way to deal with the situation in question, however, as [23] the social impact is the causes of environmental problems, the quality of the environment in the face of anthropic actions and the measures taken by society in the face of such pressures. , should take this context into account.

Degradation in the air - In the invasion process it is possible to show CO<sub>2</sub> emission to atmosphere due to vegetation removal and during the fire there was emission of other pollutants, because the place had a lot of combustible material, among them plastic emitting carbon monoxide, the process LPG gas emitting methane, the decomposing material emitting sulfur. Also according to [24] biomass burning smoke contains a large number of chemicals, including gaseous particles and compounds, namely particulate matter (PM), carbon monoxide and dioxide (CO and CO<sub>2</sub>), methane (CH<sub>4</sub>) , non-methane hydrocarbons (HCNM), nitrogen oxides (NO<sub>x</sub>), nitrous oxide (N<sub>2</sub>O) and ammonia (NH<sub>3</sub>).

Following is a Matrix that contextualizes and measures all these impacts by correlating the physical, biotic and socioeconomic and cultural environment.

Table 01. Matrix of Environmental Impacts from the Fire

Analysis Medium	Environmental impacts	Qualitative Features						Quantitative Features	
		Nature	Form	Scale	Temporality	Dynamics	Reversibility	Magnitude	Importance
PHYSICAL MEDIA	1. Likely contamination of soil by improperly storing and disposing of solid waste during fire.	Neg	Dir	Loc	MP	Tem	Rev	3	>
	2. Likely change in water quality due to tailings to the Rio Negro bed.B6: B10	Neg	Dir	Loc	LP	Tem	Rev	5	>
	3. Change in temperature, heat, generated by the action of fire.	Neg	Dir	Loc	CP	Tem	Rev	9	>>
	4. Reduction of air quality by emission of particulate matter and gases due to the burning of fuels and woody material (stilts house).	Neg	Dir	Loc	MP	Tem	Rev	6	>
	5. Probable alteration of the Rio Negro characteristics due to the siltation process.	Neg	Dir	Loc	MP	Tem	Rev	5	>
	6. Removal of vegetation cover for installations of irregular occupations.	Neg	Dir	Loc	LP	Cic	Irr	8	>>
ECONOMIC AND CULTURAL SOCIETY	7. Likely accidents during the fire, including burns and inhalation of toxic fumes.	Neg	Ind	Loc	CP	Tem	Rev	5	>>
	8. Generation of homeless or homeless.	Neg	Dir	Loc	LP	Cic	Rev	9	>>

9. Decrease in local income due to commercial job posts being affected by the fire.	Neg	Ind	Loc	MP	Cic	Rev	6	>
10. Decrease in the quality of life of residents of the area affected by the fire.	Neg	Dir	Loc	LP	Cic	Irr	8	>>
11. Allocation of investments for financial compensation to affected households.	Neg	Dir	Loc	MP	Cic	Rev	7	>>
12. Loss of historical information from residents of affected area.	Neg	Ind	Loc	LP	Per	Irr	8	>>

## SUBTITLE

NATURE: Pos = Positive, Neg = Negative;

FORM: Dir = Direct, Ind = Indirect;

SCALE: Loc = Local, Reg = Regional, Est = Strategic;

TEMPORALITY: CP = Short term, MP = Medium term, LP = Long term;

DYNAMICS: Tem = Temporary; Per = Permanent, Cic = Cyclic;

REVERSIBILITY: Rev = Reversible, Irr = Irreversible;

MAGNITUDE: Low (1-3), Medium (4-7), High (8-10);

IMPORTANT: No importance &lt;&lt;, Unimportant &lt;, Important&gt;, Very Important &gt;&gt;.

Given the likely environmental impacts previously raised through the Matrix, measures to mitigate negative environmental impacts are proposed.

Table 02. Environmental Impact Measures

Study Medium	Environmental impact	Environmental Measures	Measurement Classification
physical	1	Properly dispose of solid waste generated by the fire, according to the execution provided for in the National Policy on Solid Waste - PNRS, Law No. 12,305.	1
	2	Conduct water quality monitoring; Install containment hoses on the riverbed.	1
	3	Impact was punctual and no mitigation measure was required.	1
	4	Air quality monitoring; Pulmonary health monitoring of the residents of the neighborhood of the Educandos neighborhood.	1
	5	Restoration of the riparian forest, respecting a minimum width of 30 (thirty) meters, for the waterways.	1
	6	Implement and execute the Degraded Area Recovery Plan - PRAD.	1
ECONOMIC AND CULTURAL SOCIO	7	Preparation of an Emergency Response Plan - PAE with the Civil Defense and Fire Department for fires in slum areas.	1
	8	Public Policies - Housing and fundraising program; develop housing projects aimed at establishing programs to facilitate the access of the low-income population to housing, as well as the improvement of housing and urban and housing conditions.	1
	9	Public Policies with funding support for local merchants and entrepreneurs.	1
	10	Public Policies with Housing Construction - COHAB including in this, recreation area, health center, school and police station, at the fire place or adjacent area.	1
	11	To verify with the City Hall the progress of the Detailed Response Plan (PDR), where it requests resources from the Federal Government to reinforce the assistance to fire victims, the PDR was based on Law 12.340 / 2010, in addition to Decree 7.257 / 2010 .	2
	12	Intervention Measure - Environmental Education, including cultural, economic and immersion insertion, where the person affected by the fire can understand and feel part of that environment.	1

## SUBTITLE:

1 - Mitigating Measures

2 - Compensatory Measures

Previously raised through the matrix, mitigating measures for negative environmental impacts are proposed.

#### 4. Conclusion

As the study was a qualitative and quantitative analysis addressing the social and environmental impacts, it is of utmost importance that studies are conducted in the area of fire, with quantitative analysis instruments through the assessment of environmental impacts on soil and water, so that they are measured and quantified, I thus try to gain a statistical understanding of how the environment and the people living there were affected, taking into account irregular occupation as a cause of the fire.

It was also observed that the population growth of the city of Manaus was, in fact, responsible for the aggravation of problems related to soil occupation, lack of basic sanitation, damage to the vegetation cover, with the removal of the riparian forest there was a siltation process. Rio Negro, as well as pollution of water bodies. Homelessness was intensified, resulting in a fire that occurred in this area, the population even at the mercy of all these problems, came across the fire, which brought aggravating social problems. Finally, the rapid growth of urban space, social exclusion and the neglect of public power were conditions for the emergence of irregular occupations, these movements created a new housing format that generally does not meet urban standards, as well as not. provides safety to the community, resulting in tragedies as reported during the study.

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## THE LEADERSHIP OF A SCHOOL UNIT

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### Abstract

*The school principal has a specific role in the school environment, which for the most part is bureaucratic. However, given the constantly changing environment in which the school operates and given the relationship between the school and the local community, the school principal needs to undertake additional responsibilities and moreover also possess specific skills in order to fulfil his or her role as a principal-leader. The ultimate research goal is to determine the purpose of leadership within the school unit. The method adopted for the study was a review of the relevant literature. In light of the present study, it is evident that in order for educational organizations, or otherwise educational units, to accomplish their purpose, effective management is a prerequisite. As regards the factors that contribute to school effectiveness, researches have shown that there is an inseparable link between school unit leadership and school effectiveness. An effective school principal-leader assists and supports teachers, while overseeing the educational work, and also encourages and promotes the involvement of teachers and parents in the decision-making process, which leads to the commitment of teachers to the school organization and increases their job satisfaction and performance. Furthermore, teachers should be able to teach all children, both those with high cognitive abilities and those with a low level of academic skills. An important role in this process plays the principal of the school. However, teachers, on the other hand, should not simply accept the principal's vision, especially if they want to be an integral part of the process of school change. Instead, teachers should create a vision for the school together with the principal, and not just act as executors of his/her vision.*

*Finally, four factors characterize the successful process of improving the school unit. These factors are: recognition of the improvement process by the school leadership, interaction and communication both between school members and between the school unit and the local community, the existence of a system of values, as well as cooperation between school members, and between them and society, to design and implement the selected strategies.*

**Key words:** School Principal-Leader, Management & Leadership, Effective Leadership

### 1. INTRODUCTION

In order for educational organizations, or otherwise educational units, to accomplish their purpose, effective management is a prerequisite. After all, various studies have shown that both progress and

behaviour of students depend on the characteristics and management of the educational unit. Leadership plays an important role in the management of school units, while at the same time it is a significant factor in connecting the school with the local community and in achieving school effectiveness. The present study addresses the concept of leadership within the school unit. The school principal has a specific role in the school environment, which for the most part is bureaucratic. However, given the constantly changing environment in which the school operates and given the relationship between the school and the local community, the school principal needs to undertake additional responsibilities and moreover also possess specific skills in order to fulfill his or her role as a principal-leader. Overall, research seems to show that an effective school is run by an effective principal who works in collaboration with the staff, together they share a common vision for the school, and they put a great deal of emphasis on achieving goals. Many studies appear to indicate that the existence of school culture is important for the effectiveness of the school unit. The school principal also works outside the school boundaries, that is, with the environment in which the school unit operates, and therefore should interact with this environment. An effective school relies on the interaction between the school unit and the local community. In relation to the community, the school management has five key responsibilities: 1) to represent the school in the outside world, 2) to support senior management in the development of its work, 3) to encourage parental involvement, 4) to foster relationships with employers and 5) to encourage the community to learn (Zarotis et al. 2019; Ntalossis et al. 2019).

## **2. METHODOLOGY**

The present research is a bibliographic review study, presenting the critical points of the existing knowledge about the concept of leadership within the school unit. There is no specialized and comprehensive work on this subject in the relevant literature. This work endeavors to cover this gap and will perhaps also be a useful aid for those who in the future will attempt similar efforts. The main aim of the bibliographic review is to frame the study within the "body" of the relevant literature. The review of the current study concerns clearly formulated questions and uses systematic and explicit criteria for critically analyzing a body of published papers by summarizing, sorting, grouping and comparing.

## **3. Bibliographic review study**

### **3.1 Relationship between management and leadership**

As Koullanis (2008) states, "Managing an educational organization is the process of coordinating people (students, teachers, support staff), activities, and existing tools in order to provide education more effectively". Leadership, as Watkins (1986, as cited by Georgiadou and Kambouridis, 2005, 126) conceived it, "should be seen as a dialectical process that creatively influences the production, reproduction and transfer of certain practices and structures. Such a viewpoint makes the leadership of a school an integral part of its cultural identity."

The management theory of school organizations reports the following four forms (OECD, 2009):

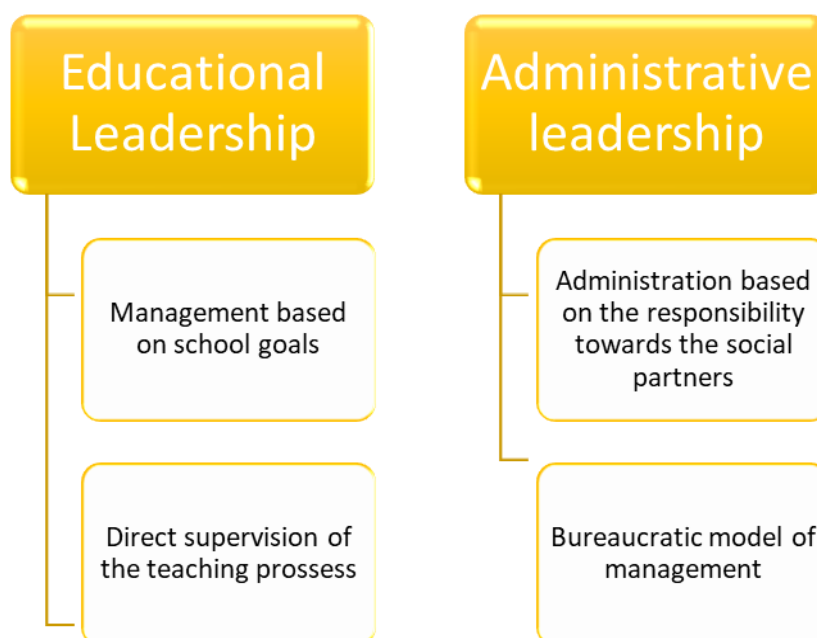
1. Management focused on school objectives: Principals take actions that are directly related to the goals of the school, focusing on ensuring that classroom teachers achieve those goals. Principals

who adopt this style of administration tend to set goals that are based on student performance and curriculum improvement.

2. Educational management: The principals who adopt this form of administration work with teachers to correct the pedagogical problems that may exist, and at the same time they inform teachers of opportunities for additional training.
3. Direct supervision of the teaching process: Based on this model, principals make suggestions to teachers about improving their teaching techniques and at the same time they often monitor pupil's efforts and progress.
4. Responsible management: Principals who adopt this style of management focus on persuading parents and teachers on the need for new ideas and processes as regards school operation in order to develop responsibility towards students, teachers, parents and the local community in general.
5. Bureaucratic management: The principals that adopt this style of administration are more concerned with procedural matters, trying to ensure that everyone in the school follows the regulations and that everything works in accordance with the law.

The two leadership styles that correspond to the previous five models of management are educational leadership and administrative leadership. Educational leadership relates to the first three models of administration, while administrative leadership relates to the responsible and bureaucratic model of administration (OECD, 2009). The figure below illustrates this relationship between management and leadership models.

**Graph 1. Relationship between management models and leadership styles**



Finally, it is worth noting that in the decentralized system of administration there are four forms of school unit leadership at decision-making level (Leithwood & Menzies, 1998). The first is the management control, which delegates this authority to the principal of the school unit. In this way, only the principal is responsible for each school unit, which maximizes cost effectiveness at all levels. Professional control

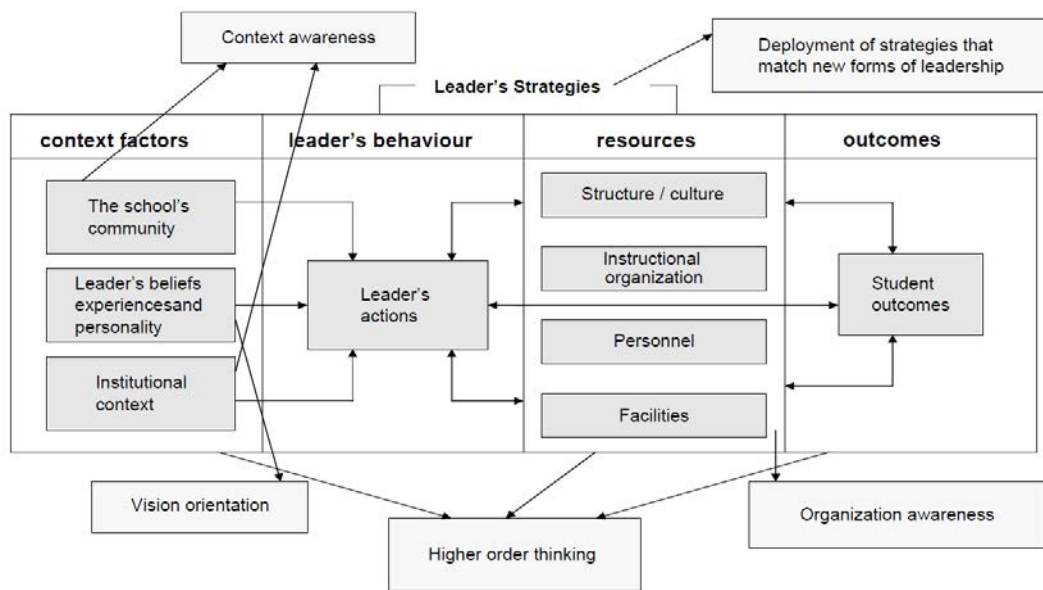
delegates the power of decision-making to teachers, aiming to exploit teachers' knowledge of what are the school needs in the classroom. At the same time, this model may motivate teachers to increase their efficiency, which leads to increased effectiveness as regards the learning process. The third form is the community control, according to which parents are responsible for making decisions. In this model, principals and teachers respond more to the needs of parents, better reflecting the needs and preferences of the local community. Finally, the fourth form is balanced control, where the decision-making process is delegated to parents and teachers, who are the main social partners of a school unit. However, the model where only principals decide is absent, since the opinion and active involvement of both teachers and parents is necessary as they express, in a way, the needs of the local community.

### **3.2 Responsibilities and competencies of the school principal**

Principals are the key factor in a school unit, since under education law, they are primarily held accountable for the school community and it is their responsibility to ensure the conditions for a democratic, competitive, effective and open to society school (Koutsospiros, 2007). The success of the school principals depends to a large extent on how they handle the human factor, that is, their leadership role. The role of the principal changes as values and structures of society change (Tsayang et al., 2010). According to Michopoulos (1998, as cited in Fasoulis, 2001), nowadays societies require efficient and effective education, and therefore the former traditional model of the school principal can no longer respond to the demands and challenges of current societies. School leadership should be seen as a function of principals' personality, competence and characteristics with less emphasis on their abilities, knowledge and effort (Feeney, 2009).

In this context, Krüger (2009) argues that school principals should have competencies that are reflected in their behaviour, attitudes and actions. All of these competencies can be defined as the ability of school principals to combine knowledge, skills, attitudes and professional identity, which are appropriate for a particular occupational situation, with their personality characteristics and their development in an integrated framework, capable of enabling appropriate action in specific occupational situations within the school unit. These competencies and therefore leadership capacity can be achieved not so much based on the individual characteristics of school principals, but through the emphasis on creating a new framework education in relation to leadership (Rhodes & Brundrett, 2006). The figure below illustrates the competencies that a school principal should possess in the overall context of effective leadership of a school unit.

**Graph 2. The competencies that a school principal should possess for the effective leadership of a school unit**



(Krüger, 2009, 121)

According to Nakos (2007), a school principal should accomplish the following objectives: (a) coordinate the school's human resources and logistics to achieve the school unit's objectives, (b) facilitate the adaptation of the school to the social and economic changes taking place in the external environment and finally (c) maintain and improve the logistical infrastructure of the school and its human resources. In this light, the school principal is both administratively and pedagogically responsible for the school, and should therefore make use of the capabilities of the staff available in distinguishing roles and responsibilities (Nakos, 2007). According to Dean (1993), the administrative functions for which the school principal is responsible are the supervision of the school's administrative work, the monitoring and control of the school's finances, or otherwise the financial management of the school, the monitoring of the building and school grounds, and the implementation of relevant legislation in relation to the health and safety of children in the school environment.

National Committee for the Principals of Secondary Schools (NASSP, 1982, as cited in Dean, 1993) identifies seven main responsibilities – functions of the school principal, which are the following:

- Developing school objectives, as well as developing policies and guidelines
- Organizing school and designing programs to implement and achieve the objectives set.
- Monitoring the implementation of policies and strategies to achieve the objectives
- Resolving any problems that arise in the school environment as well as maintaining order
- Managing and distributing school material
- Creating the appropriate climate for the personal and professional development of the educational staff
- Representing the school in the environment in which it operates

The characteristics that an effective principal - leader should have are the following (Kapur, 2007):

- Vision for the future. In all organizations the vision for the future is linked to the future of the organization. Thus, the head of a school unit should be able to identify potential opportunities and threats due to social change and social structures and institutions.
- Transfer the vision. The charismatic and effective principal-leader should convey his/her vision for the educational organization and the rest of the school community, and ensure that everyone shares the same vision and has the same philosophy and mission. He/she also needs to confirm that everyone agrees with this vision and will participate in policies to bring that vision to reality.
- Raising awareness. The principal should find those outlets and channels that will allow for the expression of any apprehension or concern and will foster the cultivation of awareness amongst students in particular, and the promotion of social awareness and cohesion.
- Cultivating critical consciousness. An effective principal - leader should also cultivate critical awareness (reflection, research and discussion). Students should gain a sense of individual and collective responsibility, learn about their relationships with other members of the local community and the community in which they live, and finally learn about human rights. Through education, students should increase their ability to participate actively in the decision-making process that leads to social, cultural and economic change.
- Creating a positive climate. The principal should ensure that teachers create a positive and safe environment which encourages students and which, at the same time, is emotionally secure.
- Communication with teachers and parents. An effective principal-leader should be in touch and communicate with both teachers and parents so that he/she can understand their needs, desires, and suggestions. Communication with parents also reinforces their sense of belonging to the school community and participating in activities within the school.

According to surveys, school principals are responsible for four main areas. The first is to evaluate the effectiveness of teachers, the second is to provide a supportive climate, the third is to convey the mission and purpose of the school to those involved in the educational process, and the fourth is to provide a climate that encourages learning. In addition, the responsibilities of the principal include team orientation and encouraging professional development (Kotton, 2003).

However, Boris - Schacter and Langer (2006) point out that the school principal is mostly in charge of administrative responsibilities than of duties related to school administration. This is an obstacle to the development of the principal as the leader of the school unit, as it is argued that a principal's duties should be more related to learning and education (Georgiadou & Kambouridis, 2010). In fact, the principal should spend less time fulfilling bureaucratic responsibilities and more time in the classroom, teaching, guiding and counseling teachers as well as enhancing their personal and professional development (Boris - Schacter & Langer, 2006).

This fact also raises a debate about the characteristics a principal should have in the context of the effectiveness of the school unit.

### **3.3 The school principal – leader in the context of the effective school unit**

Leadership is based on two directions: the first is the concept of power, which is the right of the principal to control the actions of others, and the second is the concept of influence, which means influence the actions of others without exercising power (Deji & Makinde, 2006).

An effective school principal, or otherwise principal-leader, creates his or her own vision for the school, and at the same time imparts it not only to the teachers of the school unit but also to the parents and the local community (National Research Report for Greece, 2008; Cotton, 2003). As noted by Day et al. (2001, as cited in Campbell et al., 2003), good leaders are informed by and communicate clear personal and educational values that represent their ethical goals for the school unit. After all, one of the factors that positively affect the quality of education is having a clear vision for the school in terms of understanding the results, the priorities and the evaluation, along with recognizing the school's responsibility for achieving this vision and its individual goals (Pamuktsoglou, 2001). Based on this vision, the principle sets specific goals. In this context, an effective principal - leader is committed to this vision and to the school mission, in order to fulfill the individual objectives towards the effectiveness of the school unit (Murphy, 2005).

Slater and Doig (1988, as cited in Murphy, 2005) point out that the energy for change in the school environment is channeled by principals who can promote and direct it. Furthermore, educational work is largely determined by principals (Whitaker, 1997, cited in Murphy, 2005). The principal's commitment to the school objectives and to the school mission is almost the only necessary condition for making a school unit effective (Birnie and Lustgarten, 1996, as cited in Murphy, 2005).

In addition, with regard to the objectives of the school unit, Scheerens (2000) points out that it is important to set priorities, such as the relative importance of cognitive versus non-cognitive objectives, and the emphasis on basic subjects, such as mathematics and composition, as opposed to non-basic courses. In addition to creating a vision for the school unit and his/her commitment to that vision, a principal creates a climate of support, unity and collaboration within the school that contributes to its effectiveness (National Research Report on Greece, 2008; Cotton, 2003).

This positive climate is further enhanced by the promotion of teacher participation in decision-making. The involvement of teachers in the decisions taken within the school unit requires a participatory management approach (National Research Report on Greece, 2008). The joint involvement of the principal and the educational staff in the decision-making process and the management of the educational unit is an element that contributes to the improvement of the quality of education (Pamuktsoglou, 2001). Heller and Firestone (1994, as cited in Murphy, 2005) point out that the success of teachers' initiatives is largely based on the active support of school principals, as the principal has the greatest influence on the role of teachers as leaders (within the classroom), through his/her support and contribution to their personal and professional development (Blegen and Kennedy, 2000, as cited in Murphy, 2005).

Also, in the light of a more decentralized and participatory management system, the principal should take the following steps during the decision-making process (Res, 2004):

- i. Problem recognition. The principal is responsible for identifying the problem facing the school unit, describing it in a clear and comprehensible manner, and setting the policy goals for its solution.
- ii. Specifying school unit needs and performance criteria

- iii. Offer alternative solutions
- iv. Evaluate alternative solutions and find the most appropriate one
- v. Implement solutions

Campbell et al. (2003) point out that leadership enhances school morale and contributes to teachers' leadership. In particular, inspirational leadership can lead to effective teaching, which in turn leads to an effective learning process. In addition, effective leadership can contribute to teachers' commitment to the school organization and consequently increase teachers' job satisfaction and performance (Hulpia et al., 2009). It also encourages teacher-to-teacher collaboration (Hammersley-Fletcher, 2005), which ultimately leads to increased educational quality, improved school performance and school effectiveness. At this point it is worth noting that school ethics are in line with the moral values that society expects of current students and future citizens. In the context of school ethics and principals, Spitzmuller and Ilies (2010) point out a holistic approach to school management through authentic leadership. According to this approach, the principal - leader should have strong values and ethics, and a vision for the future of the school unit. Furthermore, he/she should be optimistic and focus on results with the contribution and participation of everyone involved.

Effective leadership should not focus solely on students' academic performance and the creation of tomorrow's workforce. Instead, it should focus on the strengthening of the democratic spirit and social justice within the school unit, the reinforcement of the school's organizational culture and the creation of democratically minded citizens who will respect diversity and be tolerant of multiculturalism (Mullen and Jones, 2008). The above is based on the finding that the school is responsible for creating the patterns and behaviours that give citizens the ability to act collectively (Godoy et al., 2007).

In addition, the school principal is also responsible for adapting the school to the new teaching and learning methods dictated by the information and communication society in the context of school effectiveness (Krüger, 2009). Nakos (2007) lists the challenges that the principal of a school unit has to face in the context of present-day societies. These challenges are: the design, implementation and maintenance of an information infrastructure, the integration of technology into the curriculum, the use of technology to enhance communication with the wider community, the search for resources that will further enhance educational technology, the use of technological means to carry out administrative responsibilities, ensuring the safe access of pupils and teachers to the internet, creating conditions for teachers' further training on the use of new technologies and finally providing support and encouragement for teachers to make use of new technologies in the educational process.

Finally, it should be noted that a leader-leader understands and utilizes the individual skills of teachers, contributing to their personal and professional development, e.g. through their participation in continuing education programs (National Research Report on Greece, 2008).

From the above analysis it is understood that an effective school is run by an effective principal - leader who works together with teachers, adopting a participatory management model. The principal should have a vision for the school and moreover he/she should be able to impart it to teachers, parents and the wider local community, putting emphasis at the same time on school goals.

In addition to the above, the processes involved in managing a school unit are effectively executed when the principal (Dean, 1993):



- has a mission for the school
- inspires commitment to this mission and gives direction and purpose to his work
- coordinates school work through the allocation of tasks and responsibilities
- is actively and visibly involved in the design and implementation of the management of any change
- is ready to appreciate and praise the contribution of teachers
- has the gift of communication and informs those involved in the educational process about important decisions and actions?
- has the ability to challenge the obvious, so as to address problems and take advantage of opportunities
- is committed to school, its members and reputation.
- objectively assesses strengths and weaknesses so as to make the best use of any practices to remedy deficiencies
- emphasizes the quality of teaching and learning, every day and in every lesson
- has high expectations from all school members and all students
- Recognizes the need for support and encouragement from all in order to do their best for the purpose and mission of the school.

## **2. Conclusion**

As regards the factors that contribute to school effectiveness, researches have shown that there is an inseparable link between school unit leadership and school effectiveness. It should not be considered that leadership has only a direct impact on learning outcomes but also an indirect on the school unit through its influence on school organization and school culture. An effective school principal-leader assists and supports teachers, while overseeing the educational work, and also encourages and promotes the involvement of teachers and parents in the decision-making process, which leads to the commitment of teachers to the school organization and increases their job satisfaction and performance.

School principals are considered to be the most critical factor contributing to the reorganization of the school, based on changes in the external environment of the school unit, as well as the demands of parents, pupils and the local community. Indeed, school improvement has been linked to activities that aim to change school and the education system, and which enhance school effectiveness by increasing the desired outcomes for learners.

According to surveys, school principals are responsible for four main areas. The first is to evaluate the effectiveness of teachers, the second is to provide a supportive climate, the third is to convey the mission and purpose of the school to those involved in the educational process, and the fourth is to provide a climate that encourages learning. In addition, school principal's responsibilities include team orientation and encouraging professional development. The leadership of a school unit plays a critical role in the quality of education provided. A qualified elementary school principal should never embrace the view that the school must remain stubbornly entrenched in its strictly predetermined educational and solitary duties, devoted solely to providing knowledge and an indifferent viewer of the rapid developments in

society.

Finally, the school principal should act like a coach, partner, motivator, and at the same time there should be a distinct school goal (vision) in the direction of a common perception for the results, priorities, evaluation and responsibility, recognizing the responsibility of the school for its achievement (Zarotis et al. 2019; Ntalossis et al. 2019).

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# Comparative Analysis of e-Commerce Between China and Uzbekistan.

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## Abstract

*This research work is devoted for the purpose of showing the diverse opportunities and unravel the growing trends of e-Commerce in terms of trade between China and Uzbekistan. On-line customer research has been carried out mainly for American and European markets by academics and marketers. While e-Commerce is developing more rapidly in China with big companies raking in billions, it is somehow slow in Uzbekistan; a profound understanding of necessitating modalities is a fundamental drive into promoting further growth. This work investigates this intriguing concept in context of e-Commerce involved in inquiring about e-Business and corresponding e-Payment systems in China and Uzbekistan respectively. The article features theoretical segments through which statistical models and correlations were interpolated. The main aim being to establish segmental information and identify influential factors of e-Shopping using e-Payment models developed in the respective countries. The key findings include the geographical influence, demographic statistical analysis and internet technologies being used in the two countries.*

**Keywords:** e-Business, e-Commerce, e-Payment, Market, Internet, Survey

## 1. Introduction

E-Commerce started way back in the 1960s when organizations began to use Electronic Data Interchange (EDI) to transfer documents for their business back and forth and keeps growing at a tremendous exponential rate [1]. The 1990s saw the emergence of online shopping businesses, which have culminated into quite a phenomenon at present. It has become so convenient and easy, that anyone can shop for anything right from the comfort of their living rooms. This has evolved more with the emergence of smart devices, where now, you can shop from anywhere and anytime, with a wireless device connected to the internet. It is now entirely possible to search for almost any product or service online, without having to go anywhere physically in addition to consumers' on-line behavior which is different in nature from traditional consumer behaviors due to the unique characteristics and interaction of technologies and cultures [2-4].

E-Commerce, also known as e-Business (Electronic Business), is simply the sale and purchase of services and goods over an electronic medium, like the internet [5, 6]. E-Commerce literally refers to all commercial transactions carried out online. This means, whenever one buy or sell something on

the internet, they are involved in e-Commerce. It also involves electronically transferring data and funds between two or more parties. Simply put, it is online shopping as we commonly know it.

In this paper we investigate the relationship between China and Uzbekistan along e-commerce marketing according to steady growth patterns recorded from previous years. We carried out a survey probing influential trends in the e-Business models. A key factor influencing the successful growth of e-Commerce, identified by major corporations such as the Better Business Bureau and the Federal Administration, is people's trust in Internet vendors. Better Business Bureau went on to say, there is a necessity of "promoting trust and confidence on the Internet". The Better Business Bureau further claims that the main reason why people do not buy online is their worry with regards to online payments security, reliability of companies and the deficiency of a privacy policy. The issues regarding privacy pose a need for innovative financial solutions for e-Commerce tailor made for the customers. In addition, Luhmann's theory of trust claims that familiarity is a precondition for trust, and trust is a prerequisite of social behavior, especially with regard to crucial decisions [1, 7, 8].

### **1.1. Literature in brief**

Business and the economics of the day are now interconnected with the development and implementation of new technologies. This has become the drive for many governments to develop and implement innovative ways for financial inclusion and also ways to penetrate and benefit from the global market. According to an article by Sherzod Aktamov and Khavokhon Rakhimova most economists they show of any modern economy is now driven by innovation and implementation of new technologies of them [9]. The correlation between the growth of an economy and its corresponding technology has been proposed through the Solow-Swan model (1956) and different other findings from reputable scientist among them Kondratieff, Schumpeter (1961), Mensch, Porter (1990), Romer (1994) [10-12]. The growth of e-Commerce is expected to drive the revolution of the structures and functions of economies at various levels and direct impact experienced at macro economy. With the magnanimous rise of e-Commerce, many researches are being conducted to essentially investigate the growth trend and the driving forces around this intriguing research field. Studies were carried out by Morrison and Siegel (1997) and Helpman (1998) on attributes of e-Commerce and evidence suggests e-commerce has great impact on the productivity and the economic performance of a country [13]. There is vital need to invest in research and development so as to fully utilize the great opportunity in the e-commerce sector. E-Commerce poses as inevitable benefit to the technical and skilled workforce by pushing their wages higher, as purported by the findings from Bartel, Lach and Sicherman (2009) and Berman (2012). There is also a spontaneous benefit on marginalized sectors of economy which encompasses creating more opportunities for women. Empirical data to show that internet usage brings an open trade zone, and results indicating internet users in developing countries are more open to trade, have been provided by Wallsten (2003) and Balamoun (2002).

## **2. Methodology**

This paper contains a research conducted through qualitative analysis. The collected information was processed through highlighting the most important points, which could have a crucial role showing the potential of e-Commerce in China and Uzbekistan trade [9, 14-18]. Modelling and correlation of statistical data was used to project future trends in e-Commerce between the two countries. Based on collected narrative data, documents, logical conclusions and comprehensive recommendations were generated.

## 2.1. Different Types of e-Commerce Websites

Different e-Commerce websites are labeled or referred to differently, based on their functionality.

- **Business-to-Business (B2B):** Electronic transactions of goods and services between companies.
- **Business-to-Consumer (B2C):** Electronic transactions of goods and services between companies and consumers.
- **Consumer-to-Consumer (C2C):** Electronic transactions of goods and services between consumers, mostly through a third party.
- **Consumer-to-Business (C2B):** Electronic transactions of goods and services where individuals offer products or services to companies.
- **Business-to-Administration (B2A):** Electronic transactions of goods and services between companies and public administrations.
- **Consumer-to-Administration (C2A):** Electronic transactions of goods and services between individuals and public administrations.

## 3. Research Findings

### 3.1. Great Chinese Online Market places for e-Commerce

Over the years Chinese has seen growth its economy it being the 2<sup>nd</sup> fastest growing economy the advent of e-Commerce market knew a lot of transformation that offers tremendous opportunities for business. Three important facts are favoring this transformation: the rise of upper-middle-class, as the drivers of consumption growth; a new generation of free-spending, sophisticated consumers; and the increasingly powerful role of internet. Chinese social e-Commerce enterprises have been growing at a compound annual growth rate of 100.6%. Their penetration rate escalated to 11.9% by June 2019 (CIW, 2019), and 80% of internet shoppers use social and mobile e-Commerce channels. The penetration rate of group shopping consumers reached the highest at 57% by midyear 2019 and is expected to grow further.

#### 3.1.1. China e-Commerce Overview

E-Commerce sales in China are on way to surpass expectations as they already reached US\$1.53 trillion in 2018. However, China's e-Commerce does exist, though a bit a world away from the smooth and real-time transactions practiced in Internet advanced nations [19, 20]. In 2017, e-Commerce sales outpaced estimates by \$44.41 billion, driven largely by sales from leader Alibaba's Taobao and Tmall. In addition, Alibaba has reported fiscal year revenue growth of 51% as well a strong user growth and engagement. If we exclude impacts of consolidating acquired businesses, revenue would have gone up by

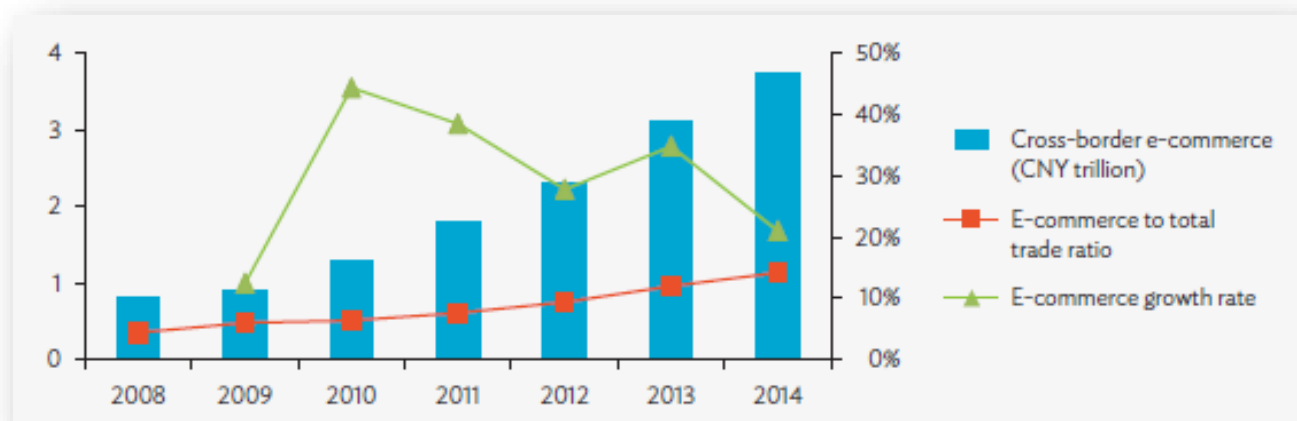
39% yearly, according to Maggie Wu, CEO of Alibaba Group. The two will still have a total of 58.2% by 2019, but Alibaba's share is slightly shrinking as the market diversifies with the emergence of retailers and newcomer Pinduoduo's recent success. Many Chinese consumers generally view most users of Pinduoduo as housewives, middle-aged, or elderly people who reside in third-tier or fourth-tier cities. They are highly sensitivity to low price and consistent with use of Kuaishou and are more willing to ask bargaining help in WeChat groups so as to save a few money (CIW, 2019).

From 2015 to 2018, Alibaba's share of e-Commerce sales in China fell from 77.6% to 53.5%. Alibaba's e-Commerce sales are now growing slower than the overall e-commerce growth rate 34.3% with Alibaba's sales forecast to increase just 22.8%. Consumption among upper-middle-class is still growing so fast, over 17% per year and, by 2020, will account for US\$1.5 trillion in urban China. That compares with a 5% growth rate among emerging-middle-class and middle-class consumers.

As of December 2018, the internet and mobile internet have a user base of 829 million and 817 million, respectively, according to the 43rd statistical report from China Internet Network Information Center (CNNIC, 2019). They both saw a net increase of 56.53 million and 64.33 million users, respectively, from 2018 to 2019.

Households will continue to make up a market because they will enter the lower rungs of the middle class over the next five years, these segments will still account for roughly half of the urban households. The emerging middle class and middle class will remain the biggest consumers in many categories, particularly such fast-moving consumer goods as personal-care products and detergents. There is also a healthy across the border trading which shows a great growth sprout as seen in Fig. 1.

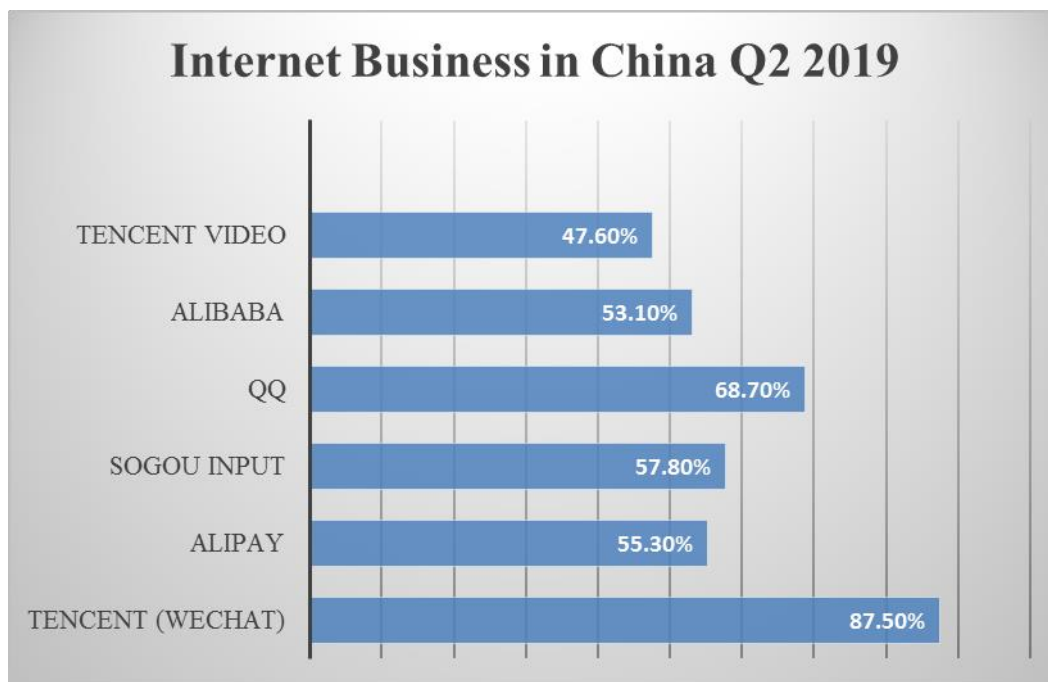
**Fig. 1.** Cross-border e-Commerce to total cross-border trade ratio (2008–2014)



### 3.1.2. Mobile e-Commerce, Popular Mobile Platforms, and Social Media

Actually, online wallets are the top payment method, nearly 33% of Chinese shoppers use the technology to complete transactions. Roughly half of all China's e-Commerce sales are made on mobile devices. There are dozens of mobile e-Commerce platforms, but in 2017 Taobao had the most monthly active users at 253.2 million. Other platforms like Meituan, JingDong, WeiPin, Tmall, eLeMe, Baidu NuoMi, and DianPing all play an active role in the market, but none are nearly as popular as Taobao in terms of active monthly users.

Understanding how to utilize the advantages of social media can raise your company or product's profile and accelerate your company's ability to sell online. The three biggest social media players are Tencent (WeChat), microblog Weibo, and social network QQ Zone. WeChat allows retailers to feature online stores and has a convenient third-party payment function. Tencent's total revenues in first quarter of 2019 were CY85, 465 million (USD12, 693 million), an increase of 16% over the first quarter of 2018 according to Tencent's announced financial results (CIW, 2019). Social media account for 32.8% of users' daily internet time on mobile devices. WeChat (85.7%), QQ (68.7%), Sogou Input (57.8%), Alipay (55.3%), Mobile Taobao (53.1%), and Tencent Video (47.6%) are among the most widely used ones currently (CIW, 2019). Tencent and Alibaba each had two places in the top 5 rankings. Tencent's WeChat (85.7%) and QQ (68.7%) took the first two spots of the top 20 ranking in 2018.



**Fig. 2.** E-Commerce trend for the 2<sup>nd</sup> quarter in China (2019).

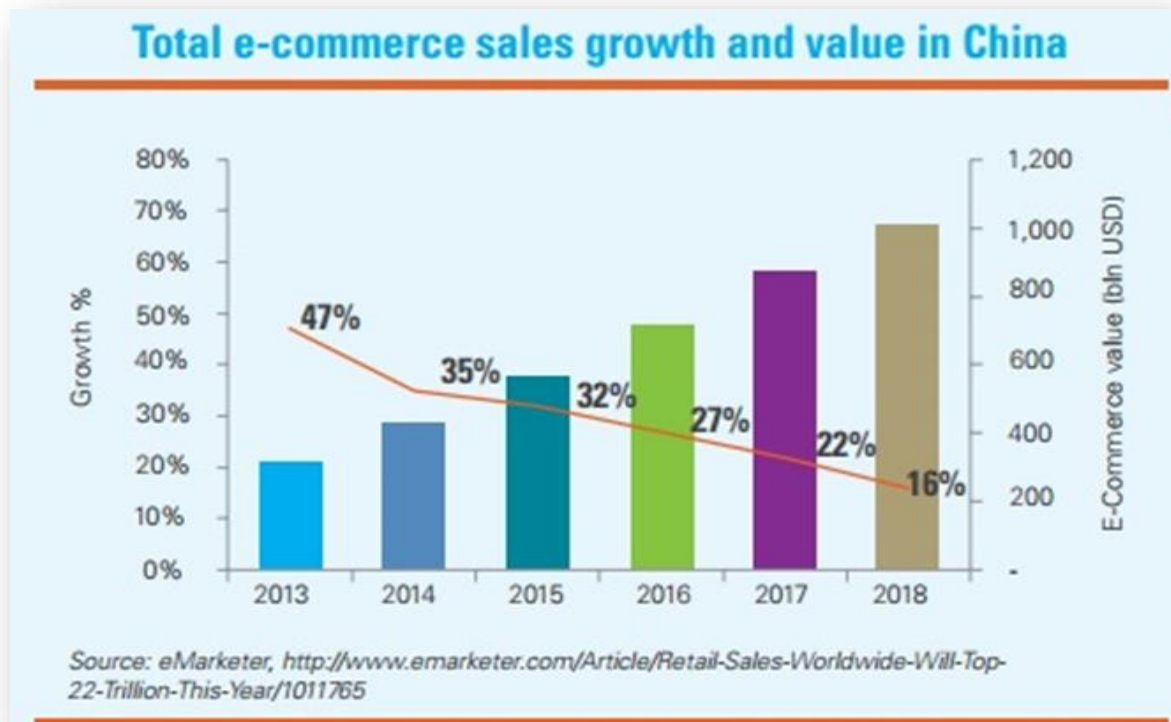
It also features push messages to introduce new product lines or deliver promotions. U.S. companies interested in exploring social media avenues and working with these sorts of social media players should seek to work with a local marketing partner to develop a strategy and support execution.

### 3.1.3. China e-Commerce Statistics 2018-2019

Chinese consumers moved more of their shopping online in 2018, sending e-Retail sales past US\$1 trillion for the first time in the world's leading e-Commerce market. Retail web sales totaled 7.18 trillion yuan (US\$1.149 trillion) in 2018, an increase of 35% from 5.43 billion yuan (US\$869 billion) in 2017, according to China's Ministry of Commerce. E-Commerce growth accelerated past the 30% mark in 2017, after slumping to 26% in 2016 from 33% in 2015. China far outpaces the United States, the second-largest e-Retail market in the world, in both sales and growth. While the U.S. Department of Commerce will not release its 2018 estimate of online retail sales until later this month, Internet Retailer estimates U.S. e-Commerce growth of about 15% in 2018 to approximately US\$455 billion.



China forecasts internet advertising market to exceed over US\$90 billion by year end 2019 out of which over 80% is from mobile advertising. The US\$36.02 billion indigenous advertisement market



accounted for nearly 50% of the total in 2018 (CIW, 2019). Advertising has consolidated its position as an important source of revenue for internet businesses. This market is expected to generate 627.34 billion Yuan (US\$93.38 billion) in revenues by 2019, an increase of 27.7% year-on-year

**Fig. 3.** Total e-Commerce sales growth in China for the year ended 2018.

China's e-Commerce exports rose 14.5 percent year on year to 6.3 trillion Yuan (1 trillion U.S. dollars) in 2018, according to a report released by the e-Commerce Research Center (ECRC). In the same year, the value of business-to-business (B2B) exports rose 13.3 percent to 5.1 trillion Yuan. Online retail sales of e-Commerce exports came in at 1.2 trillion Yuan, up 21.2% year on year.

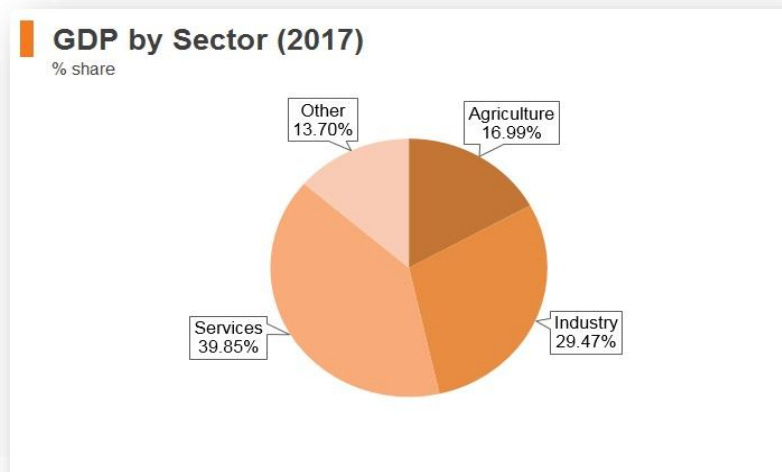
### 3.2. Uzbekistan

Officially known as the republic of Uzbekistan, it is a country located in Central Asia roughly to the west of China. Indigenous Uzbeks constitute about four-fifths of the country's total population, followed by others among them the Tajiks, Kazakhs, Tatars, Russians, and Karakalpaks. Uzbeks are the least Russified of the Turkic population previously under the Soviet Union rule, and all of them virtually still claim Uzbek as their elementary language.

#### 3.2.1. Uzbekistan economy

Uzbekistan is a dry doubly landlocked country where 10% of it is of intensely cultivated, irrigated river valleys with more than 60% of its population, live in the rural areas. The total population of the

country is 33.063 million (World Population Review 2019). The country is rich in natural resources such as natural gas, petroleum, coal, gold, uranium, silver, copper, lead and zinc, tungsten, molybdenum. Uzbekistan is now the world's third largest cotton exporter, a major regional producer of gold and natural gas, and a regionally significant producer of chemicals and machinery. The economy dominated mainly by the state. The Gross domestic product GDP ranged around 48.72 billion USD in 2017 with the real growth rate at 5.5%. GDP per capita was 1,504.23 USD (2017). Fig. 4 below summarizes GDP per sector.



**Fig. 4.** GDP by sector 2017.

### 3.2.2. Key Economic Indicators of Uzbekistan

**Table 1.** Economic indicators

Year	2017	2018
<b>Nominal GDP (billion USD)</b>	47.9	49.5
<b>Consumer price inflation (percent)</b>	12.5	17.5
<b>Foreign Direct Investment (billion USD)</b>	2.4	1.5
<b>Current-account balance (billion USD)</b>	0.95	-5.3
<b>Exports FOB (billion USD)</b>	13.95	14.26
<b>Imports CIF (billion USD)</b>	13.00	19.56

(Source: Data by country authorities and IMF estimates as of 04/22/2019)

### 3.2.3. Imports

In 2017 Uzbekistan imported goods and services worth US\$11.2 billion, making it the 85th largest importer in the world. During the last five years the imports of Uzbekistan have increased at an annualized rate of 1.7%, from \$10.3 billion in 2012 to \$11.2 billion in 2017. The most recent imports are led by vehicle parts which represent 5.12% of the total imports of Uzbekistan, followed by Packaged Medicaments, which account for 4.18%.

### 3.2.4. Exports

In 2017 Uzbekistan exported goods and services worth US\$8.38 billion, making it the 89th largest exporter in the world. During the last five years the exports of Uzbekistan have increased growth at an annualized rate of 9.5%, from US\$4.78 billion in 2012 to US\$8.38 billion in 2017. The most recent exports are led by Gold which represent 43.8% of the total exports of Uzbekistan, followed by petroleum gas, which accounts for 8.26%.

### 3.2.5. E-Commerce and the Digital Economy in Uzbekistan

The number of Internet service providers has grown in Uzbekistan, but penetration remains low and government regulation are strict. Tashkent, with 90 percent of the country's Internet users, is the only viable e-Commerce market in Uzbekistan. Although the Parliament approved the "Law on Electronic Digital Signature" in 2005, providing a basis for legal Internet transactions. The main barriers to the development of e-Commerce are insufficient electronic banking services and undeveloped trade regulations. Basic Internet service are fairly adequate and Uzbekistan has extensive fiber optic networks. The number of Internet users exceeds 13 million. Increased Internet service delivery by mobile phone operators contributes to the potential for e-Commerce, and there are approximately 23 million cell phone users in the country currently.

**Table 2.** IT indicators in Uzbekistan

<i>Item</i>	<i>Number of users</i>	<i>Total population %</i>	<i>Expected growth %</i>
<i>Internet users</i>	15,45 million	48%	8%
<i>Social media usage</i>	1.30 million	2%	8%
<i>Mobile device internet usage</i>	9.51 million	30%	1%
<i>Number of mobile phones connections</i>	22.65 million	70%	3%

### 3.3 Current Market Trends

A law on e-Commerce was adopted in 2004 and further amended in 2015. In April 2017, the Central Bank of Uzbekistan amended the decree "Regulations on the procedure for the use of bank cards by individual entrepreneurs in national currency". According to the new regulations, an individual entrepreneur has the right to transfer his bank card to other people for use. An individual entrepreneur can also use a bank card to pay for production costs as well as goods and services. Domestic e-Commerce is gaining momentum as domestic trading platforms develop. However, cross-border e-Commerce is still hampered by customs regulations and the fact that billing systems of major international e-Commerce platforms (such as e-bay.com and amazon.com) have not been extended to Uzbekistan.

### **3.3.1. Domestic e-Commerce (B2C)**

One of the key factors in the development of domestic e-Commerce in Uzbekistan is the improvement of mobile payment services. Smart phones can now be linked to bank cards for sales purchases. This method of payment for both the seller and the buyer is more convenient than a plastic bank card [21].

### **3.3.2. Cross-Border e-Commerce**

Chinese and Turkish products are popular with the local population. Most popular online purchases are health and beauty products, electronics, clothing and shoes. As a relative newcomer to e-Commerce sales, Uzbekistan's market is not saturated and open to new products and ideas. Customs regulations and poor integration with international billing systems are factors currently inhibiting e-Commerce sales and there is need to develop it.

### **3.3.4. Online Payment**

Mobile e-Commerce is still developing and not widespread in Uzbekistan. Mobile applications are used for both advertising and information purposes as well as payment, although the majority of transactions are still done by cash. Online payment is done through the use of bank cards and smartphones.

## **3.4. Uzbekistan-China Bilateral Relations on enhanced economic engagements**

Uzbekistan and China recently celebrated 25th anniversary over establishment of mutual diplomatic relations. In recent years, the two countries have developed strong bilateral ties marked by a high degree of economic engagements. China has been Uzbekistan's second largest trading partner and the biggest source of investment for three years in a row.

Uzbekistan and China plan to increase the volume of trade turnover up to US\$10 billion beyond 2020, and the figures are expected to rise more than twice in future. China directed about US\$8 billion of investments to the economy of Uzbekistan and the trade turnover between Uzbekistan and China added up US\$4.2 billion in 2016.

### **3.4.1. Uzbekistan, China vow to strengthen cooperation**

In the last two decades, a number of international transport and energy projects have been implemented. It should be noted that Uzbekistan was among the first to express its support for China's calls for the global Silk Road initiative popularly known as "Belt and Road." China and Uzbekistan have already implemented several connectivity projects, including China-Kyrgyzstan-Uzbekistan highway.

Against this background, it should be no surprise that the new railway project connecting Angren in the Tashkent region and Pap in the Namangan region is regarded as very important to Uzbekistan's national strategies of both internal and international connectivity. The Angren-Pap line is only 123 kilometers long, but it crosses high mountainous areas, including areas with an elevation above 2000 meters, and is thus quite expensive.

The cost of the Angren-Pap project was over US\$1.6 billion, and its construction has been made possible through a variety of sources. This includes more than US\$1 billion from Uzbekistan Temir Yollari (Uzbekistan Railways) and Uzbekistan's National Reconstruction and Development Fund. An additional loan of US\$350 million was secured from China's EximBank, while the World Bank provided \$195 million. Construction started in June 2013, and by 2016 more than ten new bridges and seven railway stations had been constructed as well as a 19.1 kilometer long tunnel, under the Kamchik pass built by the China Railway Tunnel Group. According to Uzbekistan Temir Yollari, about 600,000 passengers and up to 6 million tons of goods could be delivered annually. While this railway will go a long way toward improving transportation inside Uzbekistan's borders, it is not entirely sufficient. There is considerable collective need for the whole of the Ferghana Valley in terms of railroads and highways.

Moreover, the valley is significant for the development of trade and communication links between China and Central Asia.

The development of strong transport corridors between China and Uzbekistan and China and Central Asia, including highways and potentially railroads, are part and parcel of the development of new routes linking the region to the whole of Asia and ultimately Europe. The connection with the existing and developing projects are potentially significant e.g, the improvement of connections between Central Asia and Afghanistan would contribute towards the future economic recovery of the latter. Moreover, the development of transport communications between Central Asia and South to East Asia also are linked to this. A well-developed regional transport network functionary in Central Asia would increase the potential for regional interconnectivity while providing a great opportunity to develop international networks and trade, including cultural and tourism [9, 14, 22].

### 3.5. Statistical Correlation

The regression statistical method used was the correlation internet use. We employed the linear and multivariate regression technique as a statistical tool for evaluating the connections among level data over several years. To determine whether Internet use correlates to exports and or imports, we used the country-level data to estimate relationships.

#### 3.5.1. Linear regression

$$(a) \text{ Exports } ij = \alpha + \beta \text{ Internet Use } i + \gamma \text{ Control Variables} + \varepsilon_{ijl}(1) \quad (9)$$

The dependent variable is exports from China  $i$  to Uzbekistan  $j$ .

Regression Equation  $(y) = a + mx$

Slope  $(m) = (N \times \sum XY - (\sum X_m)(\sum Y_m)) / (N \times \sum X^2 - (\sum X)^2)$

Intercept  $(a) = (\sum Y_m - b(\sum X_m))$

Where,  $x$  and  $y$  are the variables,  $m$  = slope of the regression line,  $a$  = intercept point of the regression line and the  $y$  axis,  $N$  = number of values or elements,  $X$  = First Data Set,  $Y$  = Second Data Set.  $\sum XY$  = Sum of the Product of First and Second Data Set,  $\sum X_m$  = Mean of First ( $X$ ) Data Set,  $\sum Y_m$  = Sum of Second ( $Y$ ) Data Set,  $\sum X_2$  = Sum of Square of First ( $X$ ) Data Set Values

**Table 3.** Export trade data between China and Uzbekistan in millions of USD.

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,009,712.04	914,728.84	1,250,001.37	1,528,929.44	1,559,311.42	1,650,989.46	1,647,737.74	1,442,963.00	1,383,863.49	1,659,495.16	1,871,830.51

From the data above, we then used the above regression equation to estimate the connection among the variables.

Regression Equation( $y$ ) =  $a + mx$

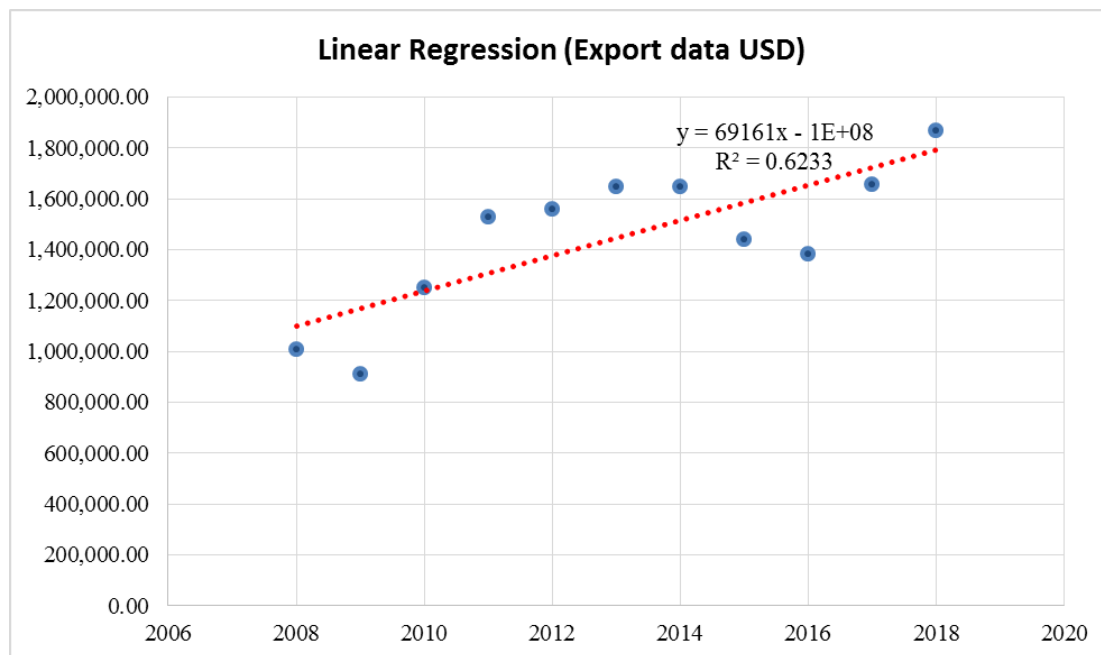
$$y = -137774362.017 + 69161.249x$$

$$\text{Slope (m)} = (N \times \sum XY - (\sum X_m)(\sum Y_m)) / (N \times \sum X^2 - (\sum X)^2)$$

$$m = 69\,161.24936$$

$$\text{Intercept (a)} = (\sum Y_m - b(\sum X_m))$$

$$a = -137\,774\,362.01725$$



**Fig. 5.** Linear regression plot for export data (USD) trend over a period of years.

**(b) Imports  $ij = \alpha + \beta$  Internet Use  $i + \gamma$  Control Variables +  $\varepsilon_{ijl}$  (1) (10)**

Similarly, to determine whether Internet use correlates to imports, we used country-level data for estimation;

**Table 4.** Import trade data between China and Uzbekistan in millions of USD.

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,674,792.99	1,421,707.91	1,809,526.75	2,062,487.43	2,153,039.18	2,236,498.68	2,373,264.39	2,312,511.80	2,246,734.81	2,436,328.61	2,631,912.70

From the data above, we then used the above regression equation to estimate the connection among the variables.

Regression Equation( $y$ ) =  $a + mx$

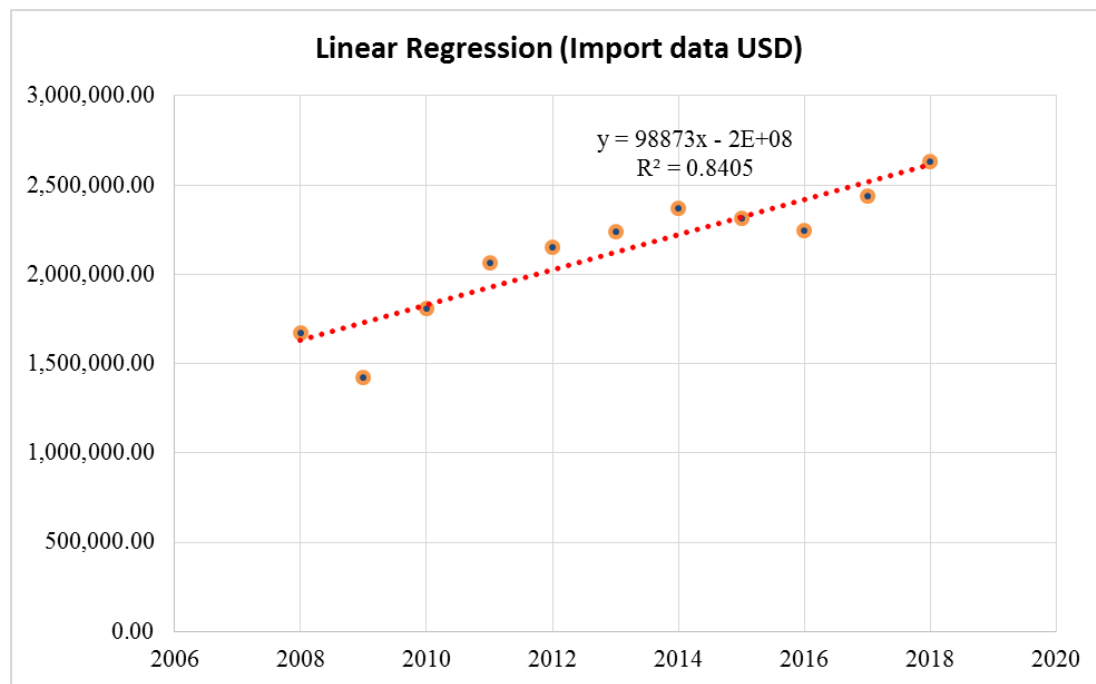
$$y = -196906896.734 + 98872.541x$$

$$\text{Slope (m)} = (N \times \sum XY - (\sum X_m)(\sum Y_m)) / (N \times \sum X^2 - (\sum X)^2)$$

$$m = 98872.54073$$

$$\text{Intercept (a)} = (\sum Y_m - b(\sum X_m))$$

$$a = -196906896.73415$$



**Fig. 6.** Linear regression plot for import data (USD) trend over a period of years.

### 3.5.2. Multivariate regression model

We used the multiple regression tool to predict the value of a variable based on the value of two or more other variables. The technique provides a simultaneous combination of multiple factors to help us to assess how and to what extent they affect a certain outcome. Fig. 7 below, the Correlation Coefficient (Multiple R) which measures the strength of a linear relationship between two variables is at 0.94 meaning there is a strong positive relationship between import and export e-Commerce data. The model has a small standard error (1.25) as goodness-of-fit measure, which shows the near-precise of our regression analysis; the smaller the number, the more certain we can be about our regression equation. Interestingly our regression statistics passed the ANOVA part by assuming a significance (F) value less than 0.05 (5%) meaning the model is acceptable. The ANOVA test gives an idea of how reliable (statistically significant) the results can be.

#### SUMMARY OUTPUT

Regression Statistics					
Multiple R	0.941056296				
R Square	0.885586952				
Adjusted R Square	0.85698369				
Standard Error	1.254264491				
Observations	11				

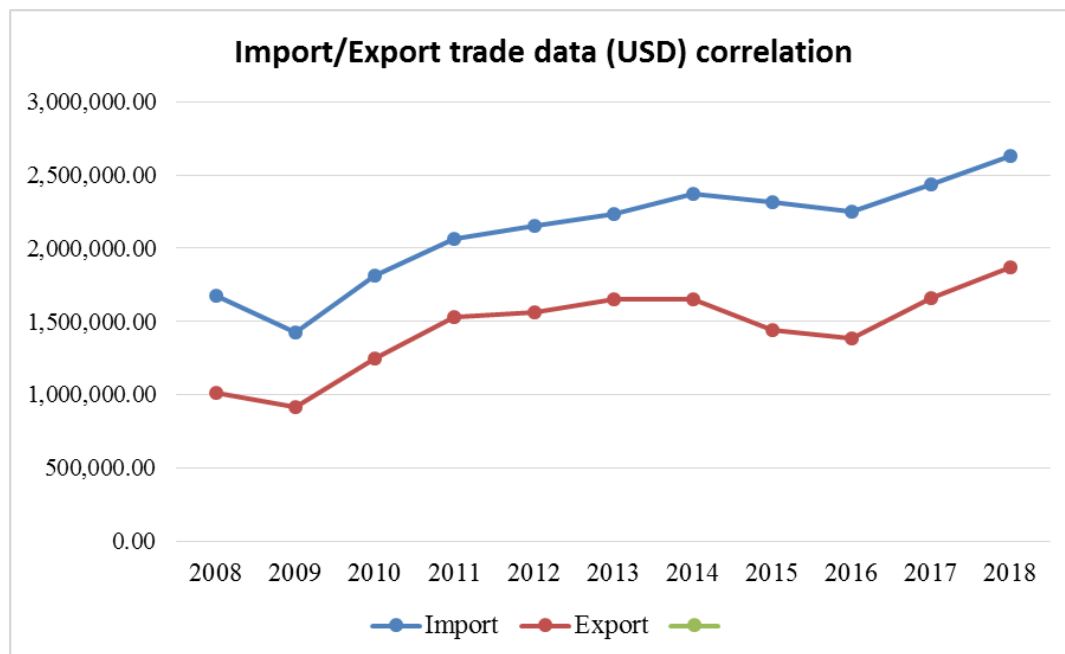
  

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	97.4145647	48.70728235	30.96104738	0.000171357
Residual	8	12.5854353	1.573179413		
Total	10	110			

**Fig. 7.** A multiple linear regression summary of import-export data between China and Uzbekistan over 11 observations.

### 3.5.3. Future trends

From Fig. 8 below, we observe a continuous parallel trend of e-Commerce trade data with a crystal clear unlikelihood of crosslinks in the near future. However, though parallel, there is relative growth of e-Commerce trade observed from 2008 to 2018 with a sharp increase mainly from 2016 to 2018. This was possibly because of enhanced trade relations between the two countries mainly implemented during this period, as already elaborated in previous sections. The general projection is that the growth trend will continue even more it is crystal clear that with more technology e-Commerce will be made the basis of trade.



**Fig. 8.** Trend in Import and Export trade data between China and Uzbekistan.

## 4. Conclusion

E-Commerce is still developing in Uzbekistan, and it is only now starting to become a priority. In May 2018, the Uzbek President signed a decree "On measures for the accelerated development of e-commerce", and approved the "Program for the Development of e-commerce in Uzbekistan for 2018-2021". In response, the market is expected to grow significantly in the coming years as shown in our statistical studies. The main barriers to the development of e-Commerce in Uzbekistan includes insufficient electronic banking services, conversion limitations and underdeveloped trade and customs regulations. The capital, Tashkent, is currently the only viable e-Commerce market in the country, as it is home to 90% of Uzbek internet users. On the other hand, the increasing number of mobile internet access contributes to the potential for e-Commerce growth, and moderate to strong growth is expected in mobile broadband use over the next five years. However, at the moment mobile e-Commerce is not widespread in Uzbekistan and is still developing. On the other hand China has developed faster internet services making it one of the global giants. Online payment is done through the use of bank cards linked to smartphones, although the majority of transactions are still done by cash.



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## **Conflicts of interests**

The authors do not have any conflicts to report.

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## Managing the Technological Potential of *Eschweilera truncata* A. C. Sm in the Amazon

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### Abstract

*Eschweilera truncata* trees, known commercially by the name of Matamatá, are abundant, widely distributed throughout the forest, and characterized by important features for forest management, but are not harvested due to the scarcity of studies of the technological attributes that would reveal their potential, such as their machining and physical properties. Otherwise such studies might contribute to the inclusion of new species in the market, strengthening the sustainability of the forest ecosystems. Given this gap, the present research aimed to evaluate the performance of Matamatá wood in terms of its physical properties and behaviour under the machining process that would be used in this sector of the timber industry. The research involved a study of the tree, from which a base disk was removed in order to analyse its apparent density, density, shrinkage and anisotropy coefficient. The tradable shaft was split into logs and planks to assess the effects of machining processes. In the data analysis, we used descriptive statistics and the Tukey test. The results obtained classify Matamatá wood as high density and identify its anisotropy coefficient of 1.90, suggesting a medium to low stability. *E. truncata* wood performed excellently in the machining evaluation, and its results in the planer, sandpaper, drill perforation, frame in the top and lathe tests were also outstanding; in addition it presented wood material of the same quality throughout, whether heartwood or sapwood. This is an important indicator of wood yield, signifying that greater use can be made of the wood. The performance of the wood was validated via the manufacture of products such as furniture, decoration and finger-boards for musical instruments. In general, it can be concluded that the wood studied may be used in the lumber industry, because it presents similar features to those in the species already marketed and because it is plentiful all over the Amazon region.

**Keywords:** Matamatá; technological characterisation; machining; forest management; small diameter species

## INTRODUCTION

Brazil is one of the world's largest producers and consumers of tropical forest lumber (ITTO, 2017). Native timber production is concentrated in the region comprised by the Legal Amazon, with Mato Grosso and Pará being the main loggers of native species (IBGE, 2016). However, the timber sector in the region is marked by the practice of maximum logging per unit area, the exploitation of a few species of commercial interest and a great waste of wood, both in the forest and in the industry. Forest extraction carried out without planning, intensively and selectively, has transformed areas with high stocks of wood to degraded forests, where wood is low in commercial value and difficult to transport (Moutinho et al. 2011).

The Amazon forest has very diverse timber species, but the extraction of wood in this region is not consistent with its potential, since the market is not interested in many species. Commercially valuable timber species become rare or economically extinct (RICHARDSON & PERES, 2016) and as a result of selective exploitation the number of species joining the list of protected species increases.

In this sense, the high demand for wood, combined with economic pressures for immediate results, raises the need to technologically characterise new wood species that are well distributed in the forest in order to introduce more of them to the market (TAQUES & ARRUDA, 2016).

In this context, species such as the *Eschweilera* genus of the family Lecythidaceae are seen as a promising alternative. Inventories carried out by the laboratory team of forest managers of the Instituto Nacional de Pesquisa da Amazônia – INPA – detected the high incidence of a species known as “Matamatá” throughout the state of Amazonas. Such species are not large in diameter compared to species commonly exploited in the timber sector, but have high population density. They also form a stable element in forest recomposition, that is, if they are managed, they can support and recover the stock that is harvested (REIS et al., 2014; REIS et al., 2016). Exploration of the forests is permitted provided that the instructions of SDS-AM resolution 17/13 are followed.

However, in order for a certain wood to be commercially exploited, its wood potential – that is, its limits and the conditions of use that it will meet – must be known. Knowledge of the physical, mechanical, chemical and anatomical properties of wood, as well as its machinability, is of fundamental importance for bringing these species into the productive sector and into competition in the different sectors of the timber industry. If we know these properties we can analyse them in comparison with the characteristics of traditional woods; that is, we can assess the qualities of new woods through the interrelationships of their properties and the similarities between species (NASSUR et al., 2013).

Despite all the advances in the use of technology to manufacture higher value-added products, there is still little or no technical-scientific information on the best combinations of production factors when we use machines to achieve a surface quality that adapts material to various purposes. Within these process variables, our ignorance about the influence of the surface quality of wood, derived from its physical and anatomical properties, stands out and needs to be remedied (PINHEIRO et al., 2017). These properties are allied to the other factors that influence the process of material removal via machining. The timber sector urgently needs more research leading to technological improvements, the rationalisation of the use

of raw materials, greater efficiency and better use of native wood if it is to seek new markets, both national and international.

The increasing difficulties in obtaining native wood, coupled with the lack of policies that allow for the sustainable and rational exploration of tropical forests, at a time when wood is in great demand for and economic pressure is exerted for immediate results, justify the development of this research. Its aim was to evaluate the possible use of *Eschweilera truncata* wood to produce goods of had high added value.

## MATERIAL AND METHODS

The wood used in this study came from the Experimental Tropical Forestry Station of the Instituto Nacional de Pesquisas da Amazônia (E.E.S.T./INPA), located in the municipality of Presidente Figueiredo, in the north of Brazil. A tree of the species *Eschweilera truncata* with a diameter at breast height (DBH) of 50 cm was selected and examined according to the procedures established for forest management.

A base disk with a thickness of 5 cm was removed to obtain tree body-specimens properly oriented with respect to the anatomical features so as to determine the physical properties and make an anatomical analysis (see Figure 1). The tests were adapted according to the procedures of ABNT NBR 7190:1997 and NBR 11941:2003.

The samples were weighed on a 0.01g precision scale, their dimensions measured with callipers and submerged in water to determine the volume using the liquid displacement method and oven dried at  $103 \pm 2^\circ\text{C}$  to weight, in order to calculate the density, apparent density, basic density, dimensional stability and anisotropy coefficient.

The apparent density at 12% ( $\rho$ ), basic density ( $\rho_{bas}$ ), retractability ( $R_{(t,r)}$ ) and anisotropy coefficient (CA) were calculated using Equations 1, 2, 3 and 4. The retractability test was performed next on these specimens, and the radial and tangential directions were measured.

$$\rho_{12} = \frac{M_{12}}{V_{12}} \quad (\text{Equation 1})$$

$$\rho_b = \frac{M_s}{V_{sat}} \quad (\text{Equation 2})$$

$$R_{(t,r)} = \frac{D_{sat} - D_s}{D_{sat}} * 100 \quad (\text{Equation 3})$$

$$CA = \frac{R_t}{R_r} \quad (\text{Equation 4})$$

where  $\rho_{12}$ = bulk density (g / cm<sup>3</sup>);  $M_{12}$ = mass at 12% humidity (g);  $V_{12}$ = volume at 12% humidity (cm<sup>3</sup>);  $\rho_{bas}$ = basic density (g / cm<sup>3</sup>);  $M_s$ = dry mass (g);  $V_u$ = saturated volume (cm<sup>3</sup>);  $R$ = maximum linear contraction coefficient (%);  $D_{sat}$ = dimension in saturated conditions (mm);  $D_s$ = dimension after oven drying (mm);  $t$ = tangential direction;  $r$ = radial direction, CA= anisotropy coefficient.

Specimens prepared for the anatomical analysis were oriented in turn in the tangential, radial and longitudinal directions in the dimensions 1.5 x 2.0 x 3 cm, respectively, containing part of the sapwood and heartwood in the same sample. The anatomy of the samples was described using the comparison

method (confrontation), supporting the method of botany collection - Xiloteca / COTI / INPA, where mainly the sensory and macroscopic anatomical features are observed. The structures were analysed with the aid of a 10 x magnification magnifying glass and through image analysis using a stereoscope equipped with a digital camera and computer with Pixel Pro 2.1 image analysis software.

The machining tests were performed following the guidelines of ASTM D1666 - 11, with adaptations regarding the sample size. Twelve samples containing heartwood and sapwood were selected in the same piece to analyse the behaviour of the wood in both regions. The following paragraphs describe the tests performed.

**Planing** - performed on a thicknesser planer (blades at 45° and with a 2 mm cut) and a performer (with a 1 mm cut); the defects found were barbs, fuzzy/crushed grain and wood burns.

**Sanding** - performed using a hand sander that allowed sanding with grit sizes of 80, 180, 280 and 360 (commercial specifications); the defects found were surface scratching and fluffy grain.

**Lateral tear** - performed in a horizontal drill that has a manual feed, using 8mm twist drill and 15mm cutter; the defects found were barbs, fuzzy / crushed grain and wood burns.

**Drilling** – using a vertical drill with 11.5, 10.8, and 6 mm diameter high speed steel bits. The holes were spaced 25 mm apart; the defects found were those of fuzzy grain, grain pullout and wood burns.

**Nail Piercing** - 18 x 24 [2 1/4 x 10] nails (commercial specification) were used. The nails were hammered into the ends of the specimens, at a distance of 10 mm from the edge and 20 mm from each other; In this test the evaluation considered only whether the nails were accepted.

**Top frame** - made with a 2 mm deep roulette; the defects found were those of raised, torn and fluffy grain.

**Lathe** - the parts were turned following a pattern of use of the same tool until the contour was very close to that described in the standard; the defects found were of fuzzy grain, plucked grain and wrinkled surface.

After the tests, the pieces were subjectively evaluated by four appraisers, who were technicians from the wood industry segment of the Instituto Nacional de Pesquisa da Amazônia – INPA e LEAM, following the criteria of grades (Table 1) in the behaviour of wood, indicating the presence or No defects. The ASTM D-1666-11 standard served as an evaluation parameter of the results obtained. The results of the tests were evaluated visually and tactfully, mindful of the sensitivity of the observers, who compared the pieces with the photographs used in this standard. Subsequently, the evaluations were analysed and the wood classification for each test was obtained by averaging the grades of the evaluators.

**Table 1** - Notes applied to the part-evaluations in the machining tests

Mark	Evaluation	Defect
1	Excellent	No defects
2	Good	Presence of less than 50% of defects
3	Regular	Presence of 50% of defects
4	Poor	Presence of more than 50% of defects
5	Unacceptable	Presence of 100% of defects

The data were analysed using descriptive statistics (mean, standard deviation and coefficient of variation) and an Analysis of Variance (ANOVA).

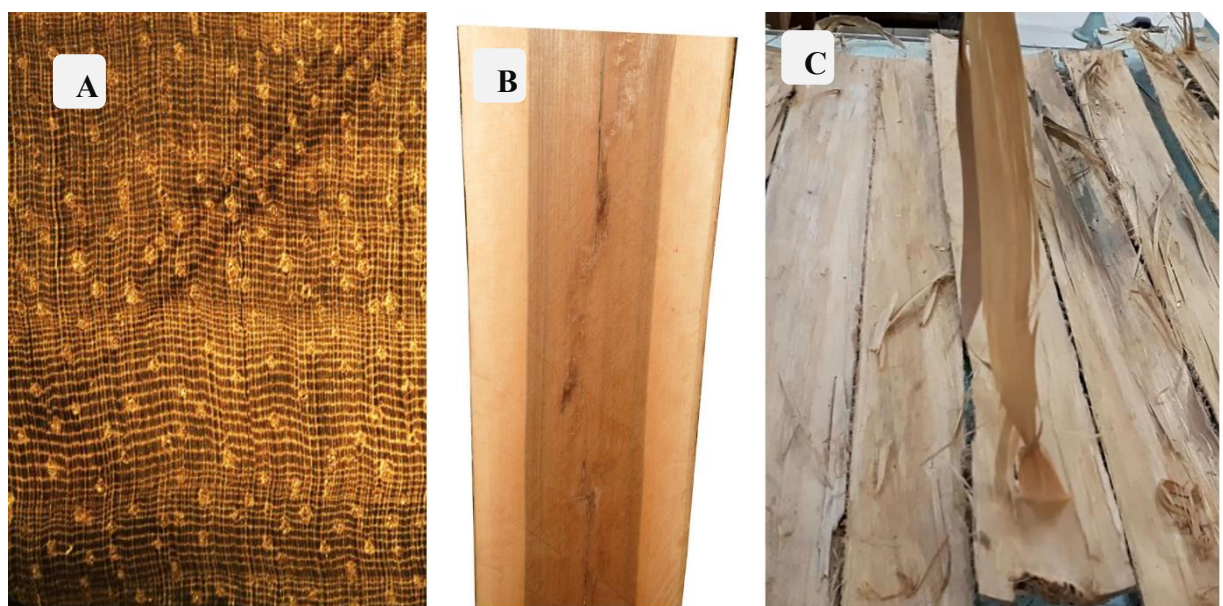
With the data obtained on the properties and the products, a comparative analysis was made of species that are currently sold in the market. This phase consulted a database of the Wood Artifact Engineering - LEAM laboratory of 100 Amazonian tree species, regarding basic density, tangential contraction, radial contraction, anisotropy and machining.

## RESULTS AND DISCUSSION

### Macroscopic anatomical features

According to the general characteristics, *Eschweilera truncata* (Lecythidaceae) wood has a rough dark brown outer bark and an inner light yellow to brown colour; its heartwood is a different shade of brown, well differentiated from light to greyish sapwood, right grain, fine texture, and a noticeable smell of fibrous liber (see Figure 1).

In the macroscopic description, sinuous thin lines were observed, suggesting the presence of a contrasted parenchyma. A few small to medium pores, solitary and grouped, were apparent to the naked eye; they were obstructed by tilose. Numerous very thin rays at the top were visible under a magnifying glass, while marked uniformity in width and spacing on the radial face was visible to the naked eye. Small, sparse spinal macules and small scattered secretory channels could be seen (refer to Figure 1A).



**Figure 1-** (A) Transversal plane macrophotography (10X); (B) Heartwood and sapwood; (C) Fibrous liber

*E. truncata* wood has straight grain, of a type of grain which is appreciated for its greater mechanical strength, easy deployment and minimum number of undesirable deformations when dried. From a decorative point of view, the tangential and radial surfaces of the wood are quite regular in appearance and with no special ornamental shapes. Texture is another very important feature, in that woods with a fine texture receive a great finish. As is characteristic of Lecythidaceae, *E. truncata* in their fibrous free

structure present fibre which is widely used in upholstery, basket making and other products that make use of wood fibres.

Mori et al. (2001) mention that the genus *Eschweilera* is considered the largest of the Lecythidaceae, with approximately 100 species, and also the most complex in terms of identification; however, all present similar characteristics, a fact that the present study confirms.

The type and texture of the grain in the workability tests are essential parameters for identifying whether the wood will perform well or poorly in the machining process. According to Mady (2000), the straight grain wood facilitates drying, unfolding, and surface finishing processes and increases mechanical resistance.

Regarding the texture, it may be recalled that wood, when it presents a fine texture, can obtain excellent results in the finishing process. Burger & Richter (1991) classify textures as coarse, medium or thin according to the distribution and percentage of the anatomical elements in the wood; these criteria were adopted to predict whether or not wood will take a good finish.

### Physical properties of wood

Table 1 shows the average values of the basic and apparent densities of *Eschweilera truncata* wood, as well as its dimensional stability and anisotropy coefficient. According to the classification proposed by Melo et al. (1990), the wood of this species has high density. The result of comparing basic and apparent density (12%) with that of other native species of the Amazon region shows that the values are close to those found in the studies by Moutinho et al. (2011), Barros (2016) and Nascimento et al. (2017 and 2018), who obtain basic density readings that range from 0.80 to 0.95 g / cm<sup>3</sup> for six different species of Matamatá. With regard to apparent density, IPT – the Instituto de Pesquisas Tecnológicas (2009) records values similar to those obtained for species such as Red Angelim (1.09 g / cm<sup>3</sup>), Goiabão (0.93 g / cm<sup>3</sup>) and Itaúba (0.960 g / cm<sup>3</sup>) at the same moisture content of 12%.

**Table 1** -Descriptive measures of the physical properties of *Eschweilera truncata* wood.

	$\rho_{12\%}$ g / cm <sup>3</sup>	$\rho_{bas}$ (g/cm <sup>3</sup> )	Rt (%)	Rr (%)	CA
Average	1.01	0.77	8.39	4.93	1.90
DP	0.11	0.04	1.04	1.94	0.67
CV %	11	5	12	39	35

$\rho_{bas}$ : basic specific mass; Rt: tangential contraction; Rr: radial contraction; CA: anisotropy coefficient; SD: standard deviation; CV: coefficient of variation.

The wood of this species is classified as having medium stability according to the classification of Galvão and Jankowsky (1984, because it has an anisotropy coefficient of 1.90. Given these data, it can be said that the wood should not present serious problems as sawn wood, provided that the process of unfolding is conducted according to the recommended techniques.

The values determined in this study are consistent with others obtained for hardwood, by several authors such as IPT (2003) analyzing wood from Cupiuba, Cedrorana, Goiabão, Jacareuba, Pau Roxo, Tauary; and Angelim presenting anisotropy ranging from 1.55% to 1.90%. Barros (2016), when he studied the species of Ingá-Vermelha, Peãozinho, Matamata, Breu-vermelho, Murici, Abiurana with anisotropy



found values from 1.60% to 2.10%. INPA (1991), among the woods that make up the Amazon Wood Catalog, lists woods such as *Eschweilera odora* (1.55%), *Hymenaea courbaril* (1.88%) and *Pilhecellobium incuriali* (1.90%).

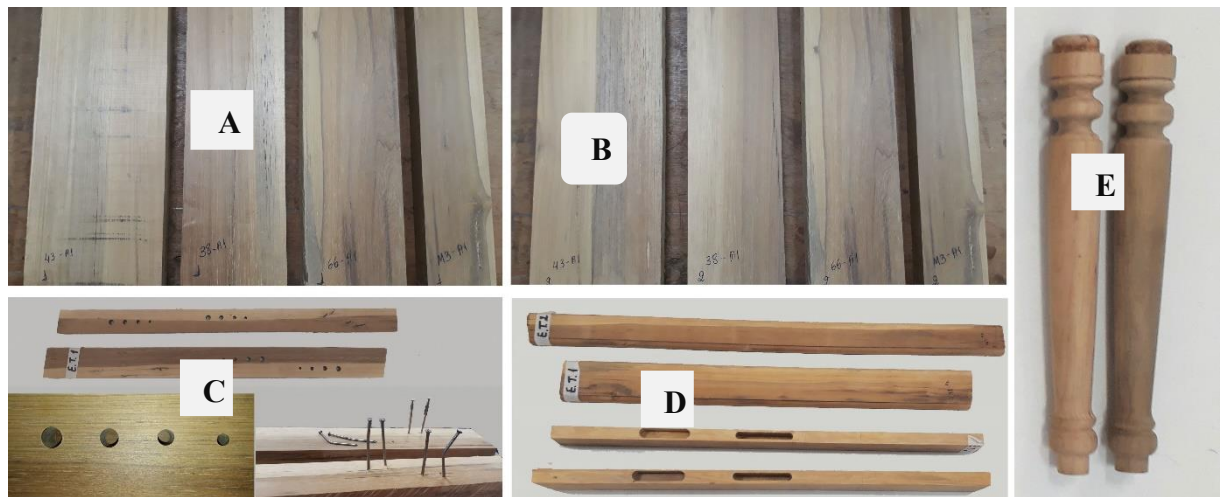
The retractability difference between tangential and radial directions is a major cause of wood defects that occur during the drying process. These defects are generated by the manifestation of anisotropy, where the higher the value, the higher the probability of defects occurring in wood that may make its use unfeasible (OLIVEIRA et al. 2010).

## Machining Process

The data collected and analysed suggest that *E. truncata* wood behaved similarly in all tests for heartwood and sapwood, showing the same quality of woody material throughout. This means that both can be used for the same purposes, increasing the wood yield. Barros (2016) mentions that no sapwood is currently used by sawmills, thus reducing wood yield. Therefore, woods that have similar characteristics provide increased yield because they are used in their entirety and consequently help to improve sustainable forest management. They reduce the number of individuals that must be felled to meet the volume desired. In short, this proposal causes less wood waste in industries, helping to make the activity more sustainable. With this in mind, Table 2 arranges the evaluations assigned to each test, in both heartwood and sapwood. It is noteworthy that the lateral tear test was divided into 2 parts (using drill and cutter) because different evaluations were received, one rated excellent and the other good. Figure 2 shows the results of machining tests on wood.

**Table 2-** Test results of *E. truncata* woodworking.

Test	Core	Sapwood	ASTM D1666 - 11 Rating
Planing	Excellent	Excellent	No defects
Sanding	Excellent	Excellent	No defects
Drilling	Excellent	Excellent	No defects
Nail Drilling	Poor	Poor	Presence of more than 50% of defects
Side Tear (Cutter)	Excellent	Excellent	No defects
Side Tear (Drill)	Good	Good	Presence of less than 50% of defects
Top frame	Excellent	Excellent	No defects
Lathe	Excellent	Excellent	No defects



**Figure 2-** (A) Planing; (B) sanding; (C) Drill and nail drilling; (D) Side Tear and Top Frame; (E) Lathe.

There are no studies to compare with the present survey that demonstrate the behaviour of wood from Matamata with respect to machining processes. However, the survey results ( $p_{bas} = 0.77$ ; CA: 1.9; Machining: excellent-good-bad) are similar to those presented by known Amazonian species, as shown in Table 3.

**Table 3** - Density data, anisotropy coefficient and machining tests (planer, lathe, drilling, nailing and sanding) of timber species of commercial interest.

Species	Basic density	C.A.	Planer	Lathe	Drilling	Nailing	Sandpaper
<i>Dinizia excelsa</i> Ducke	0.83	1.77	Good	Excellent	Good	Poor	Good
<i>Goupia glabra</i> Aubl.	0.71	1.9	Good	Excellent	Excellent	Poor	Excellent
<i>Pouteriapachycarpa</i> Pires	0.73	1.81	Excellent	Excellent	Excellent	Poor	Excellent
<i>Dipteryxodorata</i> Aubl.	0.97	1.57	Regular	Good	Poor	Poor	Good
<i>Peltogyne subsessilis</i> WA	0.74	1.86	Regular	Excellent	Excellent	Poor	Excellent
<i>Tabebuia serratifolia</i> (Vahl)	0.87	1.48	Regular	Excellent	Excellent	Regular	Good
<i>Hymenaea courbaril</i> L.	0.80	1.88	Good	Regular	Good	Good	Good
<i>Astroniumlecointei</i> Ducke	0.81	1.91	Good	Excellent	Excellent	Regular	Excellent
<i>Manilkara huberi</i> (Ducke)	0.83	1.68	Regular	Good	Good	Poor	Good

CA: anisotropy coefficient

These woods are generally employed in construction and shipbuilding; they are also widely used in the manufacture of higher value-added products, such as floors, doors, furniture and ceilings, among others; decorative blades and milled objects. From these attributions and associations with the other characteristics studied, the suitability of *E. truncata* wood for similar applications can be affirmed.

The main defects in the milling, cutting and drilling processes are linked to variations in wood properties, the condition of cutting machines and tools, and machine operator training (PINHEIRO, 2017).

## Product Manufacturing

The range of information obtained from the basic research on the species of *E. truncata* allowed the team to make use of applied research. Indeed, this showed that knowledge of the technological properties of wood linked to the machining process, using targeted cutting and proper machinery/tools is essential for raising productivity and the quality of products. As a way of applying the research, products were made using the woods after the machining processes.

In these products, the wood went through the processes of thickening, planing, top moulding, drilling, turning on a lathe and gluing. For the decorative articles, pieces containing sapwood and distinct heartwood were selected from the same piece, to provide products with diversified material. The component pieces of the coffee table were detachable, giving the product greater mobility. The spectacle frames were cut 2 mm thick from the timber by blades. The products show well the contrast between heartwood and sapwood, while the details of curves, tears and perforation perfectly demonstrate the excellent finish that can be achieved with the wood and show that it can be used in the manufacture of products that require a fine finish (Figure 3).

To make the multifunctional coffee table (Figure 4), pieces with different designs and colours were selected to show the diversity of the wood material. The processes that the production entailed were thickening, planing, sanding, lateral tearing and drilling. The design of the product used a modular structure, combining wood with aluminium plate and glass, to form a practical and versatile piece of furniture, which could be dismantled by means of screws, allowing the furniture to be disassembled which facilitate its transport. The item can be used either as a coffee table or as a “stool or chair”.



**Figure 3-** Demonstration of products made with *E. truncata* wood.





**Figure 4-** Coffee table/bench, multifunctional furniture made of *E. truncata* wood.

The following processes were used to produce the above piece of furniture: thickening, planing, sanding, lateral tearing, drill drilling and gluing. It can be seen that the wood produced excellent results in the bonding process as well. Only pieces of Matamatá wood were used in the worktop, which was glued to increase the width of the piece, while in the base (attached to the leg of the furniture) Marupá wood (*Simarouba amara*), a low density wood, which generated less friction in high density woods, was added to help the glue to bond (see Figure 5). This product was also elaborated with the use of modular structure technique; the result of the cuts made in the base of each piece of furniture allowed a new product to be made. That is, each time this item is produced, a lamp can be made out of the wood left over from its base.



**Figure 5** - Coffee table, combination of Matamatá and Marupá wood with a glass top.

All the parts went through the finishing process and were sealed and varnished, to refine the finished parts. The products demonstrate the excellent result of using this wood in the machining processes, which can be replicated in the manufacture of different products.

These results, covering the physical properties, response to machining and especially the validation of manufactured products such as furniture, decorative items, fingerboards for musical instruments and spectacle-frames, strengthen the sense that wood of small diameter species has its own kind of value. It can be managed to meet different sectors of the timber industry, especially the furniture sector. This is consistent with the sole paragraph of SDS-AM resolution 17/13 that establishes that species with a minimum cut-off diameter of less than 50 cm may be commercially managed, provided that it can be shown by study that the species in question meet the technical guidelines imposed by the standard, as obtained in this research.

Knowledge of the properties of wood, as well as its machinability, creates mechanisms for the use of alternative wood species little known in the market, enabling a more sustainable exploration of the forest. Every increase in the number of exploited species reduces the exploitation of species traditionally marketed, making management more productive and yielding more wood overall (Lucas & Son Boehs, 2007).

However, the results obtained in the developed research reinforce the need to e technology to characterise other frequent species of small diameter trees to carry out sustainable management in the Amazon.

## CONCLUSION

The performance of *E. truncata* wood, known as matamata, features excellent machinability; it can be used in the logging industry due to the high approval earned by its performance in thickening, sanding, drilling, moulding, horizontal drilling and lathe operations.

The results of the technological properties of wood make it possible to use matamatá wood in products with high added value. The products demonstrated the same quality of heartwood and sapwood wood material in the machining tests, suggesting that sapwood can also be used in the production sector.

On the basis of the characteristics analysed, *E. truncata* can be considered as an alternative in subsidising the timber market, since it presents similar characteristics to species which are commonly traded and is a very common species throughout the Amazon. The study shows that species of smaller diameters can be inserted in the market, given their technological potential.

The results also indicate a direction for future research: to investigate the possible use of other wood species of small diameter and high occurrence in the Amazon forest.

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# **Application of Behavioural Emotional Rating scale (BERS 2nd ed.) to Study Social and Emotional Behaviour of Students at Middle Level in District Mirpur Azad Jammu Kashmir**

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## **Abstract**

*Social Emotional Learning (SEL) is an 'Umbrella term' which covers all the aspects of development of an individual and can increase positive attitude towards self and others, hence reduces negative thinking. Social Emotional Learning is necessary to provide awareness to develop five core competencies i. Self-Awareness, ii. Self-Management, iii. Relationship skills, iv. Social-Awareness, v. Responsible decision making in students, as it is prerequisite for learning process. It creates a stable person who knows, how to behave in certain circumstances. The objectives of the study were to analyze the self-management in students at Middle level, identify the factors associated with responsible decision making, to develop better relationship skills that associates confidence in children, to explore the social awareness rate, to examine the abilities of children self-awareness. This study was quantitative in nature as it was implementation of BERS Scale (2<sup>nd</sup> Ed.) which is accurate & valid scale to measure attitude & is based on 4-point Likert Scale. Data was collected through BERS Questionnaires which are authentic and comprises of 55 questions. Data was analyzed through applying of statistical techniques. Results showed majority of the students said that they are stable which indicate that Education system in Mirpur (A.J.K) has been improved in the past few years due to teacher training programs and facilities provided to the students. The study recommended that Social Emotional learning is essential for students. It also suggested that students can be saved from getting into depression, anxiety, regression, aggression and other mental disorders through proper parental care, eradication of poverty, teacher training, gifted & talented education (GATE) of teachers and turning of schools into homelike environment.*

**Keywords:** SEL (Social and emotional learning), BERS (Behavioral Emotional Rating Scale), Social awareness, Self-management, relationship skills

## **1. Introduction**

The procedure of teaching someone especially in school, college or university is known as education (Collegiate Dictionary, 1999). The redemption of new responses to various stimuli is called as learning

(Blackburn, 2002). Consequently, education is a bit different from learning in that sense; learning may be positive or negative, but education is always positive. Social and Emotional Learning is relatively a new label for education tradition that has originated in form or another since the inception of Formal Education 3000 years ago (Cohen, 1999). Social and Emotional Learning is the capacity to recognize and manage emotions, solve problems effectively and establish positive relationship with others (Zins and Elias, 2007).

The action through which children and grownup attain and capably employ the knowledge, skills and attitudes to manage and recognize emotions, feel and show affinity for others, set and attain positive goals organize and maintain affirmative relationships and make accountable decisions is called as Social Emotional learning (Casel, 2016). Schools will be more profitable in their educational mission when they merge efforts to advance children's social emotional and academic learning. Fulfillment of social and emotional needs is a prerequisite for learning process. Moving from the underlying roots of the problem in the theory (Social-Emotional); the ordinary people admit the vital reason on which public schools were founded is to prepare the students to be responsible native of the country (Rose and Gallup, 2000). Learning demands fulfillers of social, emotional and physical needs prior to it, this is the base of success (Counsil, 2002). Social Emotional Learning is the phenomena through which children take control on their emotions and will be able to face the problems of the society in the future in a well-mannered way.

Social Emotional Learning Theory introduces five core competencies; Self-Awareness (Self-Confidence): Social Awareness (Interaction with others): Self-Management (Handling-Emotions): Relationship Skills (maintaining healthy relationships): Taking personal responsibility for ones decisions. Social-Emotional Theory also introduces a "Classic Meta-Cognitive Model" which was based on Self-Management Tips for students (Durlak, Weissberg, Taylor and Dymnicki, 2010).

There are five core competencies of Social and Emotional learning related to Cognitive, Affective and Behavioral sense of human beings:

- **Self-awareness:** It brings out confidence in individuals by assessing emotions and thoughts and their influence on the behavior.
- **Self-management:** A child can learn how to behave and react in certain circumstances. It involves motivating oneself for work, stress reduction ideas, management of impulses and academic goals.
- **Relationship skills:** Group work benefited a lot through learning of better relationship skills. This includes building of healthy relations with others and reward relationships. It promotes better communication skills in children.
- **Social-awareness:** There is no difference between black and white, it promotes ethics regarding diverse backgrounds and cultures of the people to recognize family, school, community resources and sports.
- **Responsible decision making:** A child will be able to develop confidence while taking decision in their personal matters and safety concerns which is better for the well-being of self and others (Casel, 2015).

### ***1.1 Statement of the Problem***

The study was focused to explore Social and Emotional behavior of students at Middle level in Mirpur (A.J.K) by implementing BERS. The research investigated five core competencies of Social and Emotional learning related to Cognitive, Affective and Behavioral sense of human beings. Social Emotional Learning is the phenomena through which children take control on their emotions and will be able to face the problems of the society in the future in a well-mannered way.

### **1.2 Objectives of the Study**

The objectives of this study were;

- To analyze the self-management in students at Middle level.
- To identify the factors associated with responsible decision making.
- To identify better relationship skills that associates confidence in children towards the teacher and the society.
- To explore the social awareness rate in students.
- To examine the abilities of children self-awareness.
- To contribute towards the existing body of the research.

## **2. Literature Review**

A great deal of research has been done on ESL. Social Emotional Learning is necessary if we want a success of a child for which we need to tell a student how to manage his/her emotions by giving them ways to critically thinking outside the box and taking care of them. Social Emotional Learning is the 'Blanket term' which refers to student's understanding and management of emotions, gaining of skills, develop interest and concern for others, make accountable decisions, managing challenging situations and develop positive relationships adequately (Casel, 2016). Social Emotional Standards are driven by intentions and not by grade level. They will not be able to understand in early childhood years and are introduced successfully at secondary level but are not a part of academics. These include Interpersonal Awareness, Self-Esteem, Motivation, Commitment, Decision making and Empathy (Schmitz, 2016)

Social emotional learning has positive impact on human brain and brain functions get better through it. Fulfillment of social emotional needs is necessary and is a prerequisite for learning process (Davidson, 2008). Hassan, (2016) said that our beloved Prophet (S.A.W) provide us the theories of Co-operative learning, Humanistic psychology, Theory of Behaviorism and response to intervention long before any scientific research. He said that understanding and meeting the personal and psychological needs of people is necessary. A saying of Hazrat Muhammad (S.A.W) we learn, 'O Aisha! Never estrange any needy from your door empty handed'. He PBUH never used foul language and taught to use minds not hands to teach the children and do take care of their self-respect. Bullying, Vanity, Pride, Selfishness and Lying are the sins according to Islam. Islam teaches respect, patience, sharing, kindness, tolerance and brotherhood. Monthly khutbah, counseling, prayers are the type of social-emotional learning and have deep roots in Islam.

Kastanek, (2011) did a study on elementary class teachers of grade level 1<sup>st</sup> to 5<sup>th</sup>. Different teachers (classroom teacher, special education teacher or administrator, classroom Aide) from Amery district have

been chosen; Survey done through 'Survey Monkey' online survey builder tool. 84 % teachers said that Social Emotional program is necessary in classrooms for avoiding distractive behavior of children. A great deal of research has been done on ESL. Lasel, (2012) Hodgins, Larm, Ellenbogen, Vitaro & Trembley, 2013; Pingault et al., 2013 concluded in their studies that Social Emotional and Behavioral attitudes are the keys of development of overall individual. Failure in developing of any one these aspects will result in Poverty, Poor relationships with others evolve a criminal.

A research has been done on Glasgow schools including children from pre-school (4-5yrs), P3 (7-8yrs) and P6 (10-11yrs). Analysis was done through providing of Good man's strength and difficulties questionnaire (SDQ) (Good man., 2013b). Questioners were filled by teachers at pre-school and P3 while at P6 by students. This research indicates that when students are introduced in school they show 'Hyperactivity' and 'Inattentiveness' and later in P6 they have got stability (Marryat, 2014). The children at Glasgow show huge misbehavior in the early years of school as compared to that in UK. This is due to the environment provided to them (Poor background belongingness, Lack of parent's attention and Criminal society) when the free lunch and care is provided at school, they got stability. Parents and teachers should take care of a child in early school years. Because these early years of development decides that whom a child is going to be in the future. Teaching students who have two bags with him while coming to school; one emotional and other book baggage, it's more than some of us agreement for. Psychological Functioning are interrelated this is proved by experiment. When we show positive attitude to others it will result in better relationships and hence lead to enhanced Psychological functioning (Wilhelm & Gross, 2012). Research has been done on twenty culturally and linguistically diverse high school students by introducing 12 lesson SEL intervention which completes all data points (Pre, post and follow up) in order to check the impact on students Resiliency and Internalizing problems. This research includes 15 males from grade 9 and 10. It results in high level of resiliency even after two months of intervention but no reduction in internalizing problems were observed (Cramer, 2013). Children's with hearing loss face a lot of difficulties with mastering Social and Emotional Development (Meadow & Dyssegaard, 1983). Preschoolers with hearing loss face lot of difficulties to maintain attention and interact with others (DeLuzio & Girrolametto, 2011). Parents of children with hearing loss face huge amount of due to inability of their child to adopt SED (Hintermair, 2006). Social Emotional Learning is basically for special education and for others with severe behavioral issues. 'A teacher that show empathy and is educated in the field of SEL tends to make a big difference both socially and academically' (Stanfield, 2017).

### **3. Research Methodology**

#### **3.1 Research Design**

The study was quantitative in nature. BERS was applied to collect the data.

#### **3.2 Population and Sampling**

The population of the study consisted of all 84 public middle schools of in Mirpur, Azad Jammu & Kashmir. Eight schools were taken as Sample, 20 students were taken from each school from 7<sup>th</sup> and 8<sup>th</sup> classes only.

### 3.3 Research Instrument

BERS (Behavioral Emotional Rating Scale) was used as data collection instrument.

### 3.4 Validity and Reliability

BERS has been applied in other researches as well and it is a standardized scale.

### 3.5 Data Collection

With the help of class teachers scale was applied and taken personally from teachers.

## 4. Data Analysis and Results

Collected data was analyzed through descriptive analysis i.e. percentage.

Table 1. My family makes me feel wanted

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	0	0
NOT MUCH LIKE YOU	30	19
LIKE YOU	40	25
VERY MUCH LIKE YOU	90	56
TOTAL	160	100

Table 1 illustrates the family influence on student behavior, 19% of the participants were of the view that their families were not making them feel wanted, 25 % were also liked by families and 56% of the students were strongly of the view that they were felt wanted.

Table 2. I believe in myself

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	02	1.25
NOT MUCH LIKE YOU	27	17
LIKE YOU	77	48
VERY MUCH LIKE YOU	54	34
TOTAL	160	100

Table 2 describes the believe of students in themselves, 17% of the participants were not confident of their belief in themselves, 48 % were in liking with their belief in themselves, 34% of the students were strongly believe in themselves

Table 3. I get along well with my family

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	0	0
NOT MUCH LIKE YOU	15	9
LIKE YOU	30	19
VERY MUCH LIKE YOU	115	72
TOTAL	160	100

Table 3 shows that 9% of the students were not comfortable with getting along with family, or, 19% of the participants were of the view that they get good going with families, 72 % students were strongly engaged with their families.

Table 4. I care about how others feel

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	0	0
NOT MUCH LIKE YOU	28	18
LIKE YOU	46	29

VERY MUCH LIKE YOU	86	54
TOTAL	160	100

Table 4 defines the family influence on student behavior, 18% of the participants were caring for other, 29 % were caring in nature for others and 54% of the students were strongly believe in caring others.

Table 5. I complete tasks when asked

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	0	0
NOT MUCH LIKE YOU	30	19
LIKE YOU	40	25
VERY MUCH LIKE YOU	90	56
TOTAL	160	100

Table illustrates that 19% of the participants were not completing their tasks when asked, 25% were satisfactorily completing their tasks, 56 % were also liked by families and 56% of the students were completing their tasks well in time

Table 6. I think about what could happen before I decide to do something

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	11	07
NOT MUCH LIKE YOU	30	12
LIKE YOU	80	50
VERY MUCH LIKE YOU	39	24
TOTAL	160	100

Table 6 illustrates that 7% of the participants were having no knowledge of the future impact of the decisions they took, 12 % were not bothered to think of their decision's future, 50% of the students were in thinking habit about their decision making, and 24% were strongly thought before taking decisions about future consequences.

Table 7. I respect the rights of others

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	02	01
NOT MUCH LIKE YOU	33	21
LIKE YOU	103	64
VERY MUCH LIKE YOU	22	14
TOTAL	160	100

Table 7 defines 21% of the participants were having not considerable respect for the rights of others, 64 % were really giving respect to the rights of others, 14% of the students were respecting the rights of others.

Table 8. Follow the rules at home

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	23	14
NOT MUCH LIKE YOU	27	17
LIKE YOU	76	48
VERY MUCH LIKE YOU	34	21
TOTAL	160	100

Table 8 describes 14 % of the participants were not following rules at home, 17 % were slightly following rules at home 48% of the students were nicely respecting the rules at home, and 21% were following the rules at home.

Table 9. I have a plan for my future career

RESPONSES	FREQUENCY	PERCENT
NOT AT ALL LIKE YOU	13	8
NOT MUCH LIKE YOU	31	19
LIKE YOU	89	56
VERY MUCH LIKE YOU	27	17
TOTAL	160	100

Table 9 illustrates 8% of the participants have not any plan of their future, 19% were with a little future plan, 56% were have future plan with them, 17% were clear future career planning.

## 5. Findings

Following findings were found based on data analysis:

1. 56 % of the participants were comfortable with their family at home and feel wanted by them.
2. 48% of the students were having strong belief in themselves.
3. 72% of the participant kept healthy engagement with their family.
4. 54% of the students were in habit of taking care of others.
5. 50% of the participants were aware of the consequences of their decisions.
6. 56% of the participants were completing their tasks well in time.
7. 64% of the students were obliging the rights of others.
8. 48% of the respondents were following the rules at home.
9. 56% of the participants were with clear future career planning.

## 6. Discussion

The present study sought to examine the implications of Behavior and Emotional Rating scale to study social and emotional behavior of the students. The findings indicate that most of the students were stable socially and emotionally may be due to the improvements which had taken place in the Education system of AJK in the past few years due to teacher training programs and facilities provided to the students. Malik (2016) published in his blog that, Pakistan remains unable to meet the Millennium Development Goals and its literacy rate is still 58%; the ministry of education neglects the social and emotional learning of children if this condition remains continue it will fade out the future of Pakistan. According to a survey 25 million students are out of school in Pakistan due to Health issues, Education, Children Rights, Child labor, juvenile justice and violence ("The International News",2015). Huge amount of children's suicide due to harsh treatment, fear of punishment and mental torture, Due to Regression students start taking drugs, teenage pregnancy becomes a critical issue due to lack of sex education, Many teens in foreign countries were suffering from AIDS, Several students are involved in schools based delinquency, Students faces a huge level of stress during the time of their studies due to different reasons.

Social Emotional Learning is the overall development of an individual (Psychological, Social, Emotional, and Physical, Linguistic etc.). It is mostly given in foreign countries like U.K; Canada etc. It can be given either merged in curriculum or separately taught during free time like through lunch time. Kastanek 2011, did a study on elementary class teachers of grade level 1<sup>st</sup> to 5<sup>th</sup>. Different teachers (classroom teacher,

special education teacher or administrator, classroom Aide) from Amery district have been chosen; Survey done through 'Survey Monkey' online survey builder tool. 84 % teachers said that Social Emotional program is necessary in classrooms for avoiding distractive behavior of children. Lasel; 2012, Hodgins, Larm, Ellenbogen, Vitaro & Trembley, 2013; Pingault et al., 2013 concluded in their studies that Social Emotional and Behavioral attitudes are the keys of development of overall individual. Failure in developing of any one these aspects will result in Poverty, Poor relationships with others evolve a criminal. Children's who attend Social & Emotional classes have no Psychiatrist disorders, those having ADHD and Conduct disorders also got stability up to 89 % by enrolment into SEL schools Cassidy et al, 2001.

Social Emotional Learning improves behavior and Grades of all types of learners, but Special children are more benefited from these programs. Social Emotional Learning often called as 'Soft Skills' or 'Character Education'. Special children's do not understand social cues easily and have difficulty in management of emotions and behavior (Schlinger, 2013). The above discussed research through their results and conclusions support the current study that fulfillment of social emotional needs is necessary and is a prerequisite for learning process and stable social and emotional behavior.

## 7. Conclusions

1. The study concluded that SEL helps students in making students self-managed and progressive in studies.
2. SEL enables students in empowering them in decision making.
3. SEL enhances the ability of self-awareness in students to lead academic affairs positively.

## 8. Recommendations

1. As SEL helps in making student self-managed and progressive in studies, the steps may be taken at private and public sector school system to provide such environment to fulfill SEL needs.
2. Training programs may be launched to facilitate the school administration to work for creating decision making abilities which will help students to become future leaders.
3. SEL may incorporated in curriculum for the development of better relationship skills in students.
4. The result of the study suggest that resourceful sessions may be conducted to enhance the capacity of self-awareness.
5. The current study in the light of its results highlight the importance of developing five core competences of social emotional learning vital for students in their academic progress.

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# **PGRSS Application in a Public Hospital Unit of Manaus and its Sustainability Characteristics**

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## **Abstract**

*Solid waste from health services, the so-called “hospital waste”, has high risks to society and the environment. Because of this, it was necessary to create legislation that would indicate a whole treatment, seeking impact resolution without losing the quality of care provided. Thus are in force the CONAMA Resolutions 358/05, RDC ANVISA 222/18 and Law 12.305 / 10 that deal with health service waste management (SSR) steps and their management, defining the conduct of SSR agents to prevent and properly treat waste with potential contamination. This requires that every institution implements these safe-conduct strategies in the handling, storage, transportation, treatment and final disposal of SSR. In this research, the steps proposed by the Health Care Waste Management Plan (PGRSS) were analyzed: (segregation, packaging, identification, internal transport, temporary storage, treatment, external storage, collection and external transportation and final disposal). in a public hospital unit, located in the city of Manaus, by observing and describing the practices performed in the unit, resulting in 8 stages out of 9, which were presented, obtained satisfactory conditions in compliance with the legislation. What needs improvement in order to meet conditions responsive to legislation is local segregation. Another issue observed was related to sustainable responsibility, which hospital unit has. When adopting sustainable practices, there should be interactions of activities and awareness of all entities, which is already observed in this specific hospital unit, with sustainable practices based on certification because it meets the importance of the relationship with the environment, seeking to obtain increasingly satisfactory results, not only to respond to the legislative condition.*

**Keywords:** Environment; Solid waste; Management plan;

## 1. Introduction

Since the 1970s there have been events worldwide that aim to discuss human interference with nature, one of these events being held in Rio de Janeiro in 2012, the conference entitled Rio + 20. In addition to discussing the impacts of human actions on the natural environment, alternatives that promote the good use of natural resources in order to mitigate the impacts on the environment were discussed [1].

It is well known that the generation of waste follows the development of the world population, where the concern with the increase of this waste only occurred from the middle of the twentieth century, due to the explosion of the population level and its new consumption habits [2].

As a result of these two factors there was an increase in product consumption resulting in an incorrect disposal of products considered obsolete. The technology has brought several products, such as components and materials of difficult degradation and greater toxicity, making the decomposition process in nature difficult, resulting in more time to dispose of these residues [2].

Solid waste, according to Brazilian Standard NBR 10.004 / 87 [3], is defined as solid and semi-solid waste resulting from origin: industrial, domestic, hospital, commercial, agricultural, service and sweeping.

Among the wastes that most harm the environment, endangering natural resources, people's quality of life and the future of society, are the Solid Waste of Health Services - RSSS [4] as: services related to health care. human or animal health, health analytical laboratories, morgues, funeral homes, embalming activities forensic medicine, drugstore and pharmacies, healthcare teaching and research establishments, zoonosis center, health product distributors, mobile units, acupuncture services, tattooing and the like.

Waste is classified according to the potential risks presented to the environment and public health (Table 1). Thus, these residues are of specific importance and treatment and are managed separately, also taking into account the toxicity of the product.

Table 1- Classification of Solid Waste

	CLASS I	CLASS II
	DANGEROUS	NOT DANGEROUS A - Not inert B - Inert
<b>DANGEROUS</b>	For a waste to be classified as class I, it must be contained in annexes A or B of NBR 10004 or those that present characteristics: flammability, corrosivity, reactivity, toxicity and pathogenicity.	<b>Non-inert:</b> Those that do not fall within the class I - hazardous waste or class II B - inert waste classifications. Class II A - Inert waste may exhibit properties such as biodegradability, combustibility or water solubility. <b>Inert:</b> Those that do not have any of their constituents solubilized at concentrations higher than water potability standards, except for appearance, color, turbidity, hardness and taste.

Source: ABNT 10,004 [5]

Thus, as mentioned, solid health waste still has some specific characteristics, where special attention should be given. To this end, every facility that treats and offers health services produces SSRs are subject to dealing with waste management and disposal that have a great chance of harming both the environment and humans.

According to [6], health care has been updated by technological advances and, at the same time, it has increased the number of service providers, reflecting the increase in the production of SSR, ie, due to the increase in the number of healthcare providers. of health care providers solid waste tends to increase further and is yet another causative factor of existing solid health waste.

These wastes are classified according to [7] and [8] into five groups: A, B, C, D and E according to the agents present or their nature (Tables 2, 3 and 4).


SYMBOLGY	DESCRIPTION
<b>INFECTIVE GROUP A</b> 	Residues with the possible presence of biological agents that, due to their characteristics of higher virulence or concentration, may present a risk of infection. According to the hazardousness and the need for differentiated treatments, group A residues are classified into five subgroups: A1, A2, A3, A4 and A5.
	<b>A1 - Cultures and stocks of microorganisms; wastes from the manufacture of biological products other than blood products; disposal of live, attenuated or inactivated microorganism vaccines; culture and instrumental media used for culture transfer, inoculation or mixing; waste from genetic manipulation laboratories. Residues resulting from the teaching and research activity or health care of individuals or animals, suspected or certain of biological contamination by risk class 4 agents, epidemiologically relevant microorganisms and the risk of spreading or causing emerging disease that becomes epidemiologically or whose transmission mechanism is unknown. Transfusion bags containing blood or blood components rejected for contamination or poor preservation, or expired, and those from incomplete collection. Leftovers from laboratory specimens containing blood or body fluids, containers and materials resulting from the health care process, containing free form blood or body fluids.</b>
	<b>A3 - Anatomical parts (limbs) of the human being; fertilization product without vital signs, weighing less than 500 grams or height less than 25 centimeters or gestational age less than 20 weeks, which has no scientific or legal value and has not been requested by the patient or family members. pathology or diagnostic confirmation.</b>
	<b>A4 - Arterial, intravenous and dialyzer line kits, when discarded. Air filters and aspirated gases from contaminated area; filtering membrane for medical and research equipment, among others. Remaining laboratory specimens and their containers containing feces, urine and secretions from patients who do not contain or are suspected of containing risk class 4 agents, nor have epidemiological relevance and risk of dissemination, or emergent disease causing microorganism. becomes epidemiologically important or whose transmission mechanism is unknown or suspected of contamination with prions. Waste from adipose tissue from liposuction, liposculpture or other plastic surgery procedure that generates this type of waste. Containers and materials resulting from the health care process that do not contain free blood or body fluids. Anatomical parts (organs and tissues), including the placenta, and other residues from surgical procedures or from anatomopathological studies or diagnostic confirmation. Corpses, carcasses, anatomical parts, viscera and other residues from animals not subjected to experiments with the inoculation of microorganisms. Empty or residual volume transfusion bags after transfusion.</b>

Table 2 - Classification of Health Services Waste Group A and Subgroup A1

**A5 - Highly infectious prion organs, tissues and fluids of suspected or confirmed cases, as well as any materials resulting from the health care of suspected or confirmed individuals or animals, which have had contact with organs, tissues and fluids of high infectivity for prions. Highly infectious tissues for prions are those thus defined in official documents by the competent health agencies.**

Table 3 - Classification of Group B, C and D Health Services Waste.





SYMBOLOLOGY	DESCRIPTION
<b>CHEMICAL GROUP B</b>  	Wastes containing chemicals that pose a risk to public health or the environment, depending on their flammability, corrosivity, reactivity, toxicity, carcinogenicity, teratogenicity, mutagenicity and quantity characteristics. Examples: Pharmaceuticals; sanitizing; disinfectants; waste containing heavy metals; laboratory reagents, including contaminated containers; image processor effluents (developers and fixers); effluents from automated equipment used in clinical analysis and other products considered hazardous: toxic, corrosive, flammable and reactive.
<b>RADIOACTIVE GROUP C</b>  	Any materials resulting from human activity that contain radionuclides in quantities exceeding the disposal limits specified by the National Nuclear Energy Commission (CNE).
<b>COMMON GROUP D</b>  	Waste that does not present a biological, chemical or radiological risk to health or the environment and can be equated with household waste. Example: Sanitary paper and diapers, sanitary pads; disposable garments, disposable caps and masks; patient food rest; material used for antisepsis and venoclysis hemostasis, gloves for procedures not in contact with blood or body fluids; serum equipment, tongue depressors and the like similar not to A1; leftover food and meal preparation, catering refuse; waste from administrative areas; sweeping waste, flowers, pruning and gardens; plaster waste from health care; animal fodder coverings with no associated biohazard; recyclable waste without associated biological, chemical and radiological contamination and animal hair.

Table 4 - Classification of Group E Health Services Waste

SYMBOLOLOGY	DESCRIÇÃO
<b>CUTTING PERFUME GROUP D</b>  	Sharpening or scarifying materials such as razor blades, needles, scalpels, glass ampoules, drills, endodontic files, diamond tips, scalpel blades, lancets; capillary tubes; micropipettes; slides and coverslips; spatulas; and all broken glassware in the laboratory (pipettes, blood collection tubes and Petri dishes) and the like.

Because of this health waste, a more consistent discussion of this problem has started in recent years, leading municipalities to implement systems for the collection and proper disposal of waste generated in their health facilities [9].

In Brazil, ANVISA and CONAMA are the bodies responsible for providing guidance on this issue. Among the resolutions that regulate waste management practices, they are in force [8], providing for the treatment and final disposal of health care waste and other measures. [7] provides for best practice

requirements for general health care waste planning (PGRSS) defining the conduct of SSR officers where, as a result, the prevention and appropriate treatment of waste with potential contamination is sought. .

Based on the guidance given by these bodies, establishments dealing with SSR should adopt policies so that the toxic waste produced is handled and disposed of so that there is no significant harm to human, health and economic development. environmental damage is as little as possible.

The article entitled “Healthcare waste and its environmental impacts: a bibliographic review” discusses the impact on the environment, gathering opinions from several authors who write about the risks that the environment is subject to when the waste Solids from health are handled and disposed of incorrectly, indicating that the main problem is the proper technical procedures for waste management, considering the type of material [10].

This waste is handled, handled inside and outside health facilities and may incur risks for those who handle it. As it is a hospital environment, the patients are the main ones affected, since they already have a compromised defense system presenting greater risk. However, persons who have direct or indirect contact, whether from within the establishment, or civilians who come into contact with the waste at the time of transport and disposal, may be subject to disease and loss of quality of life [10]. ].

The management and incorrect disposal of solid health waste generate chain reactions, which harms, pollutes and affects humans dependent directly on the clean and healthy environment for their maintenance [11].

The aim of this study is to verify compliance with the General Planning of Health Services Waste (PGRSS), from the management to the final disposal of the waste, observing what are the types of health waste existing in the hospital unit of Manaus, AM, Brazil. In addition to verifying the characteristics of sustainability that the hospital has, thus contributing to the environment and the welfare of the population. Waste generated in the health facility: gloves, burrows, mask, gauze, cotton, tape, needleless syringes, chemical vials (hypochlorite), lamps, anesthetic vials, expired drugs, disinfection liquid (glutaraldehyde), detergents, chemicals generated from automated analyzes, generated mercury, broken thermometers, barometers and pressure devices, plunder; Fluorescent lamps, tones, printer cartridges, expired drugs (oral / injectable solutions); General papers, empty packaging, cardboard, newspapers and magazines, medicine boxes, plastic container of peracetic acid, plastic cups, Prozime bottle, used paper towels, wet paper, toilet paper, tampons; Needles, ampoules, scalpels, scalps, syringes with needles, broken vials, broken petri dishes, suture slides, drills, lancet, broken coverslips.

## **2. Material and Method**

### **2.1 Kind of study**

The types of approaches adopted in the research, which made it possible to identify whether or not compliance with the stages of management of SSR in the hospital unit, were based on the descriptive method, presenting observational character. According to [12], the descriptive research exposes the facts and phenomena of reality while for [13] in the observational study one observes something that happens or has already happened.

## **2.2 Study area**

The study was conducted at a public health hospital located in the northern region of Manaus / AM, considered the largest in the northern region with high technology. The hospital unit is a partnership of the public-private initiative, the PPP (PUBLIC – PRIVATE PARTNERSHIP). The private company responsible for the administration of the hospital won, in 2013, the public bid to build, equip and maintain the non-assistance area of the hospital for 20 years.

The Hospital had its construction and equipment completed in 2015 and since they are in operation according to the international model of PPP (PUBLIC-PRIVATE PARTNERSHIP), in compliance with contract 061/2013 between the Government of the State of Amazonas and the company. toilet. It is responsible for sterilization services, sterile materials center; food and nutrition; hospital laundry; health care clothing processing; hospital hygiene and cleaning; building maintenance; medical equipment maintenance, clinical engineering; information technology, computer science; telephony; concierge; reception and surveillance.

The hospital unit was built to meet the demand of the region, with independent structures for child and adult care, with urgent and emergency care in the medical and pediatric clinic, orthopedics and general surgery specialties. As for diagnostics, the unit has laboratory tests, x-rays, electrocardiograms and ultrasound.

The hospital unit has a total building area of 30,164 m<sup>2</sup>, operating every day with adult emergency room, emergency room, operating rooms, apartments, wards and ICU. The hospital is considered a large hospital and has 312 beds.

The hospital was built with high environmental quality thinking of a sustainable construction so much that it has the AQUA-HQE - High Environmental Quality Seal which consists of a certification of sustainable construction applied in Brazil by the Vanzolini-USP Foundation.

The project includes the capture and reuse of rainwater in the use of toilets (toilet flushing) and gardening irrigation; selective waste collection; capture of natural light through the coating of the glass building; sewage treatment plant system for the preservation of natural resources. In addition, it has all environmental licenses, such as: Preliminary License (LP), Installation License (LI) and Operation License (LO) documents that allow the execution of activities observing the measures to be fulfilled, fulfilling the environmental requirements.

## **2.3 Data collect**

To obtain the expected results, sectoral visits were carried out daily, during a 25-day period, where the steps regarding the management of the RSS developed at the Hospital were observed and described, and the waste generated by the hospital unit of each classification group, besides observing the sustainable practices performed in the hospital.

## **3. Results and Discussion**

The legislation pertaining to the PGRSS, which provides for the procedures to be adopted by medical-hospital establishments, aims at reducing or eliminating waste production and providing the generated

waste with a safe and efficient disposal, ensuring the protection of workers and the preservation of public health. of the environment [7] [8] and [14].

In order to comply with these PGRSS procedures, it is necessary that the place containing the technical and administrative activities applicable to the management be managed by health services waste, having as responsible for this management all those who are part of the initial chain until the last one. existing step.

Each stage of handling of SSR corresponds to a specific procedure, where those responsible for waste must follow and the lack of knowledge and non-implementation of PGRSS in institutions results in greater risk for both health professionals and waste collectors. [15]

During the construction phase of the hospital, several studies were implemented. Among them, the (PGRSS) complies with regulatory laws, being updated annually, where are the waste management steps that must be met, and demonstrated through the flowchart (Figure 1).

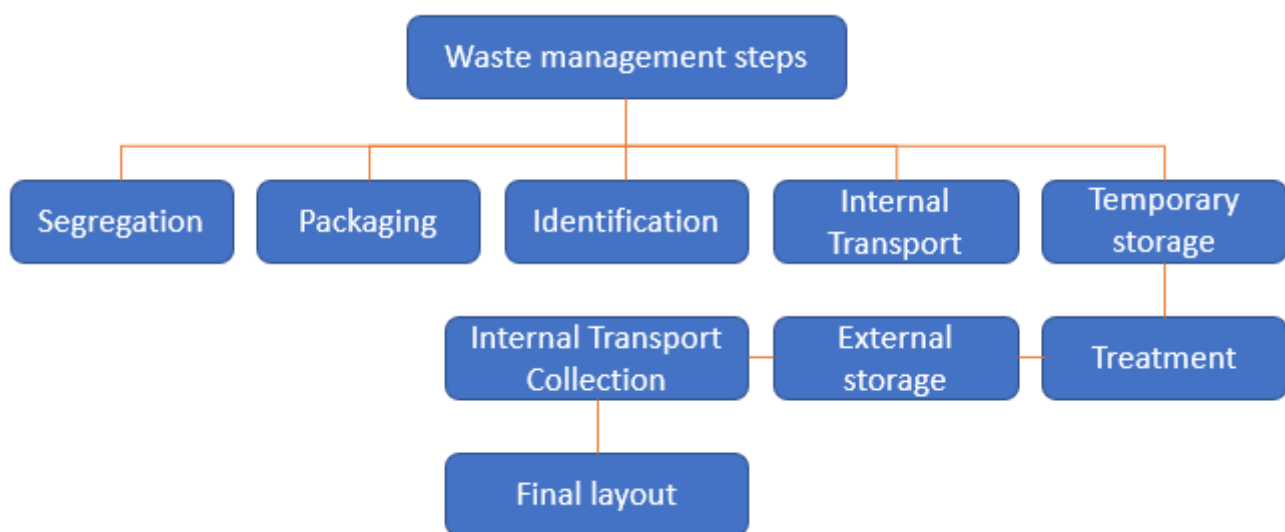


Figure 1 - Flowchart of the operation of the hospital RSS management steps according to the PGRSS.

Source: Own authorship (2019).

Each step corresponds to a type of activity developed especially for the handling, treatment and transport of SSR. According to the observations made, the PGRSS steps are being completed one by one:

**A. Segregation:** This first part involves all individuals who are part of the institution, including patients, health professionals, service providers, and management professionals. Everyone should separate the waste, at the time of generation, according to their classification, in the bins that are specifically identified for each type of RSS.

**B. Packaging:** Waste is packed segregated in bags and containers according to their characteristics: physical, chemical and biological. The waste is initially packed in plastic bags of different colors, corresponding to a waste of a certain group. The white bags are for group A infectious waste, the red bag is for packing blood products in group A1 and the black bag is for common group D waste.

Group E sharps are packaged in boxes, which after reaching their use limit are placed in white bags and later passed on to container cars. The plastic containers, which receive the RSS, have a pedal-operated lid and for liquid waste the lid is threaded. Most collectors in the hospital are white and what differentiates at



the time of segregation is the identification by means of a sticker on the collector lid.

**C. Identification:** All waste related inputs are identified with adhesive labels, examples: bags, containers, boxes, containers and waste storage locations are labeled. Fixed and printed labels and plates allow the recognition of waste by providing correct waste information using color symbols and phrases as determined by ABNT.

**D. Internal Transport:** performed by the cleaning staff, where the transfer is made from the generation point or temporary waste room to the waste center, in a script programmed by the waste management department, because the time cannot coincide with the food distribution. nor with the distribution of clean clothes. To meet this requirement, the hospital has three different elevators: one for the displacement of SSR, another for the displacement of people in general and the last for the transport of food.

Waste is transported by group, in specific container cars that: have wheels that do not emit much noise, cars with more than 400 liters of capacity have a bottom drain valve that facilitates cleaning, in the period in question it was necessary to change some cars collectors with broken wheels.

**E. Temporary storage:** The temporary storage of waste is located in points near the waste generation sectors, seeking to expedite the collection of internal areas and optimize the displacement between the generation points and the destination point. In these rooms there are collection cars for temporary storage of waste, because the waste bags cannot be directly disposed on the floor besides having a smooth and washable floor and wall.

Sanitation is performed daily under the supervision of the responsible sector. Also noteworthy is the ban on the removal of waste bags from the containers. Easy putrefying waste is collected daily and temporary storage rooms are not mandatory for all hospital complexes and can be dispensed with when the distance between the generation point and external storage justifies it.

**F. Treatment:** Waste generated at the hospital does not undergo treatment at the facility itself. SSRs are withdrawn by companies that have licenses for the process of: incineration, recycling and landfill [16] and [17]. The techniques used for the treatment of infectious waste and chemicals in the licensed company receive the incineration process, as a source of contamination that can cause disease and compromise the environment and public health. For common waste, those that do not present biological, chemical or radiological risks to health or the environment are removed by public cleaning or cooperatives that recycle them.

**G. External storage:** The hospital has a waste disposal center exclusively for the storage of waste, the areas are subdivided by waste group, identified by hanging plates according to the waste classes. Appropriate waste collection cars are placed on site, with easy access to the collection companies. The site and pickup cars are cleaned daily to prevent contamination, problems such as stench, insect flies and cockroaches providing a healthy environment for employees working on site.

**H. External Collection and Transportation:** The hospital has a contract with specialized companies that perform the removal of waste from the hospital to the company for treatment or final disposal. Always using the techniques that guarantee a good condition of the storage, preserving the integrity of the waste handler, the population and preserving the environment as the use of collection cars destined for each type of waste so that there is no contact with each other. This removes the risk of potential contamination.

Ordinary and hospital waste is collected daily from Monday to Saturday. As for the others like chemists, pharmacists, lamps, batteries and batteries are collected on a scheduled basis.

**I. Final disposal:** Waste considered infective, sharps and those containing chemical are incinerated, after the incineration process are taken to the landfill only the ashes.

Waste considered common, which is recycled, is disposed directly in the Manaus landfill and those that can be recycled, the waste cooperatives collect and dispose of for recycling. All companies providing services to the hospital have environmental licenses in accordance with the Environmental Licensing Resolution [8].

In addition to the PGRSS, some environmental studies were performed, such as: Neighborhood Impact Study (EIV); Environmental Control Plan (PCA); Environmental Management Plan (PGA); Construction Solid Waste Management Plan (PGRCC); Forest Replacement Report (RRF), which subsidized the environmental licenses of the project, which authorized the construction, installation and operation of the Hospital: Preliminary License (LP), Installation License (LI) and Operating License (LO) aiming at sustainability.

It is noticeable that since the construction there has been a concern with the environment and the surrounding population. As a hospital that includes the public-private partnership, it is managed by the private system that performs various functions, one of them being sustainability, seeking to perform activities that aim to contribute to the environment and the well-being of people.

Still in the construction phase there were studies on the flora and fauna that existed on the site and, later, there was a forest replacement contemplating the same types of trees that existed there, seeking to replace the flora that had been removed.

In October 2019, the hospital unit became the first public hospital in Brazil to have the AQUA-HQE Seal, an international certification for sustainable construction, developed from the French Démarche HQE (Haute Qualité Environnementale) Certification and applied in Brazil exclusively. Vanzolini Foundation - USP, also received the NBR ISO 9001: 2015 Seal, a standardization standard of the International Standard Organization (ISO), focused on products and services that works in the organization's quality management, focus of actions focused on customer satisfaction. / user through non-assistance services [18].

As a planned institution for sustainability, there are activities throughout the hospital that aim at sustainable construction, such as: rainwater harvesting used in the gardening service and toilets; selective waste collection, highlighting the collection of organic waste, reused for composting and the collection of edible oil collected by companies licensed to produce biodiesel; Capture natural light through the option of building using glass in multiple places so that natural light can be the largest source of light at the expense of electricity; reduction of water consumption and other practices for the preservation of natural resources, applying above all the tripod of sustainability (environmental, economic and social).

According to the results, it is observed that the stages of solid waste management of health services are put into practice by the hospital unit management company, seeking to comply with what the current legislation proposes.

Almost all steps have considerable effectiveness. However, SSR management faces difficulties in the segregation stage. Improper disposal by employees and users is the factor responsible for inefficient

segregation.

Management is committed to complying with all statutory requirements by disposing of waste bins / containers, containing labels and instructing people. However, at this moment, there is the carelessness on the part of professionals and users as they do not make the separation / segregation correctly.

Waste is often segregated erroneously, in incorrect dumps, even if they are correctly identified, thus causing a sequence of complications. With improper disposal, SSRs are intended where they should not be, as sharps going to the public landfill incurring a high risk of infection leading the company to risk being fined for improper disposal and damage to the environment through the agencies. environmental and sanitary conditions, which may result in the loss of certificates and recognition (Figure 2) [19].



Figure 2 - Waste management step

Source: Own authorship (2019).

The administrative department responsible for the management of SSR makes changes in the health unit to help the proper segregation of waste, such as placement of collectors in strategic points of the hospital, replacement of the layout of stickers, signage of collectors on the floor, realization campaigns, training on the proper disposal of waste and its importance, sectoral meetings, daily dialogues with employees informing them and removing any existing doubts.

In addition to the PGRSS document, the hospital has a PGRSS waste committee, where the committee members are professionals from the Hospital Infection Control (CCIH), Environmental Management (MA), Safety Specialist Occupational Health sector stakeholders (SESMT) and Quality. Thus, there is effective participation by the sectors involved, through reports, with the purpose of improving the waste management process.

#### 4. Conclusion

Given the results presented, it is observed that in the hospital unit in question, we seek to comply with the largest possible number of steps in the management of SSR contained in PGRSS (8 of 9). The only step

in the process that presents difficulty in compliance is segregation / disposal.

The exchange of professionals in the health unit contributes to the incorrect segregation of SSR: the bad habits of some employees acquired in other units are taken to the unit in question.

The failure that occurs in segregation influences the high cost of the weight of hospital waste, the risk of accidents with workers handling the waste, and the possibility of committing environmental crime because the waste is disposed of in landfills whereas they should receive the incineration process.

The hospital has all the necessary supplies to meet the demand for care and complies with the contract established by the Amazonas Health Secretariat SUSAM making the hospital management satisfactory with regard to the inputs intended for SSR.

The research contributes to the demonstration of a sustainable hospital, which is recognized, through international certificates, for valuing sustainable practices that aim to contribute to the environment and consequently to the well-being of the population who directly or indirectly enjoy the activities, in addition to present a PPP administration (public private partnership), fulfilling mandatory demands, by contract, generating numerous advantages or penalties in the budget, if the compliance does not occur.

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## Low Cost Process Modeling for a Manaus Industrial Polo factory

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### Abstract

*Through the centuries man has found easier and better ways to produce the goods he needs and desires. Thus through new technologies through different forms of automation, manual processes of high physical risk and high financial cost are minimized. The aim of this paper is to show that industrial automation can be applied aiming at a low cost in its implementation, presenting a fast financial return time, besides improving the product quality, reducing the production defect rates and consequently the production increase. Article was based on the automation of a modem assembly cell, where it was necessary to use four (4) operators to assemble it, the modem had a defect index of 0.12% related to annual production. The result achieved showed that after the implementation of an automatic tightening machine, only one (1) operator is required to assist in assembly and one (1) defect rate per year dropped to 0.02% per year. Industrial automation has been showing companies the power to become more competitive in the world market. Thus, it becomes essential in the process of using technologies as a tool to support business management.*

**Keywords:** Industrial Automation, Fourth Industrial Revolution, Cost Reduction, Process Management, Times and Methods;

### 1. Introduction

The first industrial revolution originated in England from 1760 to 1840. Gradually, artisanal manufacturing methods were replaced by steam-powered machines. The revolution was based on the use of water vapor as a source of energy. Such revolution has generated social and economic consequences due to the beginning of mechanization of manufacturing processes, especially in the textile industry

(DRUCKER, 2000).

The second industrial revolution took place from 1870 to 1914, which was marked by the improvement of technologies and scientific research of practical knowledge obtained at the time. There were significant developments in the areas: electrical, chemical, biological, transportation, production engineering, agriculture, materials, among others.

The processing and storage of information in digital media occurred with the optimization of communication, as well as the development and proliferation of the internet and mobile telephony (COELHO, 2016).

Over the past century, critical segments of the mechanical industry have begun to demand an advanced stage of integration with industrial automation in a programmable and more flexible manner. Thus, space was created for a new industrial complex formed by mechanical engineering, industrial automation and computing.

This has outpaced the automotive industry on some fronts, the growing weight of the electronics industry has gained expression and the rapid growth in the share of value-added products, employment and income formation in industrialized countries.

Having thus created a new production paradigm - flexible automation, the technological trend of microelectronics generating impact on industrial processes. Electromechanical twentieth-century automation with repetitive, non-programmable automation of contactors, switches, and relays; has become the subject of improvements and enhancements. Substituted, electronics by electromechanics as the basis of automation (SILVEIRA; SANTOS, 2015).

Dedicated microprocessors and computers have become able to guide the machine system or part of the chain that belongs. Continuous integrated production processes have come to make use of: programmable logic controllers, sensors, distributed or centrally controlled digital meters, whether in process control optimizing production flows, partially or totally improving the systems that needed time control real (COUTINHO, 2016).

Last and newest, market demand is for industry 4.0, created in Germany in 2011, a high-tech strategy for the year 2020 (ZHOU; LIU; ZHOU, 2015). Thus, businessmen, politicians and universities collaborate so that their ideas stimulate competitiveness among the country's industries. Where the fourth industrial generation is expected to offer improvements in industrial processes involving: operation, engineering, production planning and control, logistics and continuous analysis during the life cycle of products and services (QIN; LIU; GROSVENOR, 2016).

According to Cheng et al. (2016), the essence of industry 4.0 is based on the cyber-physical (CPS) and Internet of Things (IoT) systems, which led factories to reach a new level of production. CPS is based on the dynamic configuration of manufacturing. Unlike traditional production methods, the dynamic configuration is above production and the processes involved, because the dynamism makes the system able to change the initial design of the product at any time.

For a company to become competitive in a globalized economy in which market laws are free-flowing, both internal and external, as well as broad competition, requires a defined conceptual strategic model so that the decisions made are dynamic and flexible, so as to provide fast speed adaptation to the perceived need.

According to Silveira; Santos (2015), the integration of production systems, this integration can occur in three distinct ways: Organizational integration - characterized by the union of one or more activities previously separated; Computer integration - is characterized by the exchange of information via computer between sectors and previously isolated activities; Multiple integration - is the organizational and computer integration at the same time.

Thus, companies that apply an integrated production planning model are those that have: technological resources employed with a high degree of computerization developed, an installed database, with reliable information.

With all process variables being integrated, it is possible to establish and set an actual cost estimate for your future pricing. Establishing a master production plan at this stage, involving quantity of products to be manufactured, product types and lead times taking into account customer demand.

This paper aims to demonstrate that the investment in the transformation of manual processes into automated processes, seeking to minimize low cost and a quick pay back (investment recovery period), modeling industrial processes Manaus - AM, from the years 2017/2018. designing for 2019.

## **2. Materials and Method**

### **2.1 Kind of study**

The types of approaches adopted in the research describe the descriptive methods. According to Fantinato (2015), the descriptive research exposes the facts and phenomena of reality and the exploratory seeks to correlate the problem in order to make it more explicit for hypothesis construction.

Therefore, this study is described as a qualitative research given the theoretical and empirical orientations, as well as quantitative evaluation described by its measurable attributes (GERHARDT; SILVEIRA, 2009).

#### **Study area**

The selected area has a high demand for human labor in a company in the Manaus - AM Electronic sector, specifically in a cell, as part of an assembly line. For confidentiality reasons the company will not be cited.

The company considers for productivity calculations 8.4h and on average 20 days / month. In the assembly line, about 36 operators work separately per cell, such as: initial assembly, initial testing, final assembly, functional testing and packaging. Being the focus of this work act in the final assembly process (Figure 1).



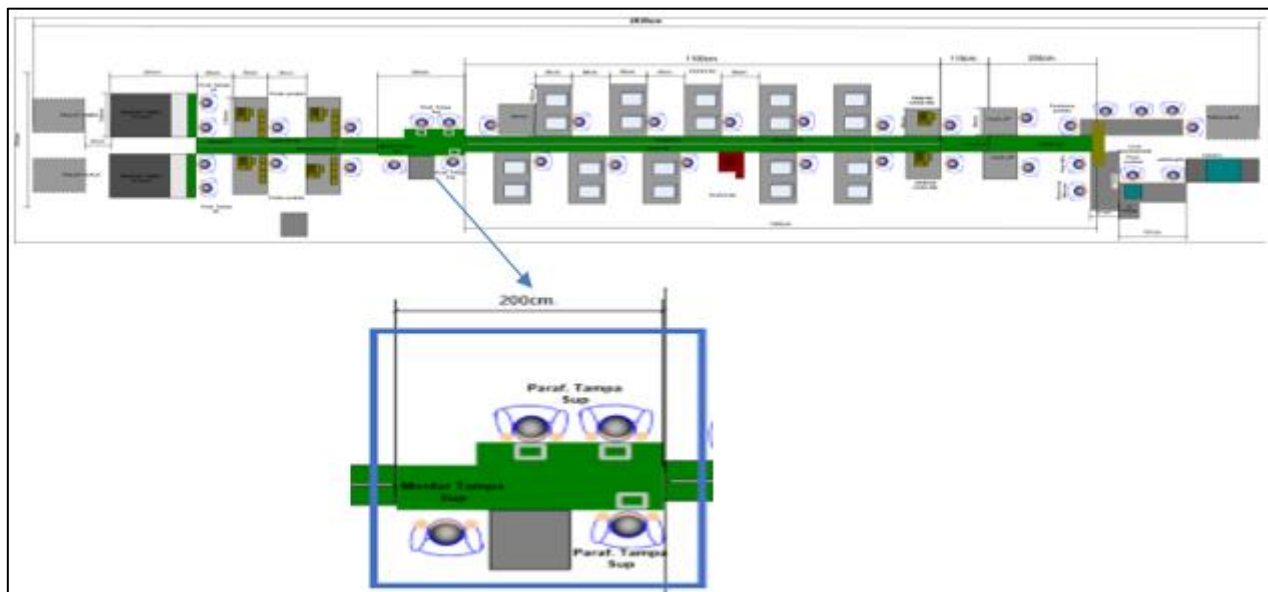


Figure 1. Production Line Layout

Source: Provided by the analyzed company (2018).

Given the above, it is expected to identify a way for the automation of the final assembly process to replace operators with machines, in order to promote improvements and economy in the assembly line. The company pays per operator to perform repetitive tightening movements. Thus, the payback calculation, how much the company would stop spending, resulting in savings for the company. The profile of their customers is diverse, most of which are companies that provide internet and pay-tv services. The company is a leader in the modem and Se-top box manufacturing industry.

## 2.2 Old Method

Most tasks are done with both hands, and the entire assembly consists of a relative number of fundamental movements that repeat and combine to take, screw, release. Study was carried out in the manufacturing process of a modem, composed of: a lower cover, a plate, an upper cover and four screws. The evaluation was based on the tightening process where, due to the tack time of the line being 6.05 sec, takt time is a metric that establishes the rate at which a product should be made (DENNIS, 2008). "Cycle time is the time that passes from the start of an individual process or activity to its completion. Several cycle times may be included in an individual process or function "(TAPPING; SHUKER, 2010).

For this scenario four (04) operators were used in the final assembly process in the production line, where one (01) to close the product (top cover with the byproduct), and two (02) to screw the product, where 01 screw 02 screws on the right side and one screw 01 screws 02 screws on the left side of the modem, one (01) checks the ones that were screwed and releases to the next post, as shown by the production line capacity study, informed by the Engineering Department. Company Processes and Development (Chart 1).

Table 1. Production Capacity Study.

Tour	Cycle (s)	Losses	Real Cycle (s)	Equipment Qty	OP QTY	Product QTY (hours)	Product QTY (Day)
INITIAL MOTAGE	17,8	5%	18,74	0	4	769	6456
PRINTING I	18,1	2%	18,47	4	4	780	6549
<b>FINAL ASSEMBLY</b>	<b>18,3</b>	<b>10%</b>	<b>20,11</b>	<b>0</b>	<b>4</b>	<b>716</b>	<b>6015</b>
FUNCTIONAL TEST	90,2	3%	92,99	20	10	774	6504
PRINTING II	8,8	2%	8,98	2	2	802	6735
GENERAL CHECK	9,4	2%	9,59	2	2	751	6305
PACKING	17,6	1%	17,78	0	4	810	6804
FINAL VERIFICATION	4,8	2%	4,9	1	1	735	6174

Source: Provided by the analyzed company (2019).

The rate of poorly closed modems averaged 0.12% of production in the analysis period of 2017 and 2018 (Figure 2 A B). Each reworked modem has a cost of \$ 5.00, as informed by the company's Quality Engineering department.

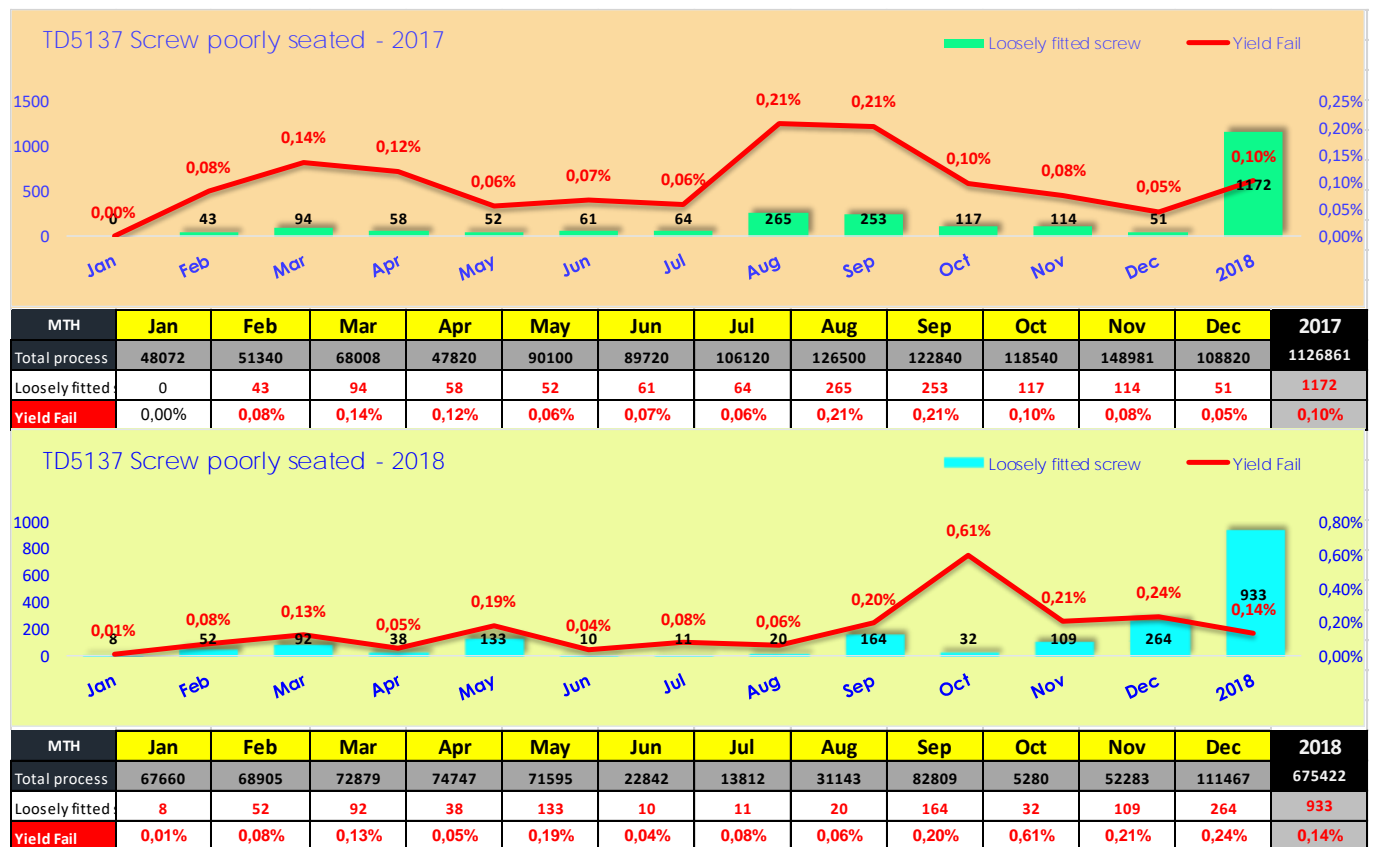


Figure 2 Index of Bolt poorly seated in 2017 (A) and 2018 (B).

Source: Provided by the analyzed company (2018).

To make a payback study, it is necessary to perform an analysis of the cost that the company has for each operator, where each operator costs R \$ 4000.00 thousand total cost per company per month, multiplying by 4, a total of R \$ 16000,00 thousand reais per month in relation to this analyzed cell.

### 3. Results and Discussion

#### Industrial Automation and its earnings

According to management, there was a 50% increase in demand for the production of modems. Modern manufacturing accounts for about 19% of the company's annual revenues. The decision to invest in the automatic tightening machine was due to the growing demand for Modems and the need for expansion of the company.

It is a complex machine with manual feed, where an operator closes the product (process of assembling the top cover with the by-product) and positions in the machine. The machine performs the screwing process one screw at a time. When the bolting is completed, the same machine checks that the bolt has been placed correctly, if not, it releases the defective product to the repair area by means of a mechanical arm. If the product is screwed correctly it is released to the next post.

With the implementation of the machine in 2019, the cell had a reduction of operators in the manual process, from four operators to just one operator. The process boiled down to the following flow: an operator mounting the top cover on the byproduct and positioning on the machine; the machine screws the four (04) modem screws, where it releases the screwed modem on the production mat, to complete the testing and packaging flow. Thus, its misplaced screw index decreased considerably on average from 0.12% to 0.02%, as shown in Figure 3.

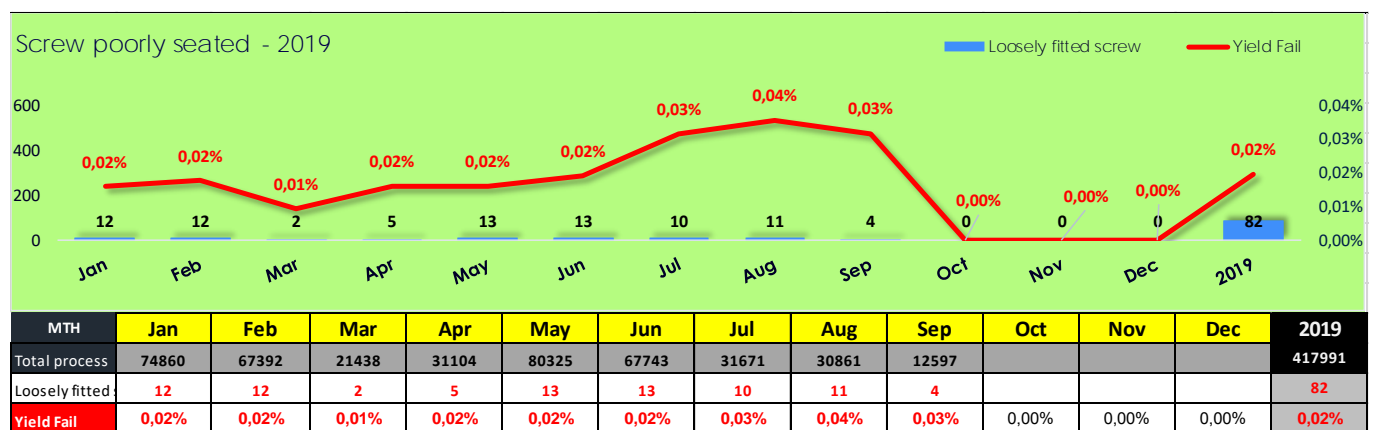


Figure 3. Screw Index misplaced in 2019.

Source: Provided by the analyzed company 2019.

After the reduction of operators and implementation of the machine, a new scenario emerged, the maintenance of the machine. During machine development, one operator was selected to receive training to perform maintenance and machine maintenance, and others were relocated to other company production lines.

In this case, what is the recovery period criterion, one asks: 'How many time periods does the project need to take to be acceptable in terms of value?' For Souza; Clemente (2012), project risk increases as Payback approaches the end of the planning horizon. Therefore, the faster the investment returns, the lower the project risk.

Analyzing the old method, the cost of the cell for two years (2017 and 2018), was \$ 384,000.00 and annual cost of \$ 192,000.00. With the current method or with an initial cost of R \$ 356,000.00, given the

investment in the purchase of the machine and the training required to keep the machine running (Figure 4).

Prior Method vs. Improved Method			Implementation Cost Analysis	
	Before	Improved		
Number of Operators	4	1	Machine Cost	R\$ 300.000,00
Operator Cost per Month	R\$ 4.000,00	R\$ 4.000,00	Maintenance Training	R\$ 50.000,00
Machine maintenance cost	-	R\$ 500,00	Maintenance by Year	R\$ 6.000,00
Cell cost per Month	R\$ 16.000,00	R\$ 4.500,00	Total	<b>R\$ 356.000,00</b>
Cell cost per year	R\$ 192.000,00	R\$ 54.000,00		

Figure 4. Payback analysis by method change.

Source: Adapted Payback Analysis.

In the first year an investment of R \$ 164,000.00 more than the investment, which was already scheduled to be made, was required. Therefore, the payback for the project occurs in two years, because the cost of the cell decreases from R \$ 192,000 to R \$ 54,000. By 2020, an even more considerable cost reduction is expected, being R \$ 132,000 compared to the old method, multiplying by 2 years, generating savings of R \$ 276,000, by the projection.

#### 4. Conclusion

It's important to note that managing a business is based on analyzing sales, cost, production, inventory level, finance, and so on, and that a good manager will need reliable, up-to-date information available at any time, only then will you be able to minimize errors in decision making.

In the current scenario of intense economic competition, organizations are struggling to stay in business. Faced with so many challenges, they seek to apply automation in their production processes, especially for its proven contribution to reducing production costs, efficiency and quick response to market demands.

These market demands lead organizations to seek constant innovations and improvements in their production processes. Industrial automation has been showing companies the power to become more competitive in the world market. Thus, it becomes essential in the process of using technologies as a tool to support business management. It is also crucial that these companies view automation and information technology as a tool of competitiveness and not as an extra cost, being a tool that will help in the consolidation of the company.

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# Transformation of Plastic Waste into Fuel by Pyrolysis

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## Abstract

*Given the scenario of difficulty of equalizing treatment and disposal costs, environmental risks and reduction of mass and volume of waste, the pyrolysis process presents itself as a promising option of heat treatment for the most varied types of waste. The present work aims to enable the transformation of plastic waste into combustion engine fuels. And specifically, perform the pyrolysis process for fuel generation through plastic waste, and describe the benefits generated by the transformation process. The methodology used is the case study, with qualitative approach. To obtain the fuel, it was necessary to use equipment that can degrade the plastic waste by heating it, being possible with the use of a pyrolysis oven. Heating the plastic residue inside the oven without the presence of oxygen causes the residue to melt without burning, releasing vapors, which upon exiting the heating chamber and finding the condensation chamber turns the vapor into liquid, more precisely into fuel oil. However, it was noticed that the transformation of plastic waste into fuel through pyrolysis causes the reduction of the impacts generated by solid waste disposal in the environment, water and air. In addition, it enables a new form of fuel generation, since previously it could only generate fuel from oil.*

**Keywords:** Fuel; Pyrolysis; Plastic waste;

## 1. Introduction

Since 2000, the plastics industry has produced the same amount of plastic as in all previous years combined. Virgin plastic production has increased 200-fold since 1950, and has grown at a rate of 4% per year since 2000 [1].

In 2016, the most recent year for which data are available, production was 396 million metric tons. This is equivalent to 53 kg of plastic for every person on the planet. Plastic production in 2016 resulted in approximately 2 billion metric tons of carbon dioxide emissions, equivalent to almost 6% of global carbon dioxide emissions per year [2].

Plastics are made from petroleum, an increasingly scarce resource on the planet, however, plastic is widely used in virtually all types of equipment such as phones, computers, appliances, cars, etc. [3]

In Brazil, the improper disposal of plastic waste has created another problem, the well-known community of waste pickers in open-air dumps, where people are exposed to all kinds of contamination in search of plastic waste for their livelihoods [4].

In Manaus, one of the main capitals of northern Brazil, has its industrial pole based on segments, electro-electronic, two-wheeled, naval, mechanical, metallurgical and thermoplastic, where with more than 600 industries, wedged in the Amazon Forest, all segments are large plastic waste generators [5].

The waste generated at the Manaus Industrial Pole (PIM) is mostly derived from packaging, which has high turnover, as it turns into urban solid waste after the consumption of the product of interest. For this reason it is important that the packaging bears the material identification symbol in order to facilitate the recycling chain [6].

In addition to the Industrial Pole, the population of Manaus is also a major generator of plastic waste, and contributes to both the plastic recycling industry and the irregular disposal of waste in inappropriate places [6].

However, with the use of new technologies, it is possible to have new destinations for this waste, with the possibility of generating other products, such as combustion engine fuels.

Given the current scenario and the difficulty of equalizing treatment and disposal costs, environmental risks and waste mass and volume reduction, the pyrolysis process presents itself as a promising option of heat treatment for the most varied waste. Pyrolysis is characterized by thermal degradation of organic material in an oxygen-deficient atmosphere, thus minimizing emissions of pollutants formed in the oxidizing atmosphere, such as dioxins and furans [7].

In addition, due to the huge variety of plastics on the market and the large volume disposed of, plastic waste management is complex, and the destination chosen will depend on a number of factors, such as the type of polymer or waste product [8].

With the need to think about sustainability, any alternatives that enable the reduction of waste in the environment becomes an alternative for preservation and concern for the environment and future generations [9].

However, with plastic waste being generated in large quantities by PIM, recycling the plastic and turning it into diesel or gasoline is an alternative source for both spreading the large mass of existing waste and creating fuel through burning. of plastic.

The present work aims to enable the transformation of plastic waste into combustion engine fuels. And specifically, perform the pyrolysis process for fuel generation through plastic waste, and describe the benefits generated by the transformation process.



## 2. Material and Method

### 2.1 Study area

The study was conducted in a private company in the city of Manaus - Amazonas, as delimited in figure 1.



Figure 1 - Area of study.

Source: Google Earth, 2019.

At the site operates a company operating in the field of gas distribution, provided by the owner to carry out the transformation of plastic waste into fuel through pyrolysis. It is a vast physical space.

### 2.2 Data collect

The methodology used in this work is the case study. Case studies have been increasingly used by social researchers as they serve research with different purposes, such as: exploring real-life situations whose boundaries are not clearly defined; describe the situation of the context in which a particular investigation is being conducted; and explain the causal variables of a given phenomenon in very complex situations that do not allow the use of surveys and experiments [10].

The approach used is the qualitative approach, that is, a research strategy that comprises a method that covers everything in specific approaches to data collection and analysis [11]. It is a device that deepens an individual universe, that is, it analyzes subjects that the researcher has little control over events and when the focus is on contemporary phenomena inserted in some real life context.

The work was carried out in four stages: bibliographic research, data collection and data analysis on the pyrolysis process and the transformation of plastic waste into fuel; analysis facilities, where the physical structure necessary to produce fuel from the burning of plastic waste was verified; the transformation of plastic waste into fuel via pyrolysis trying to indicate as a mitigating measure the use of solid waste.

### 2.3 Collection instruments

To obtain the fuel, it was necessary to use equipment that can degrade the plastic waste by heating it, being possible with the use of a pyrolysis oven. Heating the plastic residue inside the oven without the presence of oxygen causes the residue to melt without burning, releasing vapors, which upon exiting the



heating chamber and finding the condensation chamber turns the vapor into liquid, more precisely into fuel oil. This transformation process can be an alternative to conventional fuels and the reduction in the waste disposal charge in landfills, rivers, seas and the environment in general.

In this way, the sequence followed as shown in figure 2.

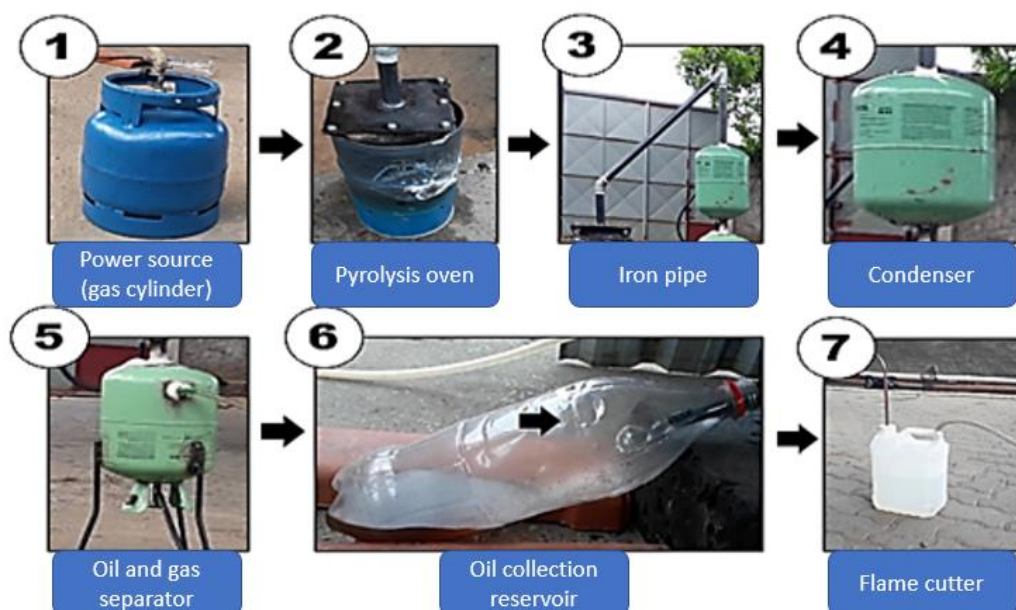


Figure 2 - Process for transformation via pyrolysis.

Source: Own authorship, 2019.

To understand the transformation procedure we have:

- 1. Energy source (gas cylinder) (item 1):** This is used to heat the pyrolysis oven, using a 5 kg gas cylinder attached to a hose that is connected to the pyrolysis oven, accompanied by a valve to control gas output;
- 2. Pyrolysis Oven:** Internally consists of a reused gas cylinder for air conditioning (R22), and externally we have a 20 liter steel drum that surrounds the pyrolysis oven. Therefore, the pyrolysis oven is heated by a 4-burner stove. And at the top of the pyrolysis oven, it has an opening for the introduction of plastic waste, which is closed by an 8 bolt flange.
- 3. Iron Piping:** Iron piping for gas vapor conduction (Item 3), where piping attached to the flange is connected to the condenser.
- 4. Condenser:** The iron pipe runs through the condenser inside which has water to cool the steam coming from the pyrolysis oven. With steam condensation, we obtain the liquefaction of plastic oil.
- 5. Oil and gas separator:** This container separates the plastic oil and the gas produced.
- 6. Oil collection container:** Plastic oil will be delivered through a hose to the oil reservoir.
- 7. Flame arrester:** The gas will be intended for flaring in the flame arrester.

### 3. Results and Discussion

Pyrolysis is a set of decomposition reactions of carbon-containing materials by heat in the partial or total

absence of an oxidizing agent [12].

One way of separating plastics takes into account the physical and thermal degradation characteristics of plastics. For the purpose of the recycling process, it is convenient to use packaging made up of as few different resins as possible.

The better separated these wastes are, the higher their added value. After separation, the material is sent to the recycling process, where it will be transformed into a new product [13].

Thus, the transformation of plastic waste into combustion engine fuel is in the projection as shown in Figure 3.

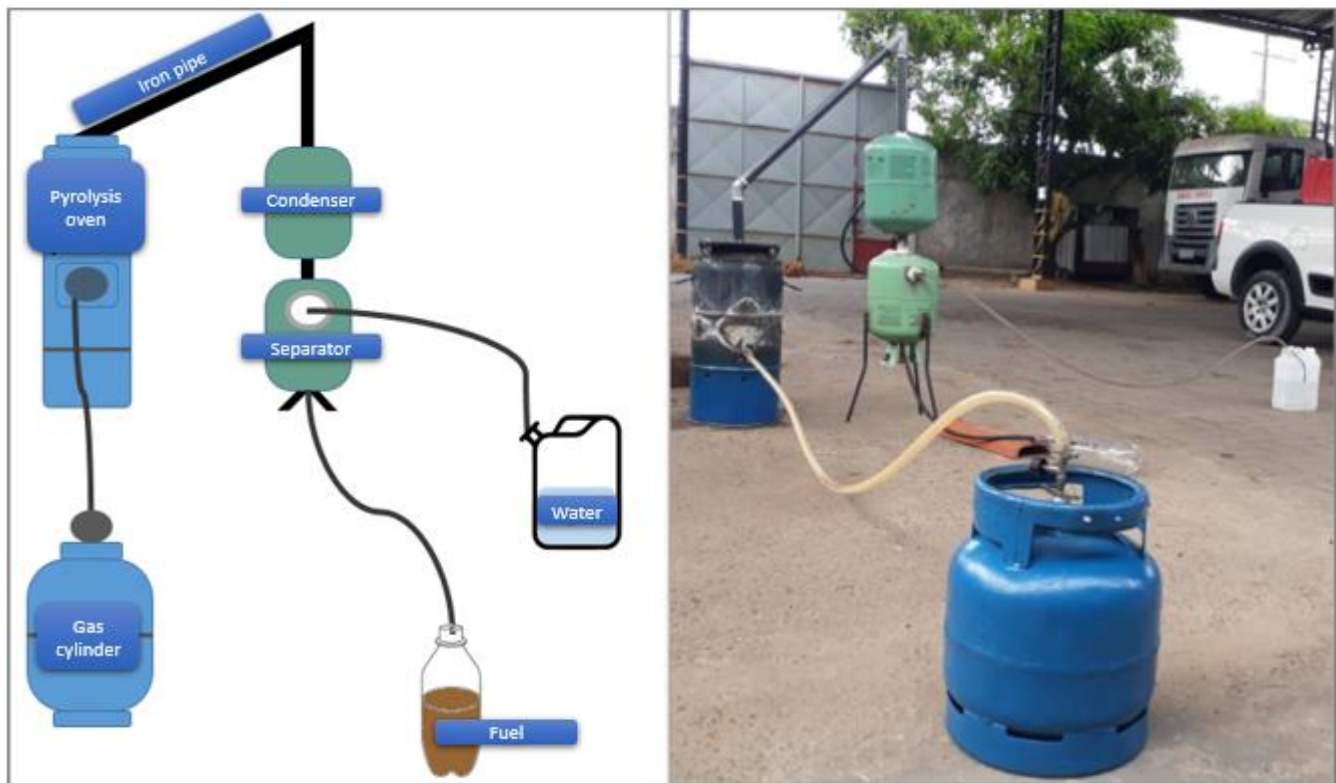


Figure 3 - Assembly process of transformation via pyrolysis.

Source: Own authorship (2019).

The procedures for obtaining plastic waste oil and gas were given as follows: placing 1 kg of plastic waste inside the pyrolysis oven; pyrolysis furnace closing by tightening flange bolts; To start the combustion, the gas cylinder valve was opened, lighting the stove; soon the condenser should be filled with water to condense the vapors of the molten plastic; the flame-arrester cut half-filled with water; the time to start dripping plastic oil and releasing the gas performed around 1 hour and 20 minutes at a temperature above 300° C.

Among the technologies available and suitable in the market, pyrolysis heat treatment is highlighted by reducing the volume of the waste by up to 90%, in addition to enabling the supply of raw materials in various industrial segments.



Figure 4 - Oil obtained by the pyrolysis process.

Source: Own authorship, 2019.

According to the results obtained, pyrolysis may play a significant role in the energy and organic recovery of these wastes, although some technological aspects are still needed to make it more attractive to implement this technology on an industrial scale [14]. .

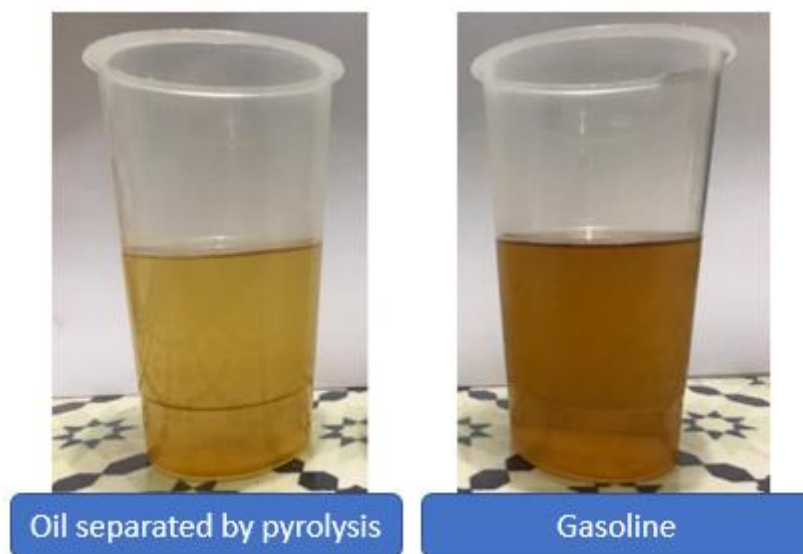


Figure 5 - Gasoline x Fuel obtained

Source: Own authorship, 2019.

As shown in figure 5, the fuel purchased from plastic pyrolysis is the color well associated with gasoline. However, in order to be able to use it, some laboratory tests will be necessary to be performed in the future by the author.

However, it is still possible to highlight some benefits generated with this fuel model:

- a) Reduction of the amount of plastic waste destined for dump and landfill;
- b) New energy production, since plastic, being made of petroleum derivatives, has a high calorific value - equivalent to gasoline and higher than coal;

- (c) improving the energy efficiency of incineration processes;
- (d) use to replace the use of conventionally purchased fuels;
- e) Considerable changes in relation to climate change and natural resource depletion [15];
- (f) recovery of the energy content contained in waste;
- g) Massive reduction of weight and volume and complete elimination of biological agents (destruction of molecular organic structures of hazardous substances).

The environmental consequences were favorable to fuels because the displacement of fossil gasoline and fuel oil generates environmental benefits. And from the economic point of view, although producing fuel from biogas is more complex, the economic benefits from its commercialization are greater, since the sales of fuel in Brazil are very high compared to other countries in America [ 16].

Therefore, investment in the plastic recycling chain is required to optimize input consumption and reduce waste emissions, which reflects production costs and increases competition for the recycled product [16]. Thus, the possibility of turning waste into raw material is viable and will produce a profitable sustainability model.

#### 4. Conclusion

However, it was noticed that the transformation of plastic waste into fuel through pyrolysis causes the reduction of the impacts generated by solid waste disposal in the environment, water and air. In addition, it enables a new form of fuel generation, since previously it could only generate fuel from oil.

Another point to note is that from the fuel generated through pyrolysis there would be a reduction in the sales value of vehicle fuel. Since fuel prices in Brazil are noticeably high compared to other countries in America.

In the context of the article presented, this process is a reverse logistics cycle, in which plastic returns to the production cycle as raw material. Enabling sustainable development, that is, worrying about future generations and reducing the impacts caused by waste.

Thus, with more studies and investment of companies that can mass produce this fuel alternative, it will be possible to improve the expectations of quality of life of people and the environment.

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# Proposal of LPS Implementation in Popular Buildings in Manaus City

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## Abstract

*This research proposes a study about a lightning protection system - LPS applied to popular buildings in the city of Manaus-AM, considering its importance for the protection of the whole structure, as well as the people who circulate in it. Atmospheric discharge is a force of nature, so it is almost impossible to stop this process from occurring or flowing with you. However, measures can be taken to avoid damage to the population, such as risk of death to living beings, as well as problems with electronic equipment and compromise of the building structure, with the adoption of lightning protection system in the most efficient way. . In addition, an atmospheric discharge, when it hits a structure, can cause internal systems to fail, considering that each structure is subject to damage determined by certain factors, such as: type of construction, function of the structure, power lines and metal pipes, among others. . The region and its intrinsic characteristics should also be considered as an indicator of climate change, indicating an increase in the region's occurrence.*

**Keywords:** Atmospheric discharge, protection systems and sizing methods;

## 1. Introduction

A Lightning Protection System (LPS) has as its basic objective to prevent the direct incidence of lightning in the structure to be protected, by constituting preferential points of incidence for the discharges that would eventually reach the structure in the absence of the system. For this purpose, in addition to capturing any atmospheric discharge, the LPS should be able to direct the associated current flow directly to the ground, according to defined paths, consisting of the conductors of the protection system [1].

The decision to use a lightning protection system on a structure may be a legal requirement (in municipal building codes), it becomes a homeowner's precaution to prevent damage or a requirement from insurance companies as lightning strikes are causes of physical damage and fire [2].

With regard to building safety, specifically in the electrical part, the technical standards [3] and [4] can be cited, dealing with low voltage electrical installations and protection of structures against lightning, respectively. [4] sets a number of criteria for the development of an LPS project. This standard divides the components of an LPS into three parts: catchment subsystem, descent subsystem and grounding subsystem [4]. In addition to Brazilian standards, there are several international standards that have in recent years established a number of new criteria, such as [5] and ASE 4022: 2008, ANSI / IEEE std. 142: 2007 [6].

Lightning is a phenomenon of nature that since the beginning has been puzzling man, both the fear caused by noise, as the damage caused. For some primitive civilizations, lightning was a godsend, for with it comes rain and abundance in the fields. For other civilizations it was considered as a punishment, the person who died in a lightning accident had probably irritated the Gods, being the punishment deserved. There were also civilizations that glorified the lightning-struck deceased, for he had been chosen from so many human beings, entitled to a funeral, with special honors.

After so many civilizations man has come to discover that lightning is a phenomenon of nature, of electrical characteristics and so must be conducted as quickly as possible to the ground in order to minimize its destructive effects [1].

The first scientist to realize that this was an electrical phenomenon was Benjamin Franklin (1752), who at the time stated that after placing a metal rod, grounded beneath a storm cloud, as he brought the body closer to the charged cloud, the body it provided the path of contact between the soil and the cloud, flowing to the earth the energy contained in the cloud [7].

After a few years, he became aware of buildings that had been hit and the lightning had not fallen on the metal end. Therefore, it reformulated the theory and stated that the metal tip would be the safest way to safely take the beam to the ground if the tip is struck by lightning. From then on, the region to which this tip would have influence began to be defined (18th century - Gay Lussac) and the first protective cones were started, whose generatrix was a function of a predefined angle, resulting in a cone. with a radius of protection.

The formation of charges in the clouds and their consequent discharge (lightning) to the earth is a normal and natural phenomenon that plagues the earth and afflicts mankind, causing material damage and death, given that the atmospheric discharge is a rapidly spreading electric spark. on land causing irreversible damage [8].

According to [9], which studies the lightning, through the atmospheric electricity group - ELAT, the phenomenon causes damage mainly to the electric sector with the burning of equipment, loss of revenues, increased maintenance expenses and penalties. Its loss is estimated at about 600 million reais, followed by telecommunications companies, with about 100 million reais, and insurance and electronics companies, with about 50 million reais each. Considering that about 60 million lightning strikes occur every year in the country, on average each ray represents a loss of 10 reais in the electricity sector.

Atmospheric discharge (lightning) is a phenomenon of unpredictable nature both in terms of its



destructive effects in relation to its electrical characteristics (duration, current, etc.), and when it affects buildings, transmission lines, towers, among others. others may have irreversible damage to the affected locations.

Currently, it is possible to determine the ray density per region more simply through the ceramic index, as well as a range of modern software that accelerate the knowledge of parameters such as waveforms, loads and current amplitudes [7].

The moment the ray is seen with the naked eye, one sees a strong light created by the electric arc of the ray. The noise or thunder called "thunder" is produced by the displacement of the air due to the sudden heat generated by the lightning. According to [10], the formation of the rays occurs by the friction of the water particles, which form the clouds, caused by the strong rising winds giving rise to a large amount of electric charges. The air behaves like a dielectric with a potential difference between the cloud more electrically negative than the earth. There are two forms of discharges: one that originates from the cloud towards the earth (descending) and one that exits from the earth to the cloud (rising).

The lightning protection system (LPS) consists of three subsystems: pickup, descent and grounding [11]. The captor subsystem is basically composed of conductive elements located in the highest part of the building the place to be implanted the system, responsible for the direct contact of the lightning. The descent subsystem has exposed or uncovered conductive elements that allow electrical continuity between the pickups and the grounding subsystem [10]. The grounding subsystem consists of conductive elements buried in the ground or embedded in the foundations of buildings, having the main role of draining the electric current in the ground, where each subsystem is subclassified in "natural" and "unnatural" systems.

The structure to be protected determines the basic requirements for installing an LPS and the elements necessary for its composition, must follow ABNT regulations. The standard [4] states that before any application of the standard is to be protected with the LPS, a risk management study is required so that by calculating the need for the LPS in place. Some sites have a low probability of lightning strikes per km<sup>2</sup>, but it cannot be based on this fact alone, numerous factors are considered for this study to be completed correctly.

The number of lightning strikes that influence the structure depends on the dimensions and characteristics of the structures and the connected lines, the environmental characteristics of the structure and the lines, and the density of lightning strikes to the earth in the region where the structure is located. and the lines [4].

This study assures in a clear and demonstrative way through probabilistic calculations, offering the certainty of the usefulness of the system in place, promoting the reduction of unnecessary expenses.

In compliance with the location and its need as the LPS is due to the level of protection adopted. This level will vary from I to IV, which will result in adequate protection efficiency for a given building. The required LPS class should be selected based on a risk assessment [4].

With the new edition of the lightning arrester standard, [4] the efficiency of the Protection Systems has been substantially increased, proving to be as efficient as the standards of other countries, including the fact that it has the standard [6] as a reference.

There are currently three sizing methods: Franklin Method, but with limitations depending on height and

level of protection; Faraday cage or mesh method; e Rolling, electrogeometric or dummy ball method.

Franklin's lightning arrester is the most widely used model, consisting of a metal rod where the pickups are located and a conductor cable that goes to the ground and the energy of the electric discharge is dissipated through the grounding [11]. The cable leading from the antenna to the ground must be insulated so as not to come into contact with the walls of the building, a method commonly used in small buildings [12].

In his experiments, Faraday found that by wrapping a volume through a metal cage, it was shielded from the effects of electromagnetic fields [1]. The method consists of wrapping the upper part of the building with a mesh that captures naked electrical conductors, whose distance between them and according to the desired level of protection. Landing the Faraday Cage it is observed that any upward discharge induced by a downward leader occurs through one of the metal parts of the cage.

The discharge current flows only through the cage, protecting what is inside it [12]. This method is suitable for buildings with a large horizontal area, and is the only method accepted by [4] to protect structures over 60m in height.

The rolling-ball method of the 1980s is an evolution of the Franklin method, being widely used for power transmission line protection, and simplifies application in buildings, serving both for dimensioning the LPS and for checking protection against neighboring buildings, gaps and specific structures such as antennas, solar heating plates, billboards etc., usually placed on top of buildings. The radius of the ball is adopted according to the selected protection level and corresponds to the meeting distance between the rising leader and the steep leader. The Franklin method, due to its limitations imposed by the Standards, is becoming less and less used in buildings and is ideal for small buildings [12].

The rolling sphere method is the latest of the three mentioned and consists of rolling a sphere throughout the building. This sphere will have a radius defined according to the level of protection, the places where the sphere touches the building are the places most exposed to discharges. In summary we can mention that the places where the sphere touches the ray must be protected by metallic elements ( Franklin pickups or metallic conductors).

The LPS is a mandatory condition in facilities and buildings as preventive measures, aiming at the protection of people, animals and buildings. It is important to be aware of the obligations and civil and criminal responsibilities related to the LPS, making it possible to identify the attributions of the owners, landlord, administrator, trustee and professionals responsible for the design and maintenance of the building or installation.

International and Brazilian safety technical standards address the implementation of the LPS. It is worth remembering that technical standards are intended to guide, while regulatory ones are mandatory.

The [4] prepared by ABNT, aims to define the minimum and acceptable conditions for: design, implementation, installation and maintenance of the LPS, in structures used for purposes: residential, commercial, industrial, administrative and agricultural. It also standardizes and legally enforces the NR-10 regulatory standard. In addition to these, there are municipal decrees and international standards aimed at overseeing the application of appropriate protections.

NBR [4] replaced NB 165 and set the conditions required for the design, installation and maintenance of lightning protection systems (LPS) of common structures used for commercial, industrial, agricultural,

administrative or residential purposes. This standard does not apply to rail, electrical, telecommunications, ships and marine platforms.

The mentioned NBR introduced important modifications: the need to calculate the risk of the building being hit by an atmospheric discharge; establishment of four levels of protection, according to risk and type of structure; permission for the calculation of the Faraday (cage) and electrogeometric (fictitious sphere) captors in addition to the Franklin method; possibility of using gutters or bluffs as natural catchers; permission for fixing the captors and downconductors directly to the ceiling and walls.

Some observations about LPSs are important: an LPS does not prevent lightning from occurring; An LPS designed and installed to the standard cannot guarantee absolute protection of a structure, people and objects. However, application of the standard greatly reduces the risk of damage; with the new edition of the lightning protection standard, [4] and the science of protection systems has been substantially increased, leaving nothing to be desired in relation to standards in other countries, including the fact that it had the standard [6], as reference.

As described in [4], the LPS is designed to intercept direct lightning strikes to the structure, including lateral discharges to the structures, and conduct the lightning current from the point of impact to earth. The external LPS is also intended to disperse this current into the earth without causing thermal or mechanical damage, or hazardous sparks that may initiate fire or explosion, and must be designed and installed in such a way that, in the event of a direct impact from lightning, There is no melting or fragmentation of material except at the point of impact.

From the premise that the site needs LPS it is necessary to pay attention to the level of protection adopted for the site. This level will vary from I to IV, which will result in adequate protection efficiency for a given building. The required LPS class should be selected based on a risk assessment [4].

According to [1], these four levels of protection can be briefly related to the structures as follows:

- Level I: Applied to structures where a failure of the protection system may cause damage to surrounding structures or the environment, such as explosive, toxic, radioactive factories or deposits, hazardous area industries;
- Level II: applied to structures whose damage in the event of failure will be high or destruction of irreplaceable and / or historical assets, as well as in cases of structures with large crowds of public, therefore, there is a risk of panic;
- Level III: Applied to commonly used structures such as homes, offices, factories (other than hazardous areas) and others.
- Level IV: applied to structures constructed of non-flammable material, with little access by people, and with non-flammable content. As an example, we can highlight reinforced concrete deposits, masonry or metal structure used in the storage of non flammable agricultural products.

In the state of Amazonas alone, 54 million lightning strikes hit the ground in 2017. Given several lightning incidents and poor access to lightning protection systems by the Amazonian population, we sought to raise and raise awareness about importance for use in popular buildings, seeking to protect a particular structure through measures that can mitigate its effects and also reflect on the concern of a portion of the population, to avoid material and personal damage as lightning causes damage and fire [9]. In order to determine the degree of hazardousness inherent in the installation as well as the maintenance

of electrical, electronic and telecommunication systems in a particular region, we must first observe the frequency of lightning in that region. The indicators responsible for providing this information are respectively the lightning density and the ceraunic index.

Lightning density can be defined as the number of lightning strikes that reach an area of one (1) km<sup>2</sup> over a time period of one year, and the ceraune index is defined as the number of days that observed lightning storms for one year [13].

The value assumed by the lightning density may vary significantly from region to region due to the intensity of latitude rainfall, as well as the relief of the region to be analyzed. Places with high relief tend to have a much higher ray density compared to other regions, and the same situation is observed in places of intense rainfall activity.

The Atmospheric Electricity Group (ELAT) develops research on atmospheric electricity through experimental techniques, numerical models and theoretical studies, this emphasis is given to lightning research in Brazil [14].

Studies published by ELAT analyze data from 1910 to 2010 and clearly show the increased incidence of lightning in large urban centers such as São Paulo, Belo Horizonte, Campinas and Manaus, with the higher frequency of lightning being attributed to temperature increase. (heat islands) and pollution.

With 2014 data, [14] has been conducting studies that address analysis of lightning deaths in Brazil. The historical series from 2000 to 2014 presented, for the first time, the city of São Paulo as the record in number of lightning deaths in the country. In the period, there were 25 lightning deaths in the state capital, against 22 fatalities in Manaus (AM) by 2013, the first placed in the ranking.

Still in 2014, urbanization in the Manaus region is directly related to the increase in lightning in the region. It is estimated that there has been a 50% increase in the lightning rate in this city in the last 30 years, and the current rate of lightning in Manaus is 13.5 rays per km<sup>2</sup> / year. Moreover, there is an increase of 3 ° C in the maximum temperature of the urban area of Manaus, in relation to the temperature found in the surrounding Amazon Forest, and this factor is responsible for the increase in lightning [14].

The aim of this study is to analyze the implementation of LPS in popular buildings seeking protection against the effect of this natural activity. Presenting a lightning protection system and its particular characteristics, describing the proposal of the need to use the LPS and the adaptations in popular buildings.

## **2. Materials and Methods**

From the point of view of technical procedures, this study sought information from: bibliographic research, as it was prepared from material already published, consisting mainly of books, periodical articles and currently with material available on the Internet. From the point of view of its objectives, this research was framed in a descriptive, explanatory research [15], as it identified the factors that determine and contributed to the occurrence of phenomena and the deepening of knowledge of reality.

Considering that lightning strikes are responsible for damage to structures, telecommunications systems, and electrical transmission and distribution systems, as well as outbreaks and failures that directly impact the proper functioning of the systems as a whole.

Basically the purpose of this work is to present the LPS as proposed by surveying a structure and detailing its degree of risk, assessing the need for protection, scaling the LPS, separating the stages for development, determining the ideal model of risk. protection and grounding system, the evaluation of the necessary criteria for the project following the ABNT norms [4], which has undergone several changes since its last version of 2005. Adequate all conditions for the safety of people and the integrity of structures.

LPS is intended to significantly reduce the effects and propagation of lightning strikes. This can prevent accidents of major impact and burdens on organizations, further damage to infrastructure, and also protects areas with flammable products within their protective radius. If well idealized is one that is thought from the beginning of the construction of structures. When properly implemented, it tends to reduce costs, as well as increase efficiency, but other cases do not dispense with it, since for their installation, metal cables are installed in meshes or wires ensuring a safe grounding in case of an electric discharge.

### **3. Results and Discussion**

Lightning can cause mechanical damage, damage to persons due to step and touch voltages, and failure or damage to internal system equipment caused by interference from electromagnetic waves generated by such lightning. The effect generated by these electromagnetic waves is called temporary induced overvoltages, which are discharges near the conductor [16].

Failures caused by lightning strikes affect the normal functioning of industries, homes, buildings and other consumer points, causing losses in the production of goods and services. Employing a lightning protection allows a kind of shielding in the structure, both in the external and internal structural part, and for the occupants of this building, against thermal, mechanical and electrical effects associated with these rays [17].

Currently, the use of electrical and electronic equipment is already part of everyday life, being applied in many systems facilitating processes, in turn these equipment, especially electronics are sensitive to electrical disturbances caused by the effects of atmospheric storms that commonly discharge lightning. on or near power grids causing irreversible interference or damage [16].

Brazil is the most lightning struck country in the world. About 50 million lightning strikes a year, according to data from the National Institute for Space Research - [18]. The explanation is geographical: Brazil is the largest country in the tropical zone of the planet, ie the central area where the climate is warmer and therefore more favorable to the formation of storms and lightning.

Lightning can be life-threatening, failure of electrical installations and electronic devices, thus requiring the design of lightning protection systems (LPS), contributing to increased safety, avoiding interruption problems, interference from communication systems and reduces physical damage to structures.

Considering that lightning strikes are responsible for damage to structures, telecommunication systems, power transmission and distribution systems, as well as surges and failures that directly impact the proper functioning of the systems as a whole.

There are no devices or methods capable of modifying natural weather phenomena to the point of

preventing lightning from occurring. Lightning strikes on structures (or power lines and metal pipes entering the structures) or on nearby earth are dangerous to people, the structures themselves, their contents and installations.

Therefore, lightning protection measures should be considered in any type of structure or building. The need for protection, the economic benefits of installing protective measures and the choice of appropriate protective measures must be determined in terms of risk management. The risk management method is contained in [4]. Also included are the protective measures considered in [4], which have been shown to be effective in reducing the risks associated with lightning.

All lightning protection measures form the complete lightning protection. For practical reasons, the criteria for design, installation and maintenance of protective measures are considered in two separate groups [4] NBR 5419 (ABNT, 2015):

- The first group refers to protective measures to reduce physical damage and life-threatening hazards within a structure.
- The second group refers to protection measures to reduce electrical and electronic system failures within a structure.

According to the basic criteria for protection of structures, part eight of [4] part one, it is defined in a general aspect, to obtain the ideal protection of a structure, it is necessary to wrap the structure in a shielded and perfectly conductive circuit, that is grounded, of the correct thickness and has adequate equipotential bonding to the electrical lines and metal pipes that the structure has, in order to prevent the discharge current and electromagnetic field from invading internal systems, causing sparks, overvoltages, electromagnetic effects and others. Dangerous disturbances.

It is often considered unfeasible to obtain full protection following these measures, and when poorly designed these protection systems can become an imminent risk, lack of continuity in the shielding of the conductive system or inadequate thicknesses may allow the current to enter lightning, which can cause damage to structures, internal circuits, electronic equipment and life-threatening people. To avoid such problems, protective measures must be taken and designed according to the current parameters and lightning protection levels prescribed in the standard.

An assessment of the need to install a Lightning Protection System is something that has to be done in any building. After this assessment, if it is proved that the building needs such a system, it will need to be designed. To do so, it must be performed by a qualified professional duly registered with CREA.

#### **4. Conclusion**

The focus of the study was to evaluate the need to apply the lightning protection system in a structure, demonstrating the criteria used by NBR 5419, since the characteristics of lightning formation, with great incidence in Brazil and the risks and probabilities of damage. , which can be caused in sensitive structures, people and systems, causing loss of human life, loss of public service, loss of cultural and economic values.

Lightning protection methods and their characteristics, such as catchment subsystems, descent subsystems, and grounding subsystems, internal LPS and equipotentialization systems, bill of materials and positioning, fixing and connection methods have been demonstrated.

The standard that deals with LPS has changed recently, from 42 pages to 309, so also its great importance, given by its update by professionals who work directly with this type of project, mainly due to the existence of many buildings that have poorly designed systems.

From these observations, it should be noted that popular buildings may adapt to their structure according to the referenced standard, which deals with lightning protection, and, from this, a reduction in the value of insurance may be claimed and also request AVCB (Fire Department Appraisal Report), which, together with the fire and panic project, certifies that the building complies with safety standards and is able to fully operate all activities present in the building.

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### **Abstract**

*In the search for solutions on the efficient use of natural resources, much has been discussed about the importance of effective public policies, as a way to minimize problems with the scarcity of natural resources, and how to achieve the desired sustainability through the implementation and exploitation of natural resources. renewable energy sources generated by the expansion of energy supply, one of which being natural resources is Biomass. In this context, biomass emerges as a great potential to solve, or at least mitigate the effects of using petroleum-based energy sources, contributing to the reduction of greenhouse gases (GHG), the implementation of public incentive policies. The use of renewable sources has become a more than current theme in the various rounds of debates on the improvement of climatic conditions in Brazil and in the world. The objective of the research was to identify the incentive policies adopted by the Brazilian government that made possible the advances and contributions generated by the use of Biomass as a renewable energy source within the national territory. The adopted method considered the aspects of a descriptive, exploratory study, with a qualitative approach based on a survey of the theoretical framework, which was used as material, books and original articles based on electronically available databases, to review the literature. available literature. The results of this study show that several benefits have been found through the use of renewable energy sources such as biomass, but this energy source is still not widespread in the country, where this is attributed to the scarcity of public incentive policy that in its great Most address the use of renewable energy as a whole, specifying the use of biomass without differentiation.*

**Keywords:** Renewable energy; Biomass; Public Policy; Sustainability;



## 1. Introduction

Due to the current environmental situation and all the consequences that the planet is suffering due, especially, to the use of fossil fuels as the main source of energy, the search for alternatives to use cleaner fuels has been gaining space worldwide. According to Couto [1], one option to compensate for this mismatch in the use of non-renewable sources linked to the environmental issue is to encourage and encourage the use of biomass as a renewable energy source through public incentive policy.

To this end, the international community has been advancing the debate on the origin, forms and rational and sustainable use of energy sources, prompting society to reflect on the indiscriminate consumption of energy and on ways to save it. [2] [3 ].

Adding to the growing global concern about environmental issues, the approval of the Paris Agreement in 2015 at the 21st Conference of the Parties - COP 21, with the accession of 195 countries and the ratification of 155, pledging to limit the increase. The global average temperature at 1.5 ° C from pre-industrial levels associated with the transport sector may have accounted for 23% of combustion gas emissions [4].

In Brazil this figure reaches 43%, according to the balance released by the Ministry of Mines and Energy (MME) in 2016 [5], has motivated many scholars, scientists and politicians to discuss the capacity that Brazil has to produce biomass for be used in the manufacture of biofuels, their different types, and especially what are the public incentive policies implemented to foster the sector [5].

Increasing fuel production from renewable sources is the most viable alternative in the short and medium term and this requires countries to comply with sustainability requirements in a broad sense: environmental, economic, social, technological and strategic because of their soil and climate conditions, Brazil has great potential to produce biomass and the value added to this base of raw material represents an important comparative advantage for greater incentive of public policy, which may assist in the incentive for the use of biomass. as a renewable energy source for the production of electricity and biofuels [6]. Biofuels represent these possibilities and are perhaps the most promising because energy demand tends to increase as the world economy continues to grow [6].

Therefore, it is emphasized that the term biofuel refers to liquid or gaseous fuels, predominantly produced by biomass "[7], the use of biofuels brings as an environmental advantage the possible reduction in greenhouse gas emissions [8], and partly replace the use of oil, which is why biofuels are included in the global energy matrix [9].

In this context, according to the referenced author most countries that are considered powers in this area, have in common a strong incentive made through their governments, in order to reduce the difficulties that consumers encounter to acquire a generation system. In Brazil, when it comes to legislation to encourage and use renewable sources by consumers, the country is still taking its first steps, with a relatively new regulation and that despite having many positive points, is not as aggressive as in other countries. countries.

The use of biomass has the advantages of its utilization techniques. There are several types of possible sources of biomass for energy. All energy contained in biomass is classified as Bioenergy. Therefore, it is a low entropy energy from the most embryonic photosynthesis and chemosynthesis processes, dilated and

accumulated along ecological chains [10]; [11]; [12]

In this sense, the authors point out that the use of biomass comes from ancient times as a source of energy (firewood) of societies without, however, relying on sustainable production. For this reason, for a long time the term biomass was associated with the idea of deforestation. Only in the twentieth century began the use of modern biomass, with alcohol program in Brazil and the practice of reforestation for wood production.

Thus, it is observed that biomass is an important source of energy for these countries and that the way this fuel is used can be improved, with more efficient technologies promoting social and environmental improvements, such as reducing pollution levels, increasing the quality of energy. life, job creation and income [13].

Therefore, we emphasize that the energy use of biomass in its diverse forms has benefits, such as ensuring greater enjoyment of available resources, adding value and optimizing the agricultural production process and minimizing impacts resulting from waste generation and disposal in the environment [14] .

Given this context, the present study aimed to identify the incentive policies adopted by the Brazilian government that made possible the advances and contributions generated by the use of Biomass as a renewable energy source within the national territory.

## **2. Material and Method**

The methodological approach adopted for this study follows the proposal of [15], which takes into account the approach to the problem, the objectives and the technical procedures adopted. The technical procedures adopted in research classified as qualitative and exploratory are broad and versatile.

It is characterized as qualitative because it allows understanding the context of the studied situation, enabling the capture and interpretation of phenomena and assigning meanings to them [16], exploratory for allowing greater familiarity with the problem raised and for being more flexible and informal, allowing the researcher to seek greater knowledge of the topic in perspective [15].

As for the research technique we used the bibliographic research that [16], is the survey of bibliographies already published in the form of books, magazines, separate publications and written press. Its purpose is to put the researcher in direct contact with everything that has been written about a particular subject.

Regarding the objectives, a bibliographical and theoretical review was conducted to deepen concepts such as renewable energies, biomass, public policy and sustainability allied to the results found during the research.

## **3. Results and Discussion**

Taking into account the theoretical aspects referred to throughout the development of this study regarding public policies to encourage renewable energy sources, we now intend to validate the results obtained. Analyzing the literature that explores renewable energy [17], they concluded that the best performing countries in the production of electricity from renewable sources adopted government strategies that allowed them to leverage both investor attraction and technology evolution.

These governance mechanisms include energy policies, legislation, regulation, specific policy instruments such as financing, market creation, tax incentives, energy research facilities and data centers. They also include appropriate institutions such as energy agencies and, departments dedicated to implementing, managing and evaluating activities related to the development of this technology. These policies can be adopted at federal, state and municipal levels [18].

Brazil has as its characteristic a high governmental expectation that intervenes in the yearning for self-sufficiency embedded in Normative Resolution No. 482/2012, therefore, public energy incentive policies should structure the system around renewable sources so that the future generator can evaluate and to observe the advantages greater than the environmental concern in the implantation of the private generating systems, considering that the public policies are developed based on the geographic reality and national market [18].

Based on this premise in the Brazilian energy matrix, biomass occupies the position of second largest source of energy, corresponding to 28% of the total and, in recent decades, Brazil has invested in the use of biomass fuels, biofuels. Since the creation of Proálcool, which due to the oil crisis has encouraged the production of sugarcane ethanol. To the PNPB that introduced biodiesel in the Brazilian energy matrix. Coming to RenovaBio that, in addition to providing predictability for the production and use of biofuels, promoting more energy security, aims to reduce GHG emissions in order to achieve the objectives signed and ratified in the Paris Agreement [19].

To this end, Brazil has a combination of factors favorable to the manufacture of biofuels - be it the availability of arable land to expand production - without the need for new areas resulting from deforestation and without competition with food production, either because it has a the highest productivity on the planet due to soil and climate conditions, as well as research centers with experience in the production and development of renewable fuels and an established consumer market with high growth potential [19].

The biodiesel policy in Brazil has gained momentum since 2000 and previous experience was decisive when developing the promotion plan. Thus, the Proalcohol program played a key role in showing success from an energy point of view, but a failure from a social perspective. For these reasons, Brazilian biodiesel policy explicitly incorporated social objectives [20]; [21]

The government has created a social certificate, coupled with a tax break to induce companies to employ families in the production of biodiesel feedstocks. In addition, the government stipulated minimum quantities of raw materials that should be produced from the family farming and large property project [21]; [22]

This policy also opened a space for the movement of civil society organizations in the debate on energy policy, which until then was restricted to technical aspects. The explicit objective of the PNPB in legislation to promote small farmers does not appear to have been met [22]. One of the possible explanations for the greater presence of large industries and the preference for exports is that the economic incentives proposed by the legislation are not sufficient. Against the background of distorted fuel prices and relatively lower export refunds on biofuels, producing biodiesel for export is the most cost-effective option for producers [23].

The engine of growth in the biodiesel market in Brazil was the domestic market, whose rate is determined

by the government through the National Energy Policy Council (CNPEG). The creation of a guaranteed domestic market and the tax incentives provided by the new legislation allowed biodiesel producers, as well as large soy producers, to move to the domestic market through government-established auctions.

In this sense, it can be said that the instruments used in the policy were successful in securing supplies and avoiding the risk of local market shortages. At the same time, Brazil appears to be reducing diesel imports, which would reinforce the achievement of the programmer's objectives [21]; [24]

However, the participation of family farming in the PNPB is marginal, and soy is the main input for biodiesel production. Indeed, recent experience shows that structural deficiencies in part of the country's family farming, which have difficulty in accessing resources, technology and capital, are a clear limiting factor for the progress of the program [22].

Petrobras Biocombustível's presence stands out as one of the two most important actors in the pursuit of PNPB's social and environmental objectives. The semi-state nature of this company allows it to find, in addition to purely private business objectives, social objectives that coincide with Brazilian energy policy in accordance with the federal government's priorities [23].

The PNPB was established to reduce dependence on oil and imports, pollutant emissions, and health care costs, as well as boosting jobs and reducing regional income disparities. This program was designed to add biodiesel to the Brazilian energy matrix. Federal law promulgated on January 3, 2005, established a mandate for the ANP to be responsible for regulating and controlling Brazilian biodiesel in the market [21] [25].

The Brazilian sugarcane energy sector has been struggling for years, evidenced by the lack of investment in new plants, leading to the closing of dozens of existing plants and the initiation of judicial recovery processes in others. The Brazilian ethanol industry also complains that the unpredictable fuel price policy has distorted markets, discouraged investment and forced dozens of factories into bankruptcy. Heavily indebted sugar and ethanol companies were forced to sell assets to rivals with stronger capital structures, such as Glencore Plc and Raízen Energia SA, with a 50-50 joint venture between Cosan SA Industria e Comercio and Royal Dutch Shell. Plc [5].

The lack of investment in new ethanol production facilities, coupled with the incentive to boost sugar production at the expense of ethanol production in 2016 in the face of strong global sugar prices. [26] contributed to an increase in Brazilian imports of ethanol into the US. While hydrous ethanol in Brazil competes with gasoline at the pump, anhydrous ethanol has a captive market as it is currently blended with gasoline at a blending rate of 27%.

However, although sales of "C gasoline" (gasoline blended with ethanol) have increased since February 2015, Brazilian production of anhydrous ethanol in recent years is not on a growth path [26]. In addition to Brazil's anhydrous ethanol production declining over the previous three seasons, the Sugar Cane Industry Union (UNICA) in April projected that anhydrous ethanol production in the Center-South region will total 10.84 billion liters in 2017. / 2018, which would represent only a modest 1.71% increase compared to 2016 regional / Production in 2017 (the sugarcane harvest begins in early April).

UNICA also projected that regional hydrous ethanol production would total 13.86 billion liters, down 7.57% from 2016/2017. In the first two months of the current season (April 1 to May 31), regional anhydrous ethanol production totaled 1.69 billion liters (21.46% below the same period in 2016) and

regional hydrous ethanol production totaled 2.61 billion liters (29.41% year on year) [26].

With the approval of Law No. 13.576 / 17, which established the National Biofuels Policy, UNICA President Elizabeth Farina was in favor of Renovabio's implementation due to the importance the program will bring to the predictability of the biofuels and renewable energy markets. .

Datagro's consultancy with Brazil's National Energy Policy Council cites that investments may increase while RenovaBio gives a better idea of the industry's potential by 2030. Instead of focusing on improving hydrous ethanol price relative to price as a motivation for flex-fuel vehicle drivers, RenovaBio could encourage fuel distributors to increase sales of hydrous ethanol to the detriment of gasoline sales. In addition, it should encourage investments in new sugar / ethanol plants and consequently the increase in Brazilian production of anhydrous ethanol - currently mixed with gasoline at a blending rate of 27% [5].

The RenovaBio program provides predictability for the sector, which is the main demand requested by industry, aiming to promote decarbonization of the transport sector - it differs from PNPB in that it is not based on tax differentiation, besides being an important driver in the gain of several segments of the industry, society, the economy, the environment [27].

Figure 1 summarizes the public policies implemented over the last decades in Brazil for the production and use of biofuels by the country.



Figure 1 - Biofuels timeline in Brazil

Source: [27]

In addition to national programs to encourage the use of renewable sources, other, more current public policies also target the diversity of the Brazilian energy matrix, as is the case of bill 3.529 / 2012, which aims to diversify Brazil's energy matrix. , based on the national policy of generating electricity from biomass. With the sanction of this law, it is inevitable the generation of electricity from biomass and the greater participation of renewable sources in the Brazilian energy matrix [28].

Biofuel production results in a reduction in foreign exchange, as well as job creation and a rural oilseed market; In the case of biodiesel, it also reduces environmental pollution due to the lower amount of sulfur present in its composition and the reuse of oils already used [29].

However, this production is also impacted by government subsidies and other political factors. It is necessary to implement energy policies that stimulate their growth and efficient use [30].

Policies to promote research, development and deployment of renewable sources fall into three categories [4] [31]: tax incentives: corresponding to the application of public resources that will not be reimbursed, including tax mechanisms such as tax reductions, exemptions, deductions and tax credits, as well as the granting of subsidies; state financing mechanisms, use of public funds with expectation of financial return, including the granting of financing, guarantees and equity interest in projects; and regulatory policies: setting rules by regulated agents.

As can be seen, despite investments in public policies to encourage renewable energy sources, such as biofuels, among others, in the current context of political and economic crisis, it is not possible to predict the actions of the Brazilian government, without deadlines and implementation statements. expected incentives for investment in renewable energy. However, it is possible to evaluate the irrefutable influence and dependence of public policies to increase the relevance of the use of renewable energy sources, such as biomass [6].

Success for the growing development of renewable energy will depend solely on global production and marketing policies in domestic and international markets, as well as a strong state presence in the implementation of fiscal measures and incentives, and especially subsidies to compensate for the difference in values in compared to other fossil fuels, as the costs of producing renewable energy are still quite high [2]. Another extremely important issue will be setting global targets for the use of biofuels that could be blended with conventional fuel.

Currently around the world, there are about 10 countries that compel oil companies to add a percentage of biofuels to regular fuel, for example, EU countries and Brazil. Given the above scenario, the importance of renewable energies in national and international debates is undeniable, especially when the urgent need to reduce greenhouse gas emissions is inserted as a way of minimizing the impacts of climate change. dependence on fossil fuels [32].

Consistent with the facts presented, it can be said that in recent years, global investments in renewable energy have grown significantly. In 2009 alone, approximately US \$ 112 billion was invested, almost 95 billion more than in 2001.

For the first time in history, investment in renewable energy has outpaced fossil fuel-based technologies. China, leader of the ranking in 2009, invested about US \$ 32.6 billion, with wind energy representing more than 70% of the destination for this resource. Because of its strong economic growth over the last three decades (1980-2010), China has experienced a considerable rise in energy demand, increasing its reliance on non-renewable sources such as coal and oil.

The US, the largest producer of ethanol in the world, ranked second, with over \$ 18 billion spent primarily on wind energy and biofuels.

Brazil, despite standing out in the global energy scenario due to harnessing its hydroelectric potential and the production of sugarcane fuels, representing approximately 45% of its total energy supply from renewable resources, still finds a large challenge in light of the country's low investment in research, development and deployment of new renewable energy sources [33]. Table 1 presents the main countries that use renewable energy.

Table 1 - Major countries in the world and their global potential in the use of renewable energy.

<b>Países</b>	<b>Potencial de uso de energias renováveis relacionadas ao potencial global (%)</b>
<b>China</b>	20
<b>EUA</b>	13
<b>Brasil</b>	7
<b>Índia</b>	6
<b>Indonésia</b>	3
<b>Rússia</b>	2

Source: [34]

From this point of view, the importance of public policies to boost the development of the renewable energy sector related to the global potential of countries is of fundamental importance, including attracting investments and encouraging entrepreneurs in this area. With public incentive policies, it is possible to enhance the development of the production chain, relieving and supporting the generation of scientific and technological knowledge, the training of professionals in the area, the integration between academic and research institutions, creating a positive dynamic among the research institutions. State and private initiative for advances in the sector.

Public policies can help create economies of scale and lower deployment costs and further expand the use of these energies. The experiences of European countries show that when the scale of production increased, the cost decreased and the population's access to these technologies became feasible [32]. In this scenario, Brazil has a privileged situation for the production of a renewable energy source using large-scale biomass, as there are extensive arable areas and favorable climatic conditions throughout the year.

For electric power generation, [35] mentions that biomass is transformed into an intermediate material, used in a driving machine, that will drive the electric power generator (through the mechanical energy produced). Given the facts, cogeneration (whereby it is possible to obtain thermal and electrical energy) is used in most sugarcane plants. Thermal energy is used as a heat source for industrial processes or in the commerce or service sector, while mechanical energy is used as work or transformed into electricity by means of generators.

Thus, the use of biofuels from biomass on a global scale, with the support of public incentive policies, may contribute to international efforts to reduce greenhouse gas emissions, as it represents a renewable alternative to the use of fossil fuels.

#### 4. Conclusion

Throughout the study under analysis several limitations and difficulties were found, which may condition the results. Thus, although there is a lot of information about public policies, the non-adoption of most of these policies by the countries mentioned in the base had implications for the results of this study. Further research and research are needed for possible adjustments to public policies to encourage renewable energy sources, so that self-sustainability exists.

Brazil has a great potential for biomass production due to its large territorial extension, with the availability of arable land, soil conditions and climate conducive to the planting of different crops, without competition between energy agriculture and food production. This scenario allows Brazil to become prominent in the development of new technologies, in the manufacture and use of biofuels. To this end, public and private sector investment is needed to foster the policy segment of encouraging the use of biomass as an energy source.

The Brazilian government, after its commitment to reduce greenhouse gas emissions, established after the commitments made at COP21, added to the need for safety and predictability for the biofuels market, with consequent increase in the sector's competitiveness, established the Policy. National Biofuels.

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# **Applicability Study of ISO 14001: 2015 for Implementation of the Environmental Management System in an Electro-Electronic Industry in PIM**

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## **Abstract**

*This article presents the result of a diagnosis made through a checklist based on the ISO 14001: 2015 normative items in a company that operates in the electronics industry. This study sought to identify the level of environmental sustainability recommended by ISO 14001, the change in behavior with the implementation of selective collection in the company and the elaboration of environmental control procedures, idealizing economic growth in a sustainable manner, preserving the environment and ensuring the environment. future of future generations. The conclusions are that the evaluated company needs to comply with 65% of the mandatory items of NBR ISO 14001: 2015, which evidenced the need for an environmental education program to assist in the implementation of the environmental management system in the evaluated industry.*

**Keywords:** Environmental Management System, Environmental Diagnosis, EMS Benefits, Environmental Education;

## **1. Introduction**

Organizations, faced with the current economic and technological scenario, impose the need for continuous changes in the way they operate and manage their business so that they adapt to the new reality and remain competitive [1].

Thus, several environmental laws and regulations have emerged that serve as guidelines to safeguard and ensure the preservation of the environment. The norm [2], is one of these norms to provide guidelines for the implementation of an environmental management system (EMS), does not define forms and methods, only directs companies, allowing each one, in their particularity, to develop their own solutions to achieve the requirement of the standard.

The EMS, based on ISO 14001 offers several benefits, the motivation of employees to achieve environmental goals, the reduction of electricity, water and fuel consumption, are examples that characterize a certified company, contributing to sustainable development, increasing its power of negotiation with investors. In contrast, society expects organizations to also bring benefits to the community by reducing the consumption of natural resources and harming the environment less [1].

One of the significant changes generated by an environmental management system is the behavioral one, because only through the environmental education tool, several indicators defined within the management are achieved [3]. The conception of environmental education is an essential component for sustainable development, beginning in 1946 with the creation of UNESCO which initiated the debate on environmental education globally [4].

We must consider that the implementation of an environmental management system must be founded, through widespread environmental education among the employees of a company, as well as compliance with environmental legislation and regulations, making the EMS become robust and efficient.

Although the main objective of companies is profit, environmental issues have become important due to the consumers' environmental awareness of these products, as well as large organizations seeking economic partners with certifications that guarantee cleaner production practices [1].

The result of the diagnosis aims to show the benefits of implementing the environmental management system in an industry, based on environmental education programs seeking behavior change, the elaboration of environmental controls in their processes, including the mitigation of environmental impacts, as a way of improve the implementation of an environmental management system in an industry [5].

## **2. Material and Method**

### **2.1 Study area**

The studied company, of Brazilian nationality, with 30 years of experience in the electronics and telecom market. It has distinguished the satellite receiver market by introducing innovative TV signal reception solutions throughout Brazil, with better performance and unique functions, ensuring better range, signal quality and stability, ease of installation, simplicity of operation and high durability (Figure 1).



Figure 1 - Industry Location Map where the diagnosis was made.

Source: Own authorship, 2019.

## 2.2 Data collect

To carry out the environmental diagnosis, a verification checklist was prepared, based on the requirements of the standard [2], where all normative items were verified and classified by status, describing the evidence of compliance with the requirements of the cited standard.

After the environmental diagnosis was carried out, an action plan was developed, using the 5W2H methodology as one of the most used resources in activity planning and project design, distributing the functions among the various members of a multidisciplinary team, ensuring the control and the execution of activities [6].

The Environmental Education Program started with weekly environmental dialogues with the main subject of Selective Collection, the acquisition and availability of collectors was an important step to start the implementation of the Environmental Management System.

## 3. Results and Discussion

For the environmental diagnosis it was necessary to apply the “ISO 14001: 2015 Diagnostic Check List”, and a detailed evaluation of the processes and activities, through on-site verification and analysis of existing documents in the studied company.

### 3.1 Context of the organization (item 4 - ISO 14001: 2015)

The Strategic Planning, determined by the organization, with internal and external actions that could affect its environmental performance was not evidenced, but it was not defined in its scope, environmental conditions that affect or are capable of affecting the organization.

**3.1.1 Recommendation**

Define which stakeholders are relevant to the environmental management system, as well as the relevant needs and expectations of those stakeholders, define which legal and other requirements become mandatory for the environmental management system.

Another recommendation to address this item is the elaboration of the environmental scope, which should describe internal and external issues that may affect the management system, its organizational structure, its processes and activities and its authority and ability to exercise control and influence.

The implementation of the environmental management system has as its main intention the improvement of environmental performance, is based on the premise that the organization should periodically analyze and evaluate its management system, thus verifying the points of improvement [6].

**3.2 Leadership (item 5 - ISO 14001: 2015)**

According to item 5 of the standard used, senior management must demonstrate leadership and commitment to the environmental system, must ensure that its environmental policy (sub-paragraph 5.2) and its environmental objectives are established and compatible with the strategic direction of the organization.

**3.2.1 Recommendation**

The diagnosed company does not yet have an environmental policy and its defined environmental objectives, making it necessary to develop an environmental policy that is aligned with its strategic business, ensuring that the results obtained ensure the effectiveness of the environmental management system.

The environmental policy of an organization is of paramount importance, as they attest that the company performs its activities focusing on the environmental management system, aiming at the sustainable use of natural and renewable resources. In general, policy within the management system seeks solutions and alternatives to maintain environmental balance, reducing or recovering environmental degradation [7].

**3.3 Planning (item 6 - ISO 14001: 2015)**

This item describes that the organization must determine the risks and opportunities related to its environmental aspects, ensuring that the environmental system achieves the desired results and continuous improvement.

Another important point addressed in the planning item is that the organization must determine the environmental aspects (sub-item 6.1.2) of its activities, products and services which it can control and those it may influence. When determining environmental aspects, the organization must take into account changes, including new product and service projects, foreseeable emergency situations.

Communication about its environmental aspects must be between the various levels and functions of the organization, and documented information must be maintained, the company must determine and have access to the legal requirements related to its environmental aspects.

The survey of environmental aspects and impacts in an industry is one of the tools used in the control and monitoring of its production activities. It establishes the organization's responsibility for the environment

and presents itself to society and its customers with the differential of being an environmentally friendly company [8].

In compliance with legal requirements and other requirements (sub-item 6.1.3), the company has LO - Environmental Operation License, where conditions were defined, such as performing bimonthly monitoring of effluent from the effluent treatment system, indicating the pH parameters, color, turbidity, BOD, COD, vegetable oils and greases, solids (dissolved, suspended, settleable, volatile, fixed and total), total nitrogen, thermotolerant nitrates, nitrites, sulfides, phosphates and coliforms and these analyzes should be submitted to IPAAM - Amazonas Environmental Protection Institute every six months, reporting to the supervisory body.

### **3.3.1 Recommendation**

Raise significant environmental aspects, considering changes, including planned or new developments, present key legal requirements applicable to the scope of the EMS and evidence of compliance with these requirements (environmental permits, environmental technical reports, etc.), present environmental objective made available to relevant stakeholders. The company performs the analysis related to the condition of its operating license, but it is necessary to deliver these reports to the competent agency.

Environmental issues in industries primarily seek to meet the conditions imposed by environmental licensing [9]. Which conveys a false thought when it comes to the environmental system, where the survey of environmental aspects and impacts is a guarantee of environmental control of its production chain.

### **3.4 Support (item 7 - ISO 14001: 2015)**

The organization shall determine and provide the resources necessary for the establishment, implementation, maintenance and continuous improvement of the environmental management system.

Regarding competence (sub-item 7.2), the organization shall determine the necessary competencies of employees performing work under its control, shall determine the training needs associated with its environmental aspects and its environmental management system and maintain documented information about the theme.

Another point to consider concerns environmental policy awareness, where the organization must ensure that employees are aware (sub-section 7.3) considering the significant environmental aspects and their actual and potential environmental impacts associated with their activities, their contribution to effectiveness of the environmental management system and the implications for not meeting the legal and other requirements defined for the environmental management system.

In sub-item 7.4, it talks about communication, the organization must establish, implement and maintain process (s) necessary for communication.

relevant internal and external to the environmental management system, including: what to communicate, when to communicate, with whom to communicate, how to communicate, always taking legal and other requirements into account, and consistent and reliable.

### **3.4.1 Recommendation**

The organization should direct an annual budget for the implementation of the environmental management system, as it is a practice in its strategic planning, the provision of resources for the various areas of the organization. It should elaborate a competence and development matrix of its collaborators, with training focused on the environmental management system. The awareness of all employees about the EMS is also audited requirement, in this item the environmental policy and the aspects and impacts of the organization should be disseminated in training, murals and informative.

The organization already provides communication channels such as intranet, TV monitors, murals, facilitating internal and external communication.

The success of the implementation of an environmental management system is the awareness of its workforce, this is through environmental education programs, as it develops the construction of critical thoughts, so that these individuals identify and realize their collaboration and importance. within the EMS [3].

### **3.5 Operation (item 8 - ISO 14001: 2015)**

In subitem 8.1, which deals with operation, the organization shall establish, implement, control and maintain the processes necessary to meet the requirements of the environmental management system. Controls can be engineering and procedural, the company must control all planned changes and critically analyze the consequences of these.

Outsourced processes must also be controlled as various environmental services are performed by service companies. Controls should be appropriate to ensure compliance with legal requirements in the organization's design, product and service development.

All controls should be kept as documented information to the extent necessary to be confident that the processes are carried out as planned.

#### **3.5.1 Recommendation**

The organization already controls service providers, significant changes in their processes, and compliance with legal requirements, the point to be improved is only to extend existing controls to the environmental management system.

In 8.2 - Emergency preparedness and response, the organization shall establish, implement and maintain the processes necessary to provide actions to prevent or mitigate adverse environmental impacts of emergencies, periodically test planned response actions, critically review and review provide relevant information, provide emergency preparedness training, and above all maintain documented information to the extent necessary to be confident that the process (s) will be carried out as planned. ).

#### **3.5.2 Recommendation PAE**

The evaluated company has an Emergency Response Plan (PAE), which contemplated the scenario of chemical spillage and leakage. It was evidenced through documented information the practice of simulations and training of the brigade members in the practice mentioned above.

The study of the environmental impact of an organization within the environmental management system



is performed by assessing the significance of impacts, and the necessary actions to eliminate or mitigate environmental aspects are proposed. such as fuel consumption (diesel), the control is to draw up a CO2 smoke monitoring and measurement plan, and also to carry out the control to assess the CO2 emission and black smoke of the trucks [12].

### ***3.6 Performance appraisal (item 9 - ISO 14001: 2015)***

The organization shall monitor, measure, analyze and evaluate its environmental performance. Always taking into consideration what needs to be monitored and measured, the methods of monitoring, measurement, analysis and evaluation. Monitoring should be performed with properly calibrated equipment and kept in perfect condition.

It shall assess its environmental performance and the effectiveness of the environmental management system, communicate relevant environmental performance information internally and externally, and also maintain documented information as a guarantee of compliance with this standard item.

#### ***3.6.1 Recommendation***

The evaluated organization does not yet have an environmental management system in place, but it will be necessary to evaluate the performance of the system in order to provide its proper functioning.

In sub-item 9.1.2 we verify the assessment of compliance with legal and other requirements, where the organization must establish, implement and maintain the process (s) necessary to comply with this normative item.

#### ***3.6.2 Recommendation Guidelines***

It is the organization's practice to evaluate legal requirements, extending the activity to environmental laws applicable to the scope of the company.

Item 9.2 gives us guidelines on internal auditing, where the organization must conduct internal audits at planned intervals to provide information on the compliance of the environmental management system. Must establish, implement and maintain the internal audit program (s), including frequency, methods, responsibilities, requirements for planning and reporting on their internal audits.

In this internal audit program, the organization should consider the environmental importance of the processes, changes affecting the organization, and the results of previous audits, always defining the audit criteria and scope for each audit, selecting auditors to conduct the audit. audits, ensuring the objectivity and impartiality of the audit process.

#### ***3.6.3 Recommendation Environmental Management***

An internal audit program for the quality management system is practiced within the organization, so for the environmental management system it is only to achieve the scope within the existing internal audit program.

Item 9.3 deals with a critical analysis of the company's representatives, and should analyze the organization's environmental management system at planned intervals to ensure its continued adequacy, sufficiency and effectiveness.

Consideration should be given to the status of actions from prior management reviews, changes in internal and external issues that are relevant to the environmental management system, stakeholder needs and expectations, including legal and other requirements, their aspects, significant environmental risks, the risks and opportunities, the extent to which the environmental objectives were met and the information on the organization's environmental performance.

#### **3.6.4 Recommendation Quality**

The organization conducts a top management review for the quality management system and should cover the environmental management system.

Recommendation: The organization conducts a top management review for the quality management system and should cover the environmental management system.

#### **3.7 Improvement (item 10 - ISO 14001: 2015)**

The organization shall continually improve the system implemented by ensuring the adequacy, adequacy and effectiveness of the environmental management system to increase environmental performance.

##### **3.7.1 Recommendation**

With the implementation of the environmental management system, the organization should continually improve it, ensuring its effectiveness and increasing its environmental performance.

Sustainable routines and waste policy adoption are practices that align with industry principles 4.0. EMS can beneficially interact with this new production model, through environmental operational controls and indicators help to avoid waste, reduce pollution and control manufacturing processes, making them more rational.

Environmental performance is defined by ISO 14001 as the measurable results of managing an organization's environmental aspects through environmental performance can measure compliance with legal requirements as well as company revenues and expenses. Programs focused on improving environmental performance can reduce waste and losses, resulting in lower costs, which is one of the industry formats 4.0 guidelines [11].

## **4. Conclusion**

The survey carried out in an electronics industry, consisted of the elaboration of an environmental diagnosis for the implementation of ISO 14001. Initially a checklist was elaborated with the main requirements of the standard, where we verified the existence of the environmental policy, the survey of risks and opportunities and by complying with legal and other requirements, this methodology has enabled us to make a reliable diagnosis, generating the necessary actions and understanding to meet the requirements of the standard.

Other aspects evidenced in this diagnosis was the practice of selective collection, the company evaluated did not have the same implemented, it is recommended that the organization carry out an environmental education work for the development of labor and the future implementation of selective collection in its

manufacturing plant.

Of the 65 items evaluated in the standard, 65% are not being met, 20% are met and 15% partially answered. Those being partially met are the items that already exist in the quality management system, and only need a scope for the environmental management system.

This diagnosis will make it possible for the evaluated company to create an implementation schedule for the Environmental Management System (EMS), which will benefit future certification and make it more competitive, showing that its production chain is in accordance with international control and monitoring standards, aiming at its economic, sustainable and social growth.

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## **Application Development for Blood Pressure Meter and First Aid Alert**

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### **Abstract**

Hypertension affects one out of every four adults in Brazil, mostly older people who, according to research, do not have comprehensive knowledge of the disease, its symptoms and how to identify them in someone, thus causing arterial damage throughout the body. consequently it can generate strokes. Two methods were used to fetch data; the amount that was based on Google polls; and the qualitative through bibliographical research and articles on blood pressure in Brazil. Using these methods, a prototype alert software was developed that can work in conjunction with existing technologies such as SMARTBANDS and SMARTWATCH, which quickly and conveniently measure pressure from their users by collecting data and sending it to the system. The data collected through the sphygmomanometer are sent to the arduino that together with the HC-05 communicates with the system, meeting the expectations. The communication of the user application with the monitor worked correctly. Having collected the data

through forms, a software and a prototype that could be used together with other technologies were elaborated to propose to smart watch manufacturers the implementation of the alert software, for the improvement of the existing technologies.

**Keywords:** Blood Pressure, Systolic, Arduino, Sphygmomanometer, Smartwatch, Smartband;

## **1. Introduction**

In Brazil about 300 thousand people die per year because of arterial hypertension, according to the Department of Health and Human Services about 24,7% of Brazilian population claims suffering the illness. In agreement with new data from VIGITEL (Risk Factors Surveillance for chronic noncommunicable diseases), 60% of the interviewees who believes being hypertensive are over 65 years old.

According to hospital Santa Lúcia, posted on April 26 2018, “Hypertension causes damage to artery throughout all the body and the impairment can lead to hemorrhagic strokes when happens frequently bleeding associated to hypertensive attack or ischemic strokes, destructions on artery lead to formation of clots”.

Blood pressure rises getting abnormal values when vascular resistance appears from blood vessels blocking a good flow for blood passage, causing a superior effort from the heart to pump blood. One of the main problems of hypertension is the stroke due to acute myocardial infarction or chronic kidney disease, hypertension can also lead the one to a cardiomyopathy (heart muscle atrophy) causing cardiac arrhythmia, abdominal bloating, shortness of breath and fatigue. It's good to remember that any disease added up to a hypertensive picture can become much more serious, the risks multiplies according to the Department of Health and Human Services.

Defined this scenario, applied to the technology of SMARTBAND and SMARTWATCH, it's possible to create an alternative to both diastolic and systolic pressure measurement, facilitating the control and prevision of arterial variation of patients, assisting decision making to prevent correlated problems about blood pressure.

## **2. Methods and Materials**

The methods that were used to make this research for elaboration of the project are: the quantitative, realization of google forms polls and polls at hospitals and on the street; and the qualitative doing bibliographic researches for analyzing articles about arterial pressure in Brazil and checking how many people would approve the start of the project, the data collect occurred at August 12, 2019 until October X, 2019.

With the goal of measuring arterial pressure and show an alert system to rescue the technology bearer user like the Smartwatch, will be elaborated a prototype.

For the realization of the data collect prototype it was used 1 Nano Arduino, 1 ESP8266, Jumps, 1 bip, 1 GPS, Sphygmomanometer, it was developed and app for android through the MIT APP inventor platform, using the JAVA language, working with box programming. The Arduinos will be programmed in C language, on the own microcontroller platform.

### 3. Development

#### 3.1. Theoretical Referential

The choice of the project thematic came from observations about the lack of assistance to the ones who have arterial pressure problems. In this topic is showed the theoretical aspects that address all the study for the idealization of the project.

##### 3.1.1. Systolic and diastolic pressure

Systolic and diastolic pressure goes along together, they're the Cardiac cycle. Systolic is measured when there is heart artery compression, where the blood is pumped to blood vessels. The diastolic pressure is measured when there is artery decompression leading the blood entrance to the heart. In a normal adult the average measure of systolic pressure is 120 millimeters of mercury (mmHg), while the diastolic is 80 millimeters of mercury (mmHg).

##### 3.1.2. SMARTWATCHES e SMARTBANDS

Both Technologies are WEARABLE "Technologies devices that can be used by the users as a clothing part" both SMARTWATCHES and SMARTBANDS have similar functions, although having a big difference in usability terms, the smartwatch works without a smartphone connected to it and the smartband needs the use of a smartphone connected to it to accomplish all its functions.

##### 3.1.3. Correct way of measure the diastolic and systolic arterial pressure using an sphygmomanometer

Anyone can measure the arterial pressure of anyone, but the one needs to have minimal basics knowledge to do it correctly. When you don't have an digital device certificated by ANVISA it is possible to use an sphygmomanometer, a manual measure that leads to a precise collect.

For the correct collect of arterial pressure, the one needs to be with his arm outstretched, supported in a table, the armband is wrapped through the left or right arm squeezing it 2cm above the elbow. The brachial must be identified right below the cubital fossa, when it is identified, a stethoscope diagram will be put above it. With the stethoscope in the ear, the cuff must be inflated, given a certain moment, the arterial pulsation will be heard and the cuff must be inflated till the pulsation is gone, when it's gone, the armband must be slowly emptied, when the sound reappears, a value will be shown in the device and it's called systolic pressure (maximum pressure), continuing cuff deflation. When the sound of pulsation is gone again, a value will be shown and it will be the diastolic pressure (minimum pressure).

##### 3.1.4. Arduino

The Arduino is a board compound by a microcontroller Atmel, with entrance and exit circuits that can be connect to a computer and programmed trough an IDE (own Arduino), using the C programming language.

##### 3.1.5. Java

Java is an object-oriented programming language developed for creation of continued platforms. On this programming paradigm, the developer can do updates or continue unfinished projects instead of creating a new one. The object makes your code more organized and easy to be modified.

### 3.1.6. *App inventor*

App Inventor is an web software created to the development of android apps using a navigator and a connected smartphone. It's possible to create apps selecting components, using block programming that shows how it must behave, all the app creations it is made by visual form together with pieces like a puzzle, the app is shown in the smartphone as you are programming in the navigator simultaneously, it is a way of test of the application. At the end of the project, it is stored and the executable is created to install it in other smartphones.

## 4. Results and Discussion

### 4.1. *Qualitative Research*

After the realization of the quiz using Google Forms, we got significant results that promotes the evolution of the project

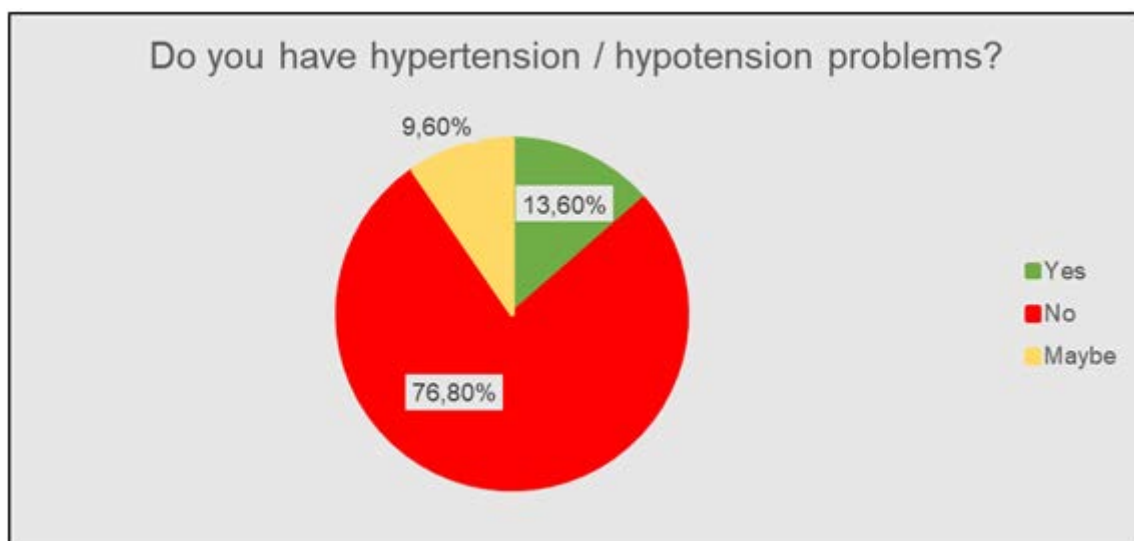


Figure 1 – Graphic 1

Source: Elaborated by member of the group

76,8% of the interviewees answered not having any trouble with arterial pressure, 13,6% answered having trouble and 9,6% answered not knowing. Although is a problem that hits 300 thousand people in our country, the bigger part who were interviewed claims not having hypertension.

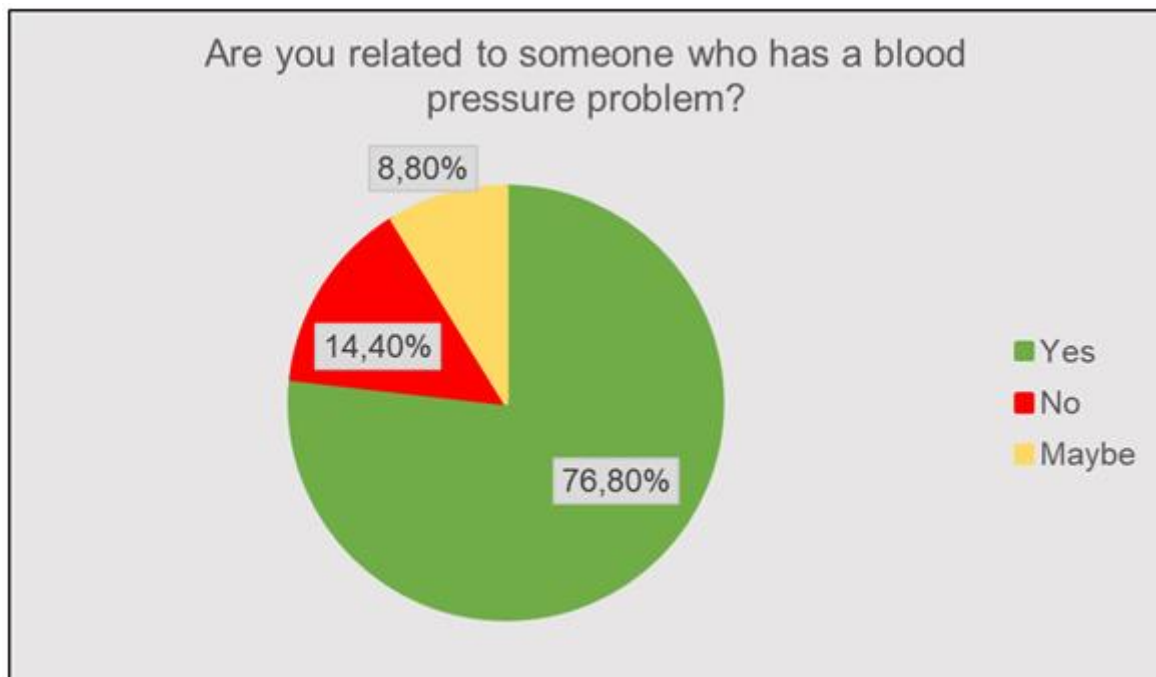


Figure 2 – Graphic 2

Source: Elaborated by member of the group

76,8% of the interviewees said that knows someone who has arterial pressure problems, which is a curious fact because this same statistic is given to the number of people who says not having problems about it.

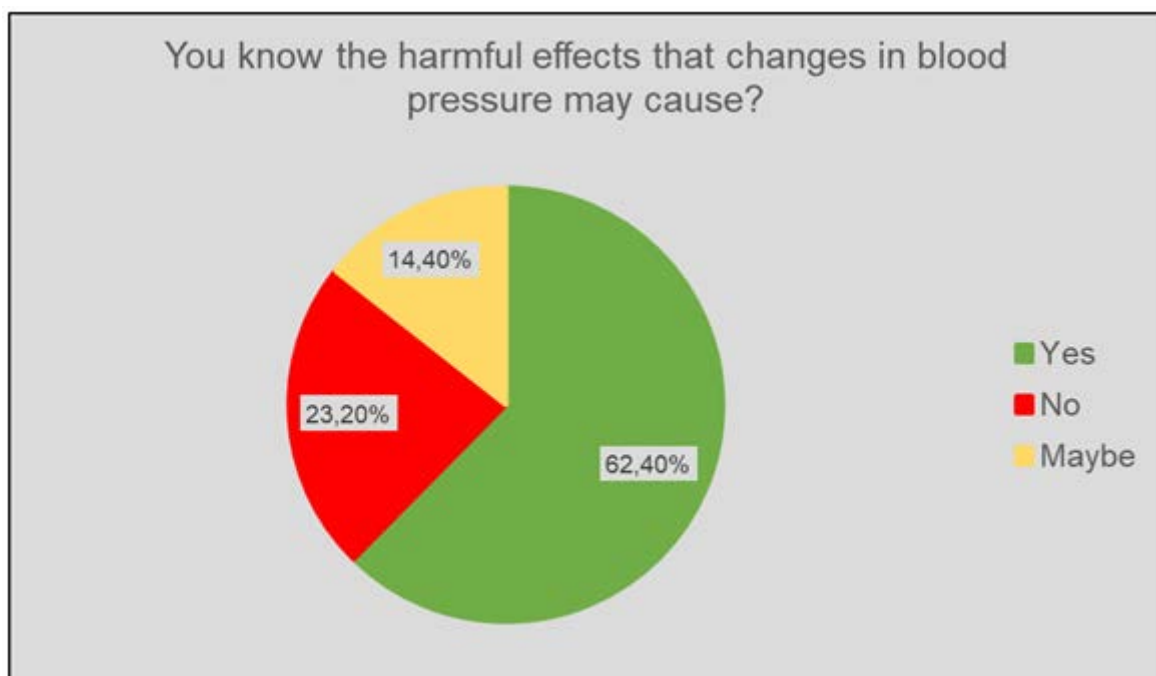


Figure 3 – Graphic 3

Source: Elaborated by member of the group

62,4% of the interviewees claims to know the harms of arterial pressure, 23,2% claims not having the



same knowledge. Summing the ones who said NO and MAYBE results in a total of 37,6%, another alarming statistic, considering the lack of knowledge about the harms that the arterial pressure can result in.

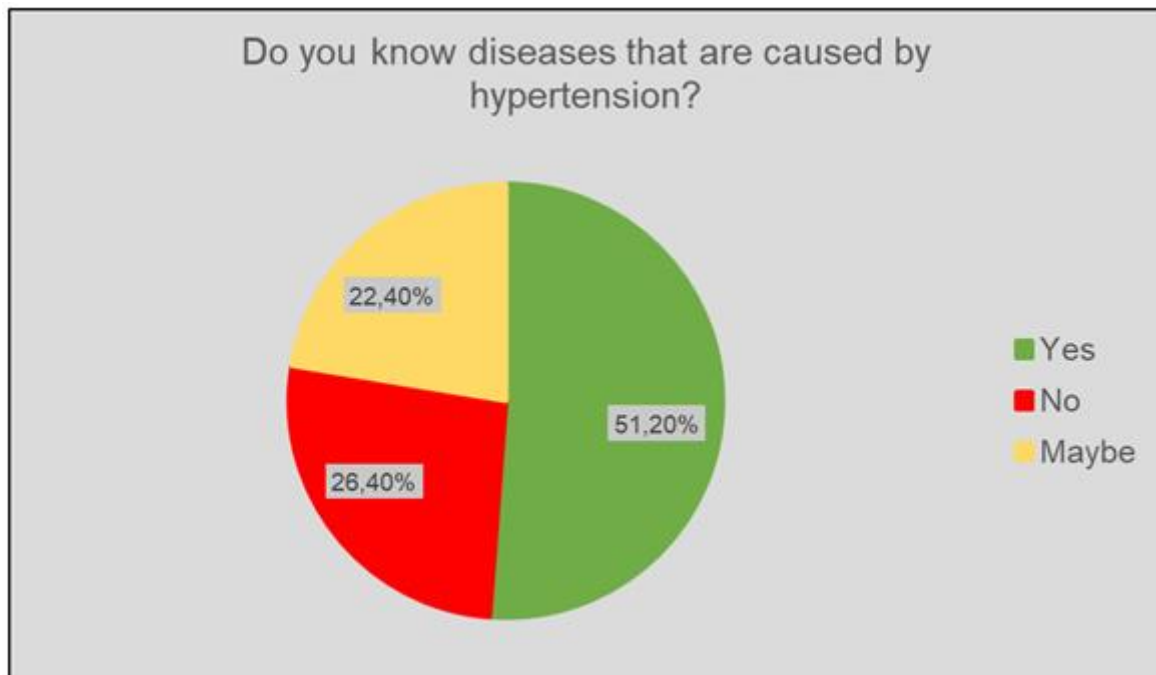


Figure 4 – Graphic 4

Source: Elaborated by member of the group

This graphic contrast with the above graphic, because we can see a reduction of people that claims to know the harms of hypertension/hypotension. Only 51,2% claims to know about the diseases. Summing data of NO and MAYBE, we have that 48,8% claims to not know about the harms of hypertension/hypotension.

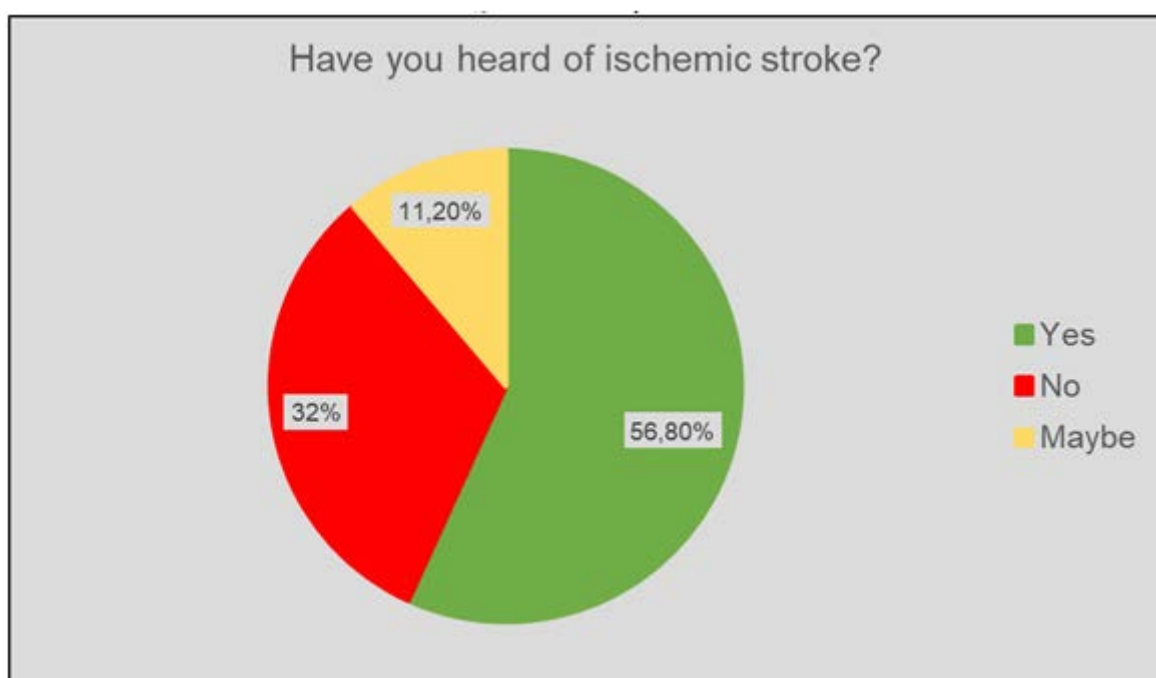


Figure 5 – Graphic5

Source: Elaborated by member of the group

56,8% claims that heard about ischemic strokes, 32% claims not to know about what it is and 11,2% have doubts. The number of people who voted NO is high and worrisome, because the ischemic stroke is the bigger cause of death and its caused by hypertension.

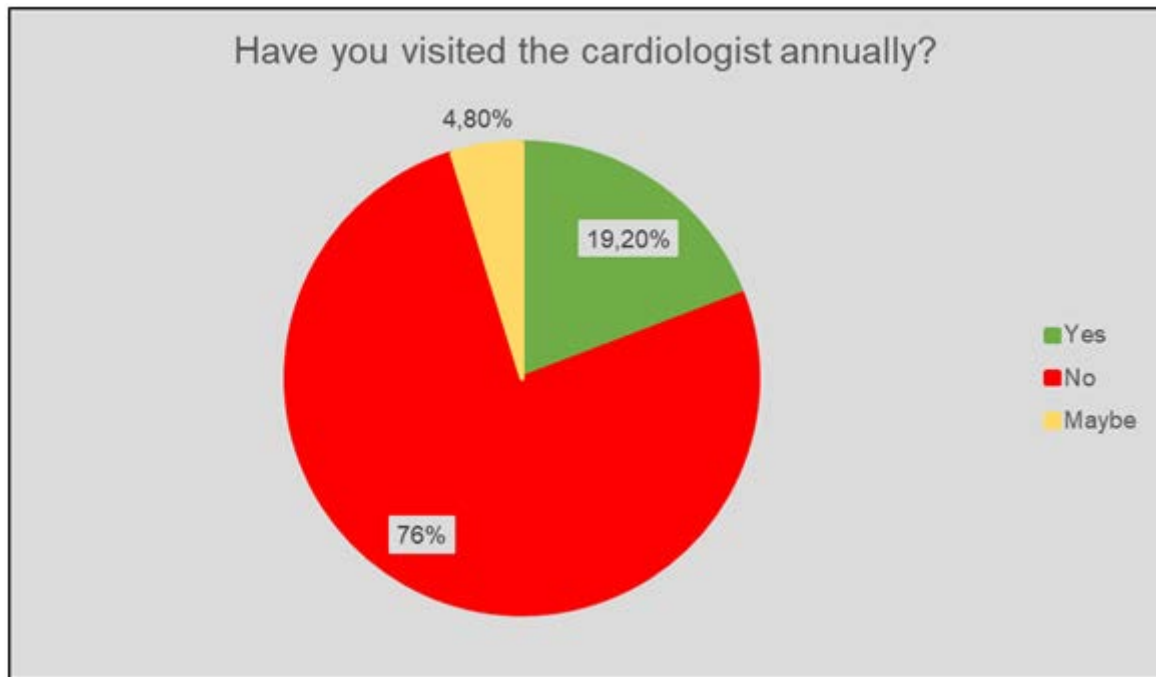


Figure 6 – Graphic 6

Source: Elaborated by member of the group

19,2% of the interviewees voted yes, 4,8% maybe. It's an alarming data, because 76% of the interviewees don't go to a cardiologist annually, and it is recommended going at least once a year, during the CHECK UP.

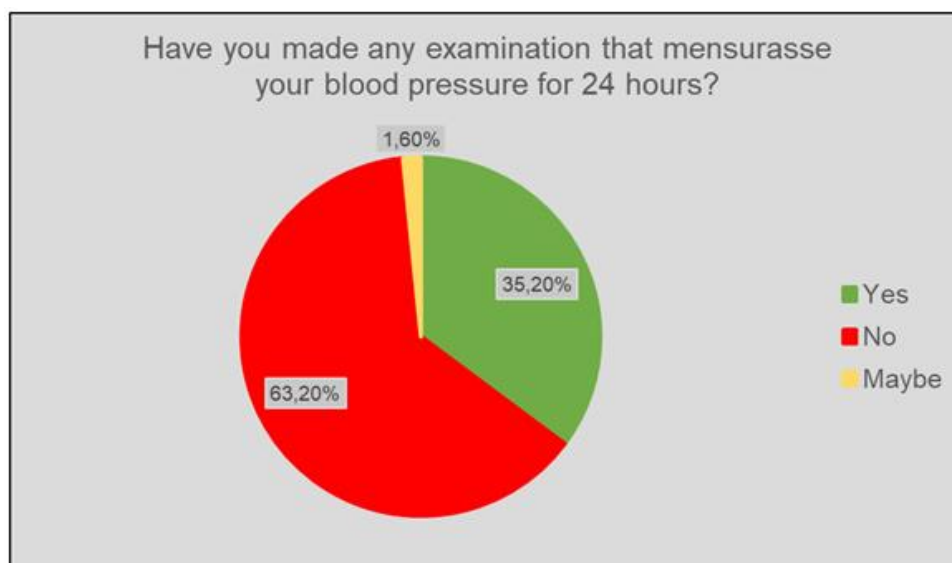


Figure 7 – Graphic 7

Source: Elaborated by member of the group

63,2% of the interviewees never did a 24 hours map, 35,2% of the interviewees did an exam that measures the pressure during 24 hours and 1,6% said not to know if did or not something about it.

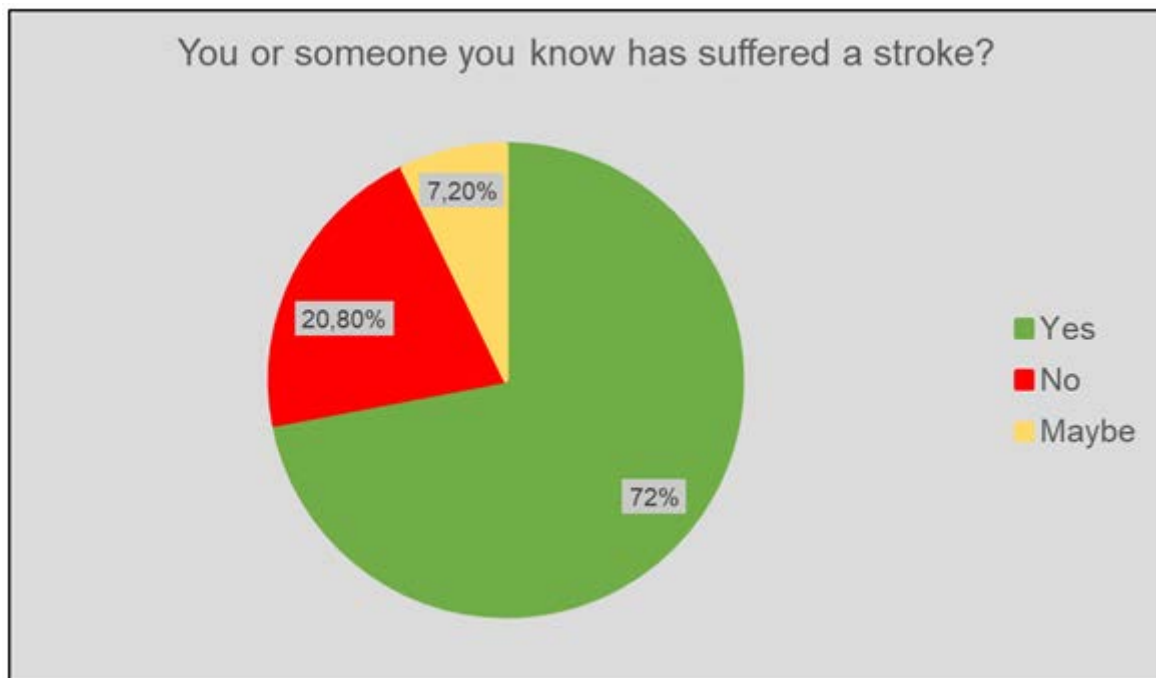


Figure 8 – Graphic 8

Source: Elaborated by member of the group

20,8% of the interviewees voted no, 72% of the interviewees claims that yes and 7,2% voted maybe. Another alarming graphic, because show a high index of strokes crisis.

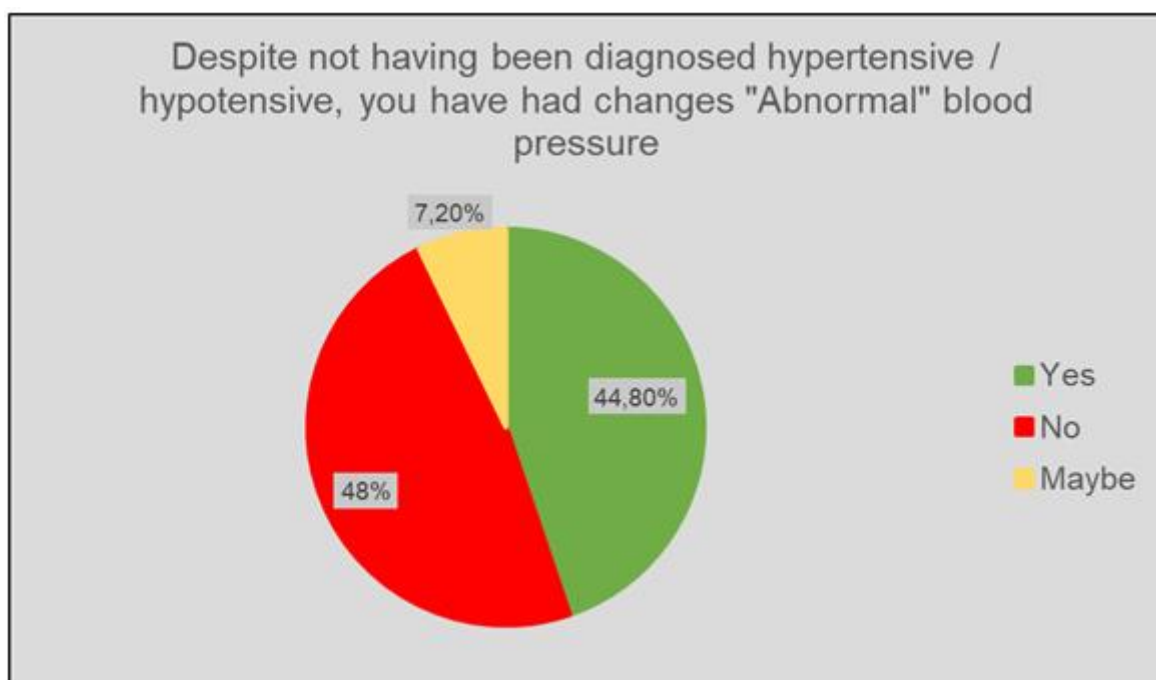


Figure 9 – Graphic 9

Source: Elaborated by member of the group

48% voted no, 44,8% voted yes and 7,2% voted maybe, in other words, don't know about it. This data contrast a lot with the number of interviewees who voted not going to a cardiologist periodically (a year).

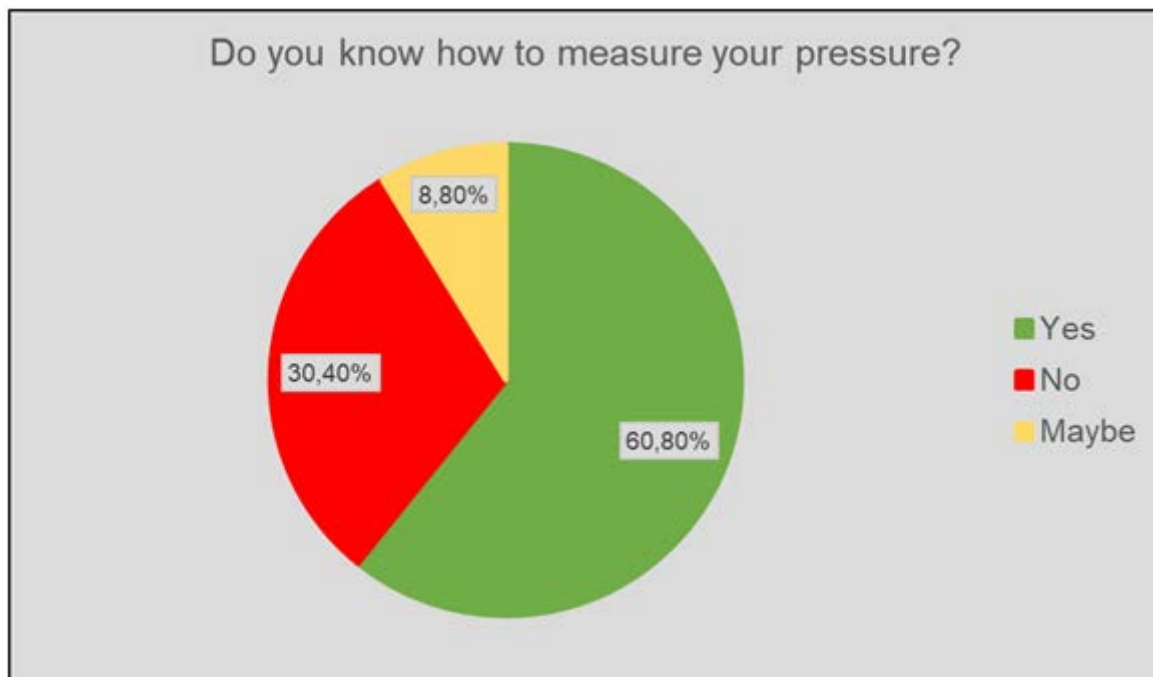


Figure 10 – Graphic 10

Source: Elaborated by member of the group

60.8% claims knowing how to measure the arterial pressure, 30,4% claims not knowing and 8,8% claims maybe. It's seen on the graphic that the percentual of interviewees not knowing how to measure the arterial pressure is higher than average.

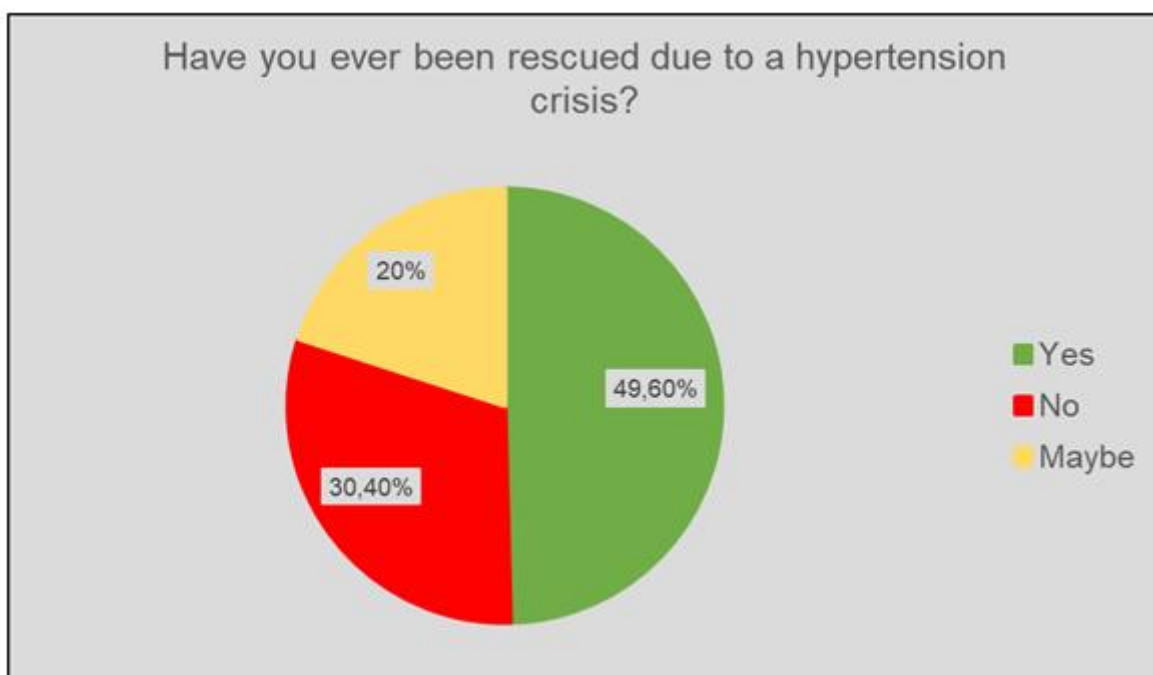


Figure 11 – Graphic 11

Source: Elaborated by member of the group

49,6% claims to need help during a hypertensive crisis. 30,4% claims no and 20% claims not knowing if it was necessary or not. The number of yes is high, and fortifies the idea of the project, about the need of an alerting system.

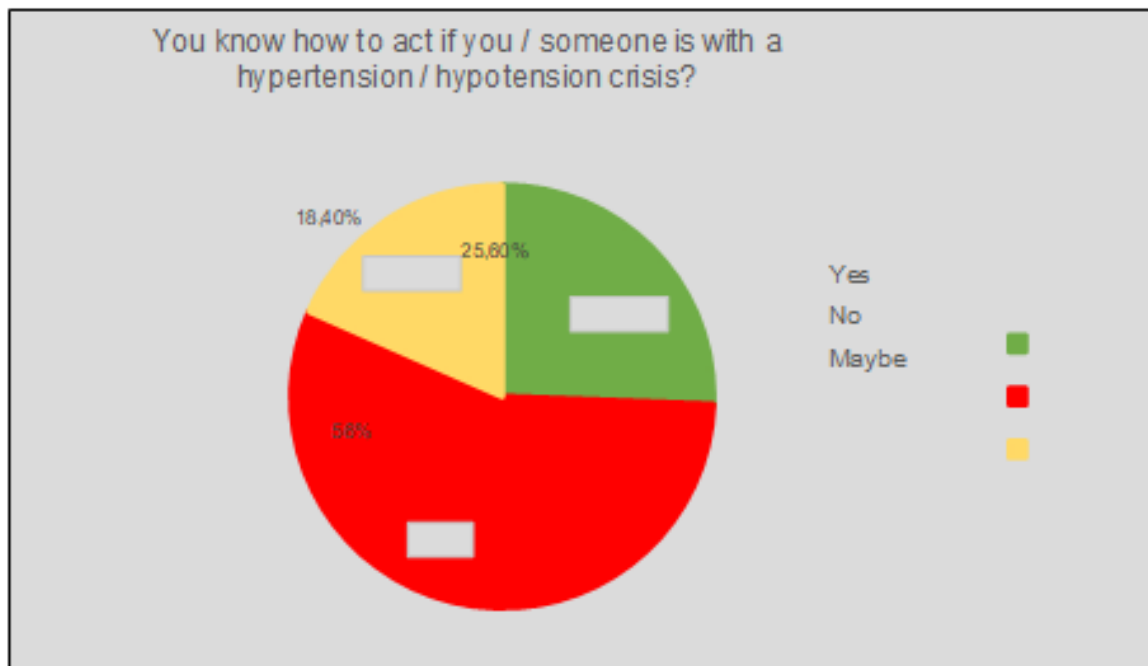


Figure 12 – Graphic 12

Source: Elaborated by member of the group

56% claims not to know how to help a hypertensive, 25,6% claims to know how to help. The number of interviewees who claims not knowing how to help is higher.

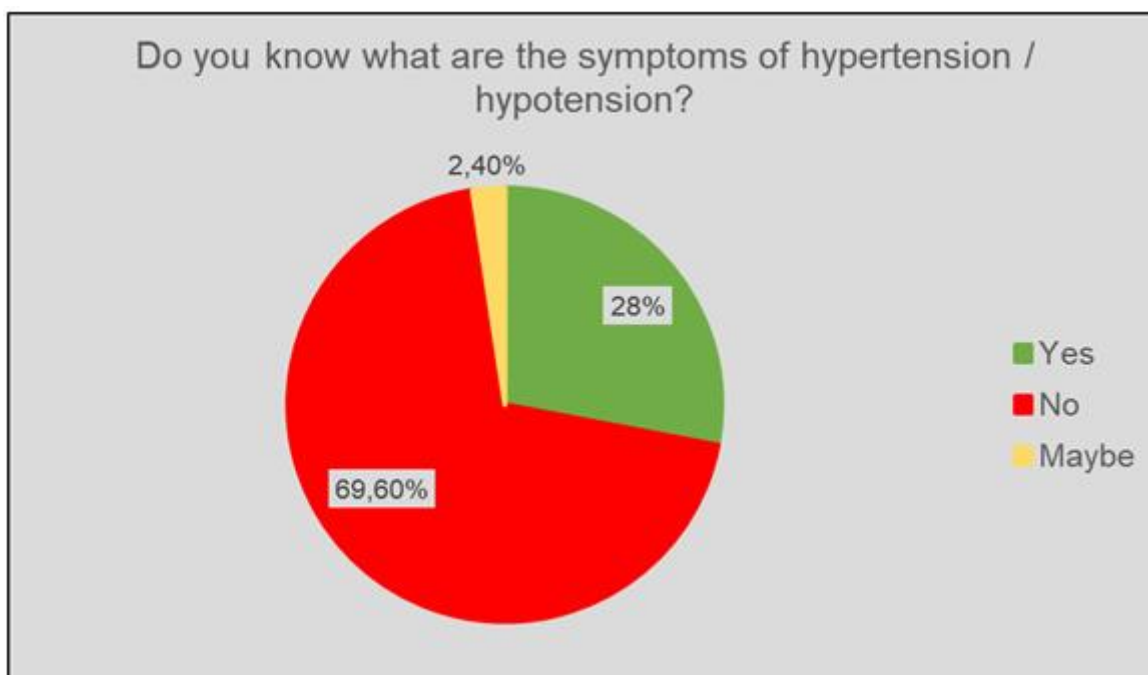


Figure 13 – Graphic 13

Source: Elaborated by member of the group

69,6% claims not knowing how to identify a hypertensive crisis, 28% claims to know how to identify and 2,4% maybe knows. The number of interviewees who doesn't know the symptoms of hypertension are much above the average, this data is alarming because a lot of people have already died for not knowing how to identify if it was with a higher or lower pressure than normal.

#### 4.2. *Prototype*

It was idealized an alarming software to complement existing technologies like SMARBANDS, SMARTWATCHES or any kind of smartwatch capable of measuring the arterial pressure that has the necessary equipment to do it, to simulate the operation of this application will be made a prototype to measure the arterial pressure of the user, it will collect the data and the prototype will send to the system, if it noticed abnormal values, the system will emit an alert to the responsible user to provide aid to the prototype user. The system will work this way: it has a monitor and user screen, the user screen will be connected to the own user device and the monitor screen will be on to somebody device (responsible one) who has shared code, in case of values higher or lower than the average, the application will emit an alert, opening automatically the location of the user.

For the elaboration of the prototype it was used an sphygmomanometer to collect data about the user's pressure, it is connected to the Arduino, which there is an barometric pressure gauge on.



Figure 14 - Sphygmomanometer INCOTERM.

Source: Page of MEDCLEAN. (Hospital Medical Products).

After the arterial pressure data has been captured by the sphygmomanometer, it will be converted to an absolute pressure sensor – MPX5700AP. The calculation is done by the Arduino logics, the values will be converted in barometric values and displayed like arterial pressure.



Figure 15 – Arduino

Source: Mundi Shop Page: Limites Technology.



Figure 16 - Absolute Pressure Sensor - MPX5700AP.

Source: Electronics Chest Page

The system receives the data by the HC-05, the application sends the data to the user-monitor releasing automatically the GPS location, so the responsible for helping can go to the user.



Figure 17 - HC-05 Module.

Source: Short Circuit Page.



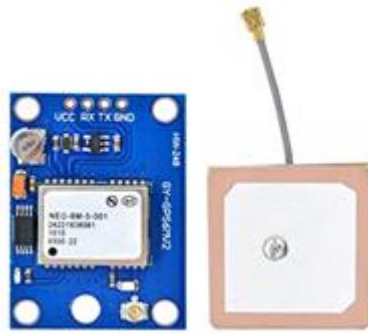


Figure 18 - GPS Module for Arduino

Source: Amazon Page

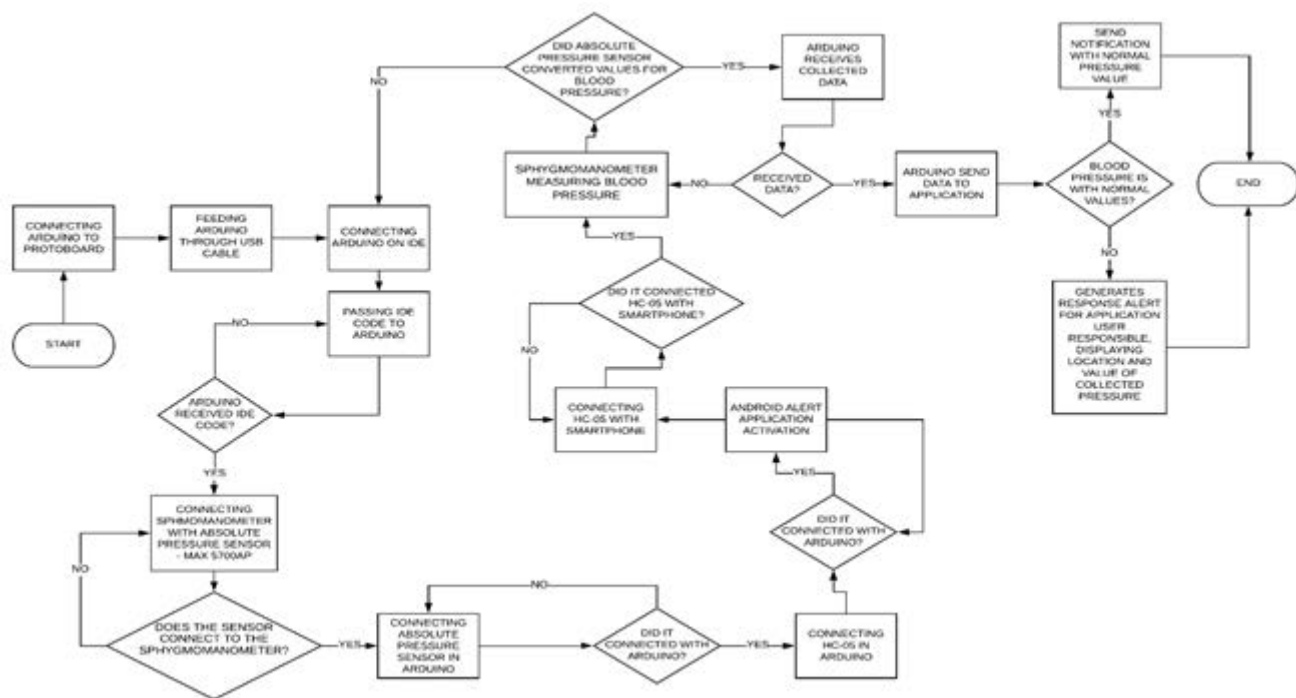


Figure 19 – Prototype building model

Source: Elaborated by member of the group

## 5. Final Considerations

The data collected by the forms shows the uncertainty of population about the knowledge of facts that a disease who covers tightly our country, it was found that despite the name HYPERTENSION be well known, people don't know how to identify or react to a hypertensive crisis, was evaluated that out of every 8 people who answered the form 7 of them also knows someone who suffers the disease.

It was accomplished the elaboration of an alert software that can be used together with other existing technologies like SMARTBANDS, SMARTWATCHES or any kind of smartwatch that has the appropriate device to measure the arterial pressure. It met the expectations well. To collect data and give it to the system, we transformed an sphygmomanometer manual to digital, the same passed data to the Arduino and the microcontroller together with the HC-05 communicated well with the system.

It is proposed to SMARTWACH and SMARTBAND manufacturing companies, the implementation of



software XXXXXX, for the improvement of existing technology.

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# Management System Design Using Smart-Grids in Manaus

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## Abstract

*With the large increase in population among the capitals of the Brazilian states Manaus is a city with great energy potential being in the national interconnected system (SIN), reconciling the expansion of its generation capacity fits the scope provided for in the Ten Year Plan for Expansion of Electricity that The objective is for the energy sector planning, with benefits in terms of increased reliability, reduction of production costs and reduction of environmental impacts, already in the plan through distributed generation, which aims to fit micro generation of as a way to increase supply capacity the plan that provides targets for the country to comply with the COP24 Plan of Countries with the largest amount of clean energy to reduce the environmental impacts caused by the warming of the atmosphere caused by emission of pollutant gases such as the case of CO<sub>2</sub>, thinking about how to improve the use of energy juice generated in its capital and partially supplied by the national system, this work has the purpose of collecting data pertinent to the consumption in order to create a possible projection of the increase and influence of renewable energies in Manaus City through the Smart Grid system as an insertion model the diversification of the capital's generation park.*

**Keywords:** Intelligent Electric Networks; Renewable energy; Energy Expansion;

## 1. Introduction

Electricity has been declared as an essential consumption good for socioeconomic and cultural development, as it has a great influence on the accessibility of goods and services, as well as its use for income generation in certain regions, which have, for example, manufacturing culminating in the

generation of direct and indirect jobs.

The growing demand for the expansion and operation of the Brazilian Electricity System (SEB) to be carried out more efficiently and less costly, in order to accommodate uninterrupted supply-side options to meet the requirements of an increasingly dynamic market. Seeking standards of quality and reliability makes the planning process of the power sector gaining primary importance in determining system configuration and performance [1].

Nowadays it is unthinkable to live without electricity, since in the world, daily, new technologies are emerging to improve our quality of life and most of them are related to the use of electricity. Thus, one of the current models, aimed at reducing the wear of the resource is based on photovoltaic solar energy, which converts solar radiation directly into electricity through photovoltaic modules (PV), not emitting greenhouse gases, being an environmentally friendly energy [2].

The resources used in the various types of technologies, not only in photovoltaic solar energy, have great energy potential, but most of these resources are intermittent, and since Brazil is a large country, region by region is considered. Although applications based on different types of materials have been developed, crystalline silicon dominates the world market for manufacturing and marketing [3].

In this context, considering new sources for Brazil, an emerging economy country, is extremely important, especially in terms of energy security. Since the country is located in an intertropical region that has a considerable vertical incidence of sunlight - which favors the increase of radiation rates in almost the entire country - it is reasonable to discuss the potential of using solar photovoltaic energy and its nuances within the Brazilian reality. [4]

Deploying demand-sensitive loads and distributed energy resources in the distribution system is the initial step towards making the grid more sustainable. Thus, based on the premise of Distributed Energy Generation, there is greater control through reduced demand that allows the utility to utilize current network capacity as much as possible and therefore to postpone capacity expansion projects that are normally associated with the environment. [5]

In the electricity sector, the evolution of the matrix in its various sources is configured in continuous growth, due to some characteristics such as: low loss rate during conversions, ease of transport and direct conversion to other types of energy, such as thermal, chemical, luminous, mechanical, among others, plus the emerging demand for electricity due to the lifestyle of modern society [6].

According to [7], photovoltaic (PV) energy has grown substantially in recent years while achieving considerable cost reductions, thus increasing the challenge of establishing integrated energy matrix models combining different energy sources and envisaging the fact that solar energy is a dominant model in the long run.

According to [1] in the future, the Energy Sector will go through a period of profound transformations, which will require relevant action by the Ministry of Mines and Energy in at least two major dimensions. On the one hand, the process of correcting the distortions of the past must be completed, with a view to restoring the vitality of this strategic sector to the national economy, as well as to the welfare of all Brazilians. On the other hand, the energy sector will have to be planned for the future, making it able to incorporate new technologies and thus be competitive in new market configurations.

## 2. Material and Method

### 2.1 Kind of study

Exploratory research aims to bring a greater understanding of the object of research, which aims to discover, find, elucidate phenomena or explain those that were not accepted despite being evident. Exploration currently represents an important competitive differential in terms of competition [8].

### 2.2 Study area

The selected area is the city of Manaus / AM, as well as development information was used, pertinent to its implementation history, with the national system as well as its use over time. Thus, the use of the collected data demonstrates the type of information needed for growth projection and implementation of the Smart Grid system in the region, so that a projection can be made.

### 2.3 Data collect

Data collection was based on content analysis of documents, articles and data conditioned and registered by public agencies, freely accessed objects characterized as primary sources (documents that will still be analyzed to create information) or secondary sources (information that have already been elaborated).

### 2.4 Collection instruments

According to data presented by [9] points out that the estimated population in the city of Manaus, AM is approximately 2,182,763 people a significant increase compared to the previous common sense with a population density 158,06 "hab /" [ "km" ] ^ "2".

According to [10], the installed capacity of electricity generation in the state of Amazonas was 2,315 MW, of which 275 MW correspond to generation by Hydroelectric and 2,040 MW by Thermoelectric, during 2016, the total residential consumption of electricity in the state of Amazonas was 2,125 GWh, which shows residential consumption is higher than the country's average, which can be explained by the climatic characteristics of the Amazon region, however, its lower consumption of electricity per capita reflects the lower industrial development. of the region as a whole.

## 3. Results and Discussion

[11] was experimentally connected to the National Interconnected System (SIN) on 07/09/2013, but was confirmed the conclusion of its interconnection works on 05/05/2015 thus causing the unbundling of the generation, transmission and energy distribution by starting a new process of services and new contracts of amounts of gas plants.

The power plant system in Manaus consists of an energy complex based on thermoelectric power plants (UTE), hydroelectric power plant (HPP) and independent producers (PIEs), consisting of UTEs, with energy supply services contracted to supply certain demands (table 1).

Table 1: Manaus Generation Capacity

Generation	Capacity (MW)
UTE - Aparecida	172
UTE - Maúa	436,5
UTE - Cidade Nova	15,4
UTE - São Jose	36,4
UTE - Flores	69
UHE - Balbina	250
UTE - Electron	120
UTE - Breitener Tambaqui	60
UTE - Breitener Jaraqui	60
UTE - Manauara	60
UTE - Rio Amazonas	65
UTE - Gera	60
Total	1404,3

Source: Amazonas Energia Management Report (2017).

As observed, most of the energy supply systems are generated largely by thermoelectric plants, where part of the TPPs are supplied by natural gas from contracting amounts from companies from municipalities such as Coari, AM, Figure 1.

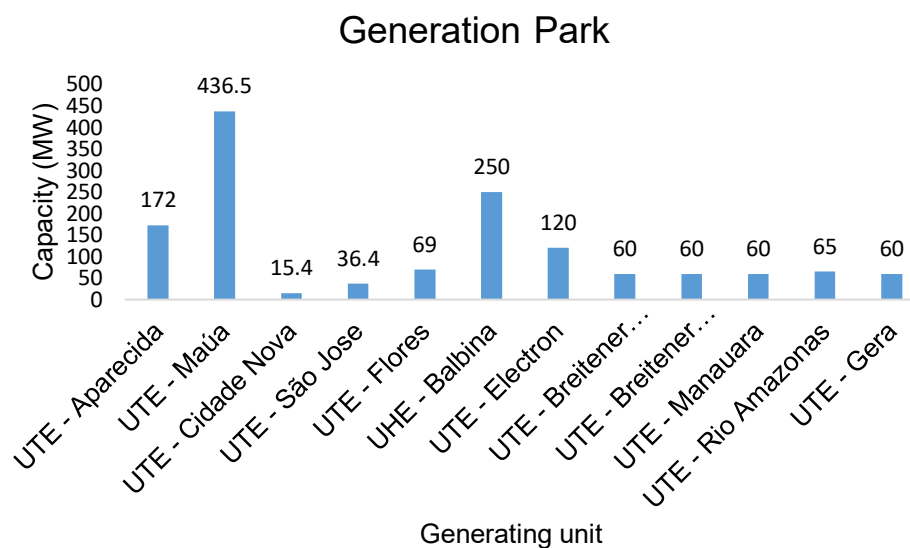


Fig. 1: Generation Park

Source: Amazonas Energia Management Report (2017)

With the increase in consumption over the years, it was possible to find data regarding the average consumption of the capital, the information indicates that after the insertion of Manaus to the SIN and that the current moment of the country there was a decrease in the use and generation of energy. thermoelectric plants, but the increase in energy demand was supplied by the source of the national system, where the Manaus industrial park, despite a financial crisis, had its consumption significantly increased, follows graph with the annual average energy consumption of the Capital Figure 2

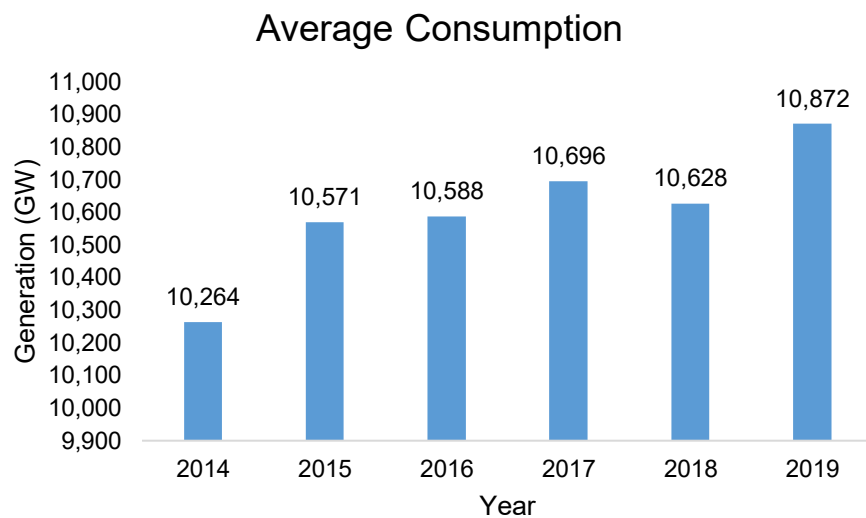


Fig. 2: Average Annual Consumption

Source: Amazonas Energia Management Report (2017)

The energy required in this scenario in recent years has not increased, contrary to annual averages, it has decreased over time, with the creation of new tariff policies by utilities as a way to encourage energy rationing by of demand with the creation of the so-called off-peak consumption uses, its use had a decrease in the generation required to meet the utilization demand Figure 3.

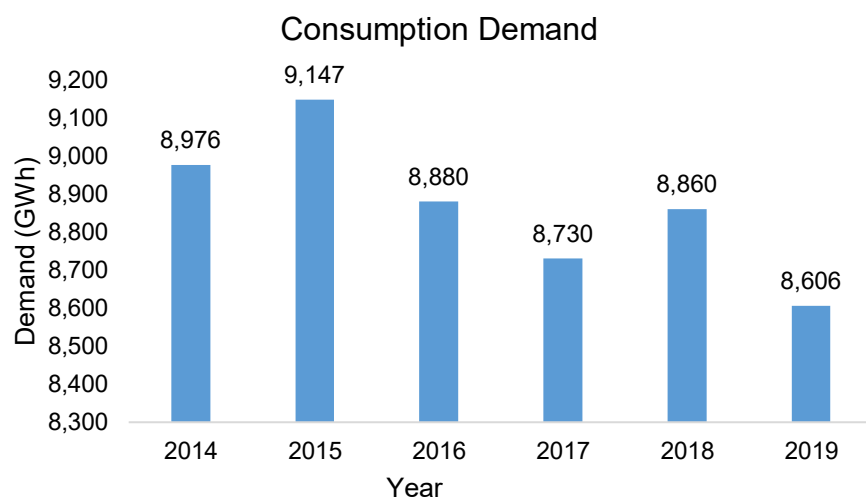


Fig. 3: Consumption Demand

Source: Amazonas Energia Management Report (2017)

Using the annual averages data, it is possible to create a projection of consumption and thus we have in view that with the increased use of energy, it is necessary to diversify the generation park, together with the insertion of renewable energies. Figure 4.

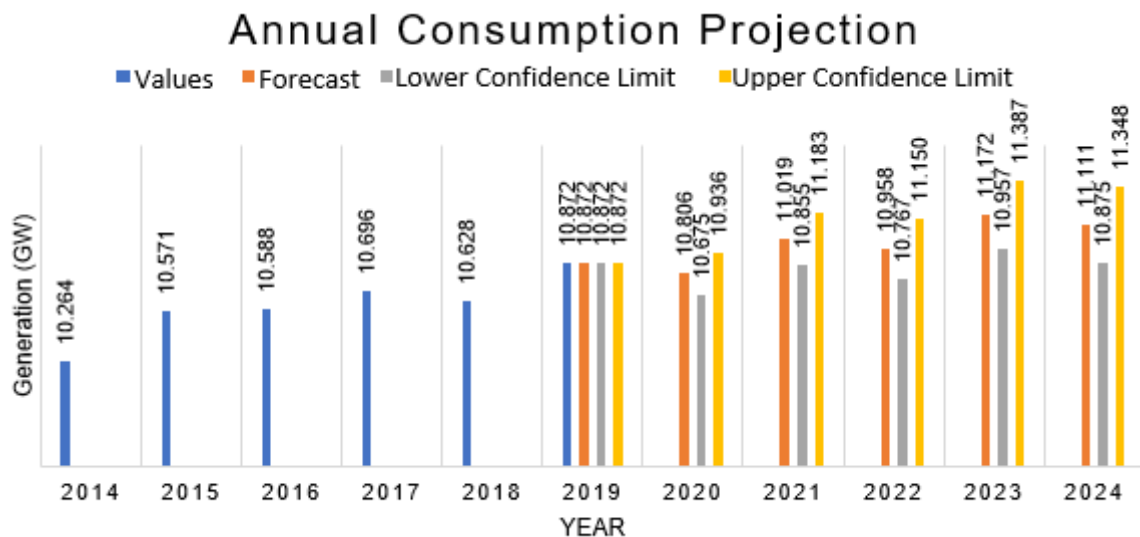


Fig. 4: Annual Consumption Projection

Source: Personal Collection

In recent years, it has been noted that the traditional power generation and transmission system has become inefficient and outdated to meet all demand. However, with the growth of research on the concept of smart grids, new technologies are emerging, to build aspects of a grid that can guarantee sustainability, reliability, availability through automation and control of the power grid thus allowing the optimization of the generation, transmission and distribution system as a way to improve system efficiency [12].

With the advancement of technology, there is a significant improvement in the efficiency of end-use equipment, as well as the methods of implementation of generation, transmission and distribution of electricity, seeking a better use of supply and consumption resources through real-time control. of the system, being one of the ways to maximize the efficiency of the grid, in order to avoid waste [13].

## 4. Conclusion

With the increased use of electricity as a consumption good we have to make better use and rational use, the implementation and connection of Manaus to the SIN concerns the better flow of energy systems with each other, which can be made better use of resources allocated to the capital to serve not only the capital, but to serve other regions when it is suffering due to the seasonality of its regions, thus using the concept of Smart Grid in the proposed National System that improves the management of this resource, it is also obtained quality as a purpose for the customer, in this case the consumer.

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# **Application of SWOT Analysis for Optimizing the Process of an Automotive Services Company**

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## **Abstract**

*Every entrepreneur or entrepreneur has as his main dream to see his business flow and gain successful proportions in the environment where it operates and for that to happen, there are countless researches, analyzes, studies, patience and an unending dedication to stand out and achieve. the desired success. Within a company, the person in charge or the owner of your business analyzes with a broad view, whether external or internal, its weaknesses and strengths. In order to remain in the market, the automotive accessories sales and retail sector adopts a set of systemic mechanisms that use methodological processes within a context, set goals, undertake actions, mobilize resources. and decision making to achieve goals in order to achieve success. Analyzing the importance of organizational strategic planning in institutions or companies in a competitive market requires a refinement of quality tools within planning facets for a better understanding of the subject.*

**Keywords:** Strategic planning; Brainstorm; SWOT Analysis, Opportunities and Threats; 5W2H;

## **1. Introduction**

The company Phoenix Car, in order to enter this rapidly developing and highly profitable market, wants to carry out a strategic business planning, using tools previously mentioned as swot analysis, seeking a search for locality, bids, marketing, new suppliers, financial market, interest. consumers and others. Exploiting your strengths and weaknesses, opportunity and threats.

This paper deals with a strategic planning study within a sales company in the automotive accessories segment, refining its respective tools, such as the swot analysis that aims to search and collect strengths related to weaknesses and related opportunities. to threats, then "sifted" by two other tools called brainstorm and 5w2h. The brainstorm aims at a gathering of all stakeholders and then a brainstorming that will redirect to 5w2h, which refers to a "checklist" of certain activities that need to be carried out as clearly as possible by the employees of company.

The purpose of this paper is to describe the joint implementation of swot, brainstorm and 5w2h analysis in an automotive parts and accessories company in the sales and retail market.

## **2. Theoretical Reference**

Today, the business world is increasingly improving, the importance of sales and the entire team, with the main objective of achieving satisfactory results for the organization (MEGIDO; SZULCSEWSKI, 2007). According to Drucker (1987, p.47), when a company sets goals and objectives and makes efforts to achieve those goals, it defines why it exists and how it carries out its activities, so planning is vital for companies that are in the early stages. as well as those who wish to develop increasingly in the business environment. Thus, through the positive results of the planning, the company will understand its necessity in the execution of its activities. Planning is a matter of necessity for organizations that seek their space in the market, besides being a competitive differential. Proper planning exposes the strengths and weaknesses of the organization, contributing to improvement in activities. In this context, planning is characterized as a very efficient tool that companies use to achieve the expected results.

The word administration for Chiavenato (1993) is used repeatedly in everyday life, casting doubt on its concept. Being important in any classification, use of resources to accomplish goals, whether individual, family, group, organizational or social. Therefore, for Chiavenato (1993) to manage means to make an analysis of the objectives proposed by the institutions and companies and transform them into organizational actions of the administrative functions, that is, the planning, organization, direction and control by the effort of all, elaborated in all areas and levels of the organization in order to achieve the proposed objectives in the most appropriate way.

Business competitiveness in recent years has been considered a key factor for the vitality of organizations and the analysis of strengths, weaknesses, threats and opportunities has become a key tool for this process to happen. (FERNANDES, et al, 2013).

### **2.1 Brainstorm**

According to Meira (2003), brainstorming, adapted to Portuguese as an "storm of ideas", is a process aimed at generating ideas on a defined subject and searching for solutions, where the group's goal is to create the largest number of ideas. ideas about this pre-defined subject, in a pleasant climate and conducive to breaking paradigms.

According to Lucinda (2010), brainstorming must obey five basic rules:

- a) Do not criticize the ideas presented;
- b) Present the ideas as they come to mind;

- c) Generate as many ideas as possible;
- d) Select the ideas relevant to the solution of the problem;
- e) Present the results to the participants.

## **2.2 SWOT Analysis**

It is a tool used for conducting environment analysis and is the basis for strategic and management planning of an organization. SWOT serves to position or verify the situation and strategic position of the company in the environment in which it operates (MCCREADIE, 2008).

SWOT analysis is a tool developed for environment analysis, it serves for the management and planning of the organization that helps the strategic position of the company within the necessary environment. Environment analysis is divided into two parts: Internal Environment (Forces and Weaknesses) and External Environment (Opportunities and Threats). The internal environment is of paramount importance for the organization to know its strengths (these are internal advantages of the organization over competitors) and its weaknesses (these are the internal disadvantages of the organization over competitors). (OLIVEIRA, PEREZ, SILVA, 2005).

Still according to Oliveira; Perez; Silva (2005, p. 44) "The analysis of the internal environment is one of the most delicate in the planning process, as it demands a critical evaluation of the policies and procedures long established within the company". The external environment, on the other hand, allows the organization to know and monitor its opportunities (strengths of the organization that helps to grow competitive advantage) and its threats (strengths of the organization that helps to understand competitive advantage). The organization that uses this analysis can have a broad view of its external and internal environment and thus can leverage its performance to better meet market needs.

According to Ferrell and Hartline (2009, p.130) "One of the biggest benefits of SWOT analysis is that it generates information and perspective that can be shared among the various functional areas of the company." SWOT analysis is important for any organization in terms of knowing the potential and threats that are inside and outside the organization's environment. This analysis is of paramount importance in business planning by assisting and collaborating with the decisions to be made by organizations. (KOTLER; KELLER, 2007).

## **2.3 Analysis of Internal and External Environment (Strengths and Weaknesses)**

The purpose of the internal environment analysis is to know which are the strengths and weaknesses that the company presents, highlighting the qualities and defects facing its market segment. At this point, the prospects of comparison with other organizations should be taken into account, thus benchmarking, that is, evaluation processes from one company to another. The company must be aware of its weaknesses so that they can be worked on and not become a problem, preventing other companies from addressing this flaw, as well as their strengths, to know what is their differential among others. , making this a way of being competitive. However, one should know that every company does not need to repair all its weaknesses, nor boast about its strengths (OLIVEIRA, 2010).

By conducting an external analysis, the company identifies key threats and opportunities in its competitive environment. It also examines how competition in your environment is likely to evolve and

what implications this evolution has for the threats and opportunities you are facing. Internal analysis helps the company identify its organizational strengths and weaknesses. It also helps you understand which of your resources and capabilities will be the most likely sources of competitive advantage and which will be the least likely source of those advantages. Finally, internal analysis can be used by companies to identify areas of their organization that require improvement and change (BARNEY; HESTERLY, 2011, p. 7, emphasis added).

“Forces are resources and skills available to the organization to exploit opportunities and minimize threats” (MATOS, MATOS, ALMEIDA, 2007, p.151).

For Martins (2007), are the most positive aspects of the company in relation to its product, service or business unit, should be factors that can be controlled by the company itself and relevant to strategic planning. Strengths are positive internal factors that the company has complete control over and should be exploited to the fullest in order for the company to maintain a good market position and mitigate its weaknesses.

According to Rezende (2008), the strengths or strengths of the organization are the internal and controllable variables that provide favorable conditions for the organization in relation to its environment. These are characteristics or qualities of the organization that can positively influence the performance of the organization. The strengths must be fully explored by the organization.

Weaknesses are considered deficiencies that inhibit the performance capacity of the organization and must be overcome to avoid organization failure (MATOS, MATOS, ALMEIDA, 2007). According to Martins (2007) are more negative aspects of the company in relation to its product, service or business unit. They must be factors that can be controlled by the company itself and relevant to strategic planning.

## ***2.4 Opportunities and Threats***

According to Maximiano (2004), the investigation of opportunities and threats is a basis for the formulation of strategies, so that it will adapt to the environment and be able to face its competitors obtaining a competitive differential.

Opportunities for the organization are external and uncontrolled variables, which can create favorable conditions for the organization, provided that it has conditions or interest to use them (REZENDE, 2008).

Threats are current or potential external situations or phenomena that may hinder the execution of strategic objectives (CALLAES, BÔAS, GONZALES, 2006).

Threats are more negative aspects of the company's product / service in relation to the market where it is or will be inserted. These are factors that cannot be controlled by the company and are relevant to strategic planning (MARTINS, 2007).

For Moraes (2011), threats are external forces that can impact the company's success, such as competition, operational capacity and the cost of asset increases.

According to Martins (2007), threats: these are activities that can lead the company to a reduction of revenue or even its disappearance. They are linked to competitors and new scenarios, challenging the current strategy of the venture. To avoid them should be analyzed their degrees of possibility of occurrence and severity levels.

### **2.5 5W2H**

According to Lucinda (2010), the five-whys method was created by Professor Taiichi Ohno and consists of discovering, through questions, the root causes of a particular problem in question.

Daychouw (2007), says that the 5W2H method can be used in several areas of knowledge, helping in planning.

Also, according to Daychouw (2007), this method consists of asking seven questions about an action to be taken, in order to obtain the information that will support planning in general. The name of the method, 5W2H.

## **3. Tools and Methods**

This work was based on its nature, approach, objectives and technical procedures employed.

Following the step by step of the case study model, although through the analysis of real data collected analogously to the research, it was possible to develop a specific study to meet the company's needs regarding quality of care, quality of services provided, customer visibility and time reduction. So, the study is being carried out within the general vision of the automotive accessories company located in the city of Manaus / AM.

Origin is applied naturally, although we seek to qualify motives and causes that directly affect consumer discontent and by separating meaningful methods to identify and correct identified problems.

It is qualitative because it seeks to analyze and understand the inherent topics related to the research of quality measures, originated in the definitions of consumers. So, the purposes that characterizes as analytical, as it seeks to understand the causes of problems that generate dissatisfaction in customers. Through a swot analysis, brainstorm and 5w2h implemented in the project that succeeded and solved the negative topics. It was necessary to make a very clear and explanatory analysis of what was designed, accurately distributing each task according to the answers related to each area. It was noticeable that this application was not at all difficult, perhaps the most complex was to formulate the exact solutions for each question.

Applying this method of 5w2h that consists of direct questions and answering all these questions of the tool, who made the project was the entrepreneur himself who aims to improve the company within three months and within the company, through training and improvement, coupled with the addition of new, faster and more effective communications media such as communicating radios implemented in the industries. The new method will cost an investment of approximately three thousand reais, but will bring lasting and real benefits.

## **4. Sales Mapping**

A well-structured market logistics department is essential for any distribution and sales industry. By analyzing different locations or territories, companies in the segment gain an understanding of their own market position and the detection of potential competitors, optimizing their sales and bringing new means of market positions. With this in mind, all strengths and weaknesses, opportunities and threats were analyzed through the SWOT matrix. The form of service prioritizing customer satisfaction and “dial

deliveries” are indispensable factors for strengthening the establishment. The good location that gives more soluble access to customers who can also count on the availability of products whenever they are triggered in the store. Based on this, we find that there are negative answers to the selected questions. The team is great, but they lack the means of improvement, such as time spent between content separations and lack of rapid communication between sectors. Taking these considerations into account, it was noted that customers migrate to the competition even given the cost benefit.

In the company, given its good location and quality service, we can attribute more things such as home delivery service, discount for people who follow the store on social networks and loyal customers, i.e., taking the attention of the competition.

The threat of customer loss due to the identified delay can be a risk, so when deciding to choose our store, even with the lowest price and quality services, time is indispensable for supporting the venture.

To reduce time, costs and errors in the sales process, we will lead to improved results such as the solution to it. In the sales industry, the delay with customer service and the delay in shipping the part or accessory from stock to the delivery counter is great.

Once the main problems are identified, a brainstorm will be portrayed with everyone involved, generating as many ideas as possible to select the ideas relevant to solving the problems and presenting the results to those involved.

In a sales and retail team were asked some questions about the best way to perform the activities, the time it takes for the process to be completed, where the process hangs and so on. The time taken to separate material from inventory to seller, from seller to system, and from system to customer is approximately 10 to 12 minutes and during that time we can offer courtesies to customers.

#### **4.1 Company Mission and Vision**

The mission and purpose of the Phoenix Car company is to foster this automotive accessory market, from which, move millions of dollars in the economy, bringing more competitiveness and news.	The vision of the company Phoenix Car, is to reach a higher level as an organization, bringing jobs and generating wealth for the state and federation.
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#### **4.2 Brainstorm Application**

For the emergence of new ideals, ways of solving problems etc. A general meeting was held, bringing all employees of the company to discuss new ideas and means of solutions that can add value to the institution. Thus, the emergence of the use of quality tools, more precisely the swot matrix together with the 5w2h.

#### **4.3 SWOT Company Analysis**

<b>STRENGTHS:</b> Good location, development and improvement team, small business with good service flexibility, sales of automotive accessories, home delivery and social media sales.	<b>WEAKNESSES:</b> Lack of improvement and speed with the time spent separating sold products and delivery to the end consumer, lack of communication between sectors, price of some products above the
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	competition, delayed response response via social networks.
<b>OPPORTUNITIES:</b> As the Brazilian market moves two billion reais per year. With this, the company has the opportunity to enter, grow and innovate in this competitive and constantly developing market that requires constant innovations due to the great demand and the great interest of consumers for news, consequently to an annual increase in the financial movement of this automotive segment. We must also take into account the gains, development of the organization and learning.	<b>THREATS:</b> However, threats will always exist. The company is surrounded by strong competitors who see improvements, growth and innovations with the company. The location of the company is close to competitors, causing customer doubt, as the time taken to separate products to be delivered both in full and dial deliveries, customers may end up dropping the order and leaving for another store that has faster service.

#### 4.4 5W2H Application

**What action will be performed?** Given the analysis of weaknesses and threats, the action that will be taken is the request of communicating devices to speed up the process of time spent and improve service. Training will be done to improve the activities.

**Who will perform or participate in the action?** All employees and managers.

**Where will the action be performed?** In all sectors of the company.

**When will the action be performed?** December 2, 2019.

**Why will the action be performed?** To perfect the sales process, service and quality.

**How will it be performed?** It will be performed by the responsible of the company, through the studies presented in a simple way, through training in the handling of new devices and improvement tests.

**How much?** In all, it will cost three thousand reais.

## 5. Conclusion

We conclude that through strategic planning followed by powerful quality tools, SWOT analysis, coupled with brainstorm and 5w2h, made possible a study or survey of various parameters of strengths, weaknesses, opportunities and threats, presenting the ideas suggested in the meetings and selecting the most relevant ones for problem solving. As well as a possibility of solving problems, improving processes and correcting errors, thus, developed schemes of solutions to problems or eventual future problems, bringing security and control to the enterprise, its collaborators and customers.

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## Technological Control Assessment and Concrete Receiving

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### Abstract

*With the growth in the area of construction, a greater demand is obtained from both the consumer and the current standards, due to this there is the need for a refined assessment on the process of technological control of concrete. Concrete is one of the most important materials in construction, this material is the most tested and properly controlled, thus bringing the need for the development of this article. Upon receiving the concrete on site, according to the NBR technical standard [1], a series of conferences and preliminary test were analyzed, from which there is the first evaluation of the material in the fresh state, with the slump test, to deepen the Diagnosis of concrete evaluation A laboratory was hired to perform tests and ensure quality and reliability. In the laboratory, specimen ruptures were made through the compressive strength test, which is essential for the final verification of structural strength. The objective of this study is to evaluate the technological control of the concrete, focusing on the process of receiving, molding of the specimens and rupture in the hardened state, thus making it difficult to appear any failure, whether due to non-conformity in the process, the verification of the service resistance required or due to some tribulation in the constitution of the elements produced by the concrete, work or laboratory. This research took place particularly in a venture, located in the city of Manaus, addressing hypotheses and theses verifying their veracity about the changes in the results demanded, making clear the ways to improve the dissertated methodology.*

**Keywords:** Technological Control of Concrete; Concrete Evaluation;

## **1. Introduction**

The element widely used in civil engineering is concrete. As [2] this material undergoes the action of various types of stresses over its useful life, what is most relevant is the compression because it allows the determination of the performance of concrete in buildings.

In conjunction with the concrete there is the technological control, which aims at the analysis of the tests for preliminary and final acceptance of the work, are constituted by a slump test and the compressive strength test. This last test is the most used because of the properties of the materials and their easy comprehension.

To occur the correct qualification of the concrete first must occur the hiring of third parties in order to control the excellence of the material, at the receiving stage it is extremely important that all relevant points are in accordance with the technological control standard, so that there is no non-compliance. compliance and ensure safety in the structure.

The aim of this paper is to evaluate the technological control of concrete in three environments, construction site, company responsible for the concreting service and laboratory, showing the stage of receipt, molding of the specimens and the tests in the fresh and hardened state, identifying failures. and causes, clarifying through tables and graphs the results obtained from studies made with the help of technical visit and documents obtained by suppliers, as well as bibliographic research that has the purpose of adding more technical information to the final considerations of the proposed theme.

## **2. Theoretical Reference**

In civil construction the most used material is concrete, the main governing standard is ABNT NBR [3] which aims at the basic requirements required for the design of concrete structures, this standard has been updated and its scope has been expanded, as well as the other norms. It is very important that the standards serve to ensure compliance in a company, preventing specific weaknesses and ensuring the quality, comfort and sustainable development of the enterprise.

BAUER [4] emphasizes that concrete needs to be subjected to control like any other product that has a responsible position. Given the large number of variables that influence their characteristics, it is worth stating that in addition to a rigorous selection of materials and a competent study of dosages, it is relevant, as for the other standard industrial products, the control of performance and characteristics. of the concrete end product.

All concrete produced requires proper control, minimizing the risk of defects in the quality of the concrete or structure becomes necessary, hence the need for technological controls, [5].

It is essential that in all works that use concrete, obtain a technological control. The NBR [1] (Concrete - preparation, control and receipt), emphasizes that to have the control of concrete characteristics, first need to be specified in design by qualified professional.

When the site buys the dosed concrete from the plant, they are in charge of obtaining the material tests and the experimental dosages, so the responsibility belongs to the concrete itself, according to ABNT NBR [6]. It is of utmost importance that the work be done in parallel tests, to obtain the guarantee that the whole process done in the concrete works with the right results.

The Concrete Technology Control determines the need for testing of samples taken from fresh concrete, as well as the main tests in the process of receiving concrete at the site to verify the quality of material consistency and then the strength test.

First test when concrete arrives at the site is called Cone Slump Test which is used to check the workability of the material. It is one of the most widely used tests in the world because of its simplicity, it defines the consistency of the concrete for workability in its fresh state through the abatement and its degree of use. This test demonstrates the objective consequence of the compressive strength of concrete and its water-cement ratio.

According to NBR [7], with the material already prepared and the wetted plate (Figure 1), the cone is filled in three concrete layers, in each layer with application of 25 strokes in a distributed way, each layer is thickened from the As even as possible with the distribution of the strokes, causing the rod to penetrate approximately 20 mm from the previous layer, the technician has 5 to 10 seconds to lift the cone, according to item 5.3 of the aforementioned standard.



Figure 1: Cylindrical cone and wetted plate

Source: Enterprise X, 2019.

The technician then positions the rod over the inverted cone to verify the distance between the sample height and the bottom of the rod (Figure 2).



Figure 2: Checking the sample height

Source: Enterprise X, 2019.

BAUER [8], says that the workability of this material is essential for a compaction that ensures the maximum density possible, applying a workload compatible with the densification process to be employed.

The next test is called the compressive strength test, it is not done at the construction site, only the samples are taken for the laboratory test, which checks the strength of the already hardened material. According to ANDOFALTO [9], simple compressive strength is the most important mechanical property of concrete, not only because concrete works predominantly on compression, but also provides other physical parameters that can be related in practice to compressive strength.

According to the internal specification of the work, two samples are taken by truck. In this step it is necessary to apply the lubricant in the mold, then using a metal rod is made the thickening in each of the layers (total of 02 layers), with 12 blows. According to NBR [10], it is important to emphasize that when removing the stem, if voids appear, it should be lightly tapped on the outside of the mold until it closes. After the thickening in all its extension, the surface is razed.

According to NEVILLE [11], the concrete in the structure may be inferior due to inadequate densification, segregation or insufficient cure, thus if the specimen compressive strength test is treated in a standardized manner that comprises full density and wet cure over an established period results in a representation of the potential quality of the concrete.

It is crucial to hire a qualified laboratory to perform this service, to have a result with quality and responsibility.

Technological control fits learning and technological experience, requiring only specialized technicians to perform the test procedure, with proven technical experience. However, to be effective in the assay, control routines must be standardized.

To meet reliability requirements the laboratory must have calibrated facilities and equipment.

The technological control aims to evaluate the procedures of the material as well as the mixture or application, if it controls the quality encompassing the verification of the results of the tests performed for control, normative reference and analysis as to the fulfillment or not of the enterprise specifications, as well as the adequacy monitoring. the facilities, due calibration of the instruments or equipment used to measure any property, the methods and documentation used, the technical competence and professional experience of those involved, in short, all the criteria to ensure reliability and appropriateness to the results obtained, [12].

### **3. Methodology**

Data collection was performed primarily through a literature search using books, theses and articles that addressed the subject. Such research collaborates with the data collection so that the proposed theme is understood according to the view of different authors.

The study was conducted in three locations, in a company that specializes in concrete dosing (called Concreteira Y), where its headquarters is located in Manaus, the second site visited was at the construction site (called venture X) where the headquarters is in Minas Gerais. Gerais, with branches in several states including Manaus, the third place was the laboratory specialized in technological control of

concrete (named laboratory Z) located in Manaus. This nomenclature was adopted at work in order to avoid exposure.

During the technical visit, an interview was conducted with specialists in the area, such as laboratory technician Z and concreters rocker Y, asking the following questions: the duration of the concrete transport until arrival at the site, how is the construction performed? slump test at the construction site and the compressive strength test in the laboratory.

The company responsible for the work outsourced the laboratory qualified to perform the specimen tests, following the concreting for sample removal according to NBR [1]. Before the concrete arrived, the work was organized the material near the place of concreting.

To perform the test within the estimated time, it was performed the verification of the site of concrete casting and whether the method used would be pumped or conventional.

The concrete used in the work was applied to the concrete wall structure of project X. According to the structural design, the particularities required for this concrete are:

- The fck established in the structural design for the characteristic compressive strength of the concrete used on the site must be 25 Mpa.
- The tangent modulus of elasticity of the concrete used in the work must be equal to 28 GPa (will not be evaluated by testing in this study).
- The water / cement factor, ie the relationship between the volume of water and the volume of cement used in the concrete trace used in the work, must be less than or equal to 0.60.

Adding the characteristics required in the structural design specifications, the concrete that was applied in the execution of the concrete wall was composed using the coarse aggregate the “pebble 1”, as a material workability criterion the slump test was performed. required ( $220 \pm 30$  mm). Thus, meeting the additional specifications required by undertaking X.

Two-stage concrete and fresh hardened concrete tests were performed. In the fresh state the test performed to determine the concrete consistency was the cone abatement test, according to the NBR [7]. In the hardened state the mechanical performance of the concrete was defined by performing the compressive strength test according to NBR [13].

After removing the concrete for the Slump test during the truck unloading operation, it waited for 1/3 of the concrete to be taken to collect the sample for the compressive strength test, because the higher mixer turnover leads to better homogeneity. .

After molding, specimens (Figure 3 and 4) were identified for the compressive strength test at 24 hours, 7 days and at 28 days.

Figure 4: Identification of specimens

RESPONSIBLE COMPANY	
Client	
Constructions:	
Fck:	
Mpa:	

Date:	
Series:	

Source: Enterprise X, 2019.



Figure 5: Identified Bodies

Source: Enterprise X, 2019.

The specimens were taken to the laboratory after 24 hours of their molding, to perform the compression test, as shown in figure 6 below.



Figure 6: 24-hour specimens

Source: Laboratory Z, 2019.

Upon arrival at the laboratory the cores were dipped into the cure tank (Figure 7) according to NBR [14].



Figure 7: Aged specimens

Source: Laboratory Z, 2019.

The specimens were ruptured using a pavttest manual hydraulic press, as shown in Figure 8. The press can be controlled to progressively increase the load until specimen ruptures.



Figure 8: Manual Hydraulic Press

Source: Laboratory Z, 2019.

## 4. Results and Discussions

It will be presented the results obtained by the research carried out in all existing sectors in the project X. Through this research it was possible to find out the level of nonconformities.

### 4.1 Checking Test Slump Results

The standards ABNT NBR [1] and ABNT NBR [6], stipulate that the molding must be done every 50 m<sup>3</sup> of concrete, respecting the criteria defined in the work. It is established that each concrete mixer truck has a concrete batch, ie 100% of the material received is tested.

The project design required the  $220 \pm 30$  mm slump for wall concreting due to its better workability in



this process. Figure 9 presents the comparative result between the Final Slump, obtained in the field for each concrete sample, and the Project Slump.

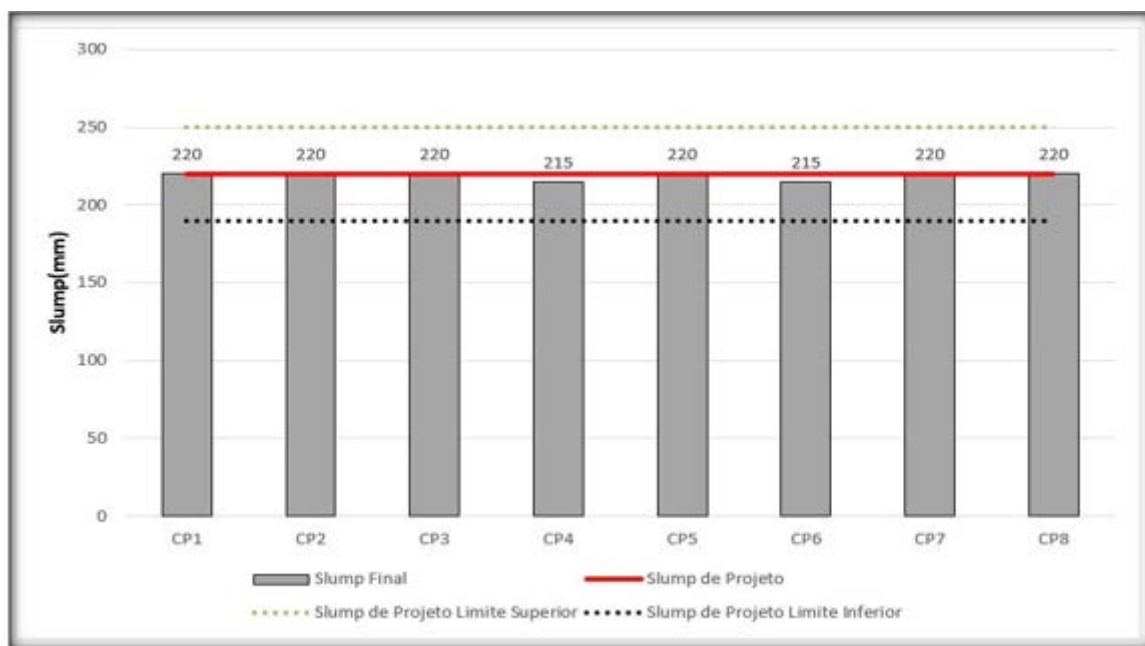


Figure 9: Final Slump vs. Project Slump

Source: Prepared by the Authors, 2019.

From Figure 9, it was found that the Slump data obtained for each sample are within the upper and lower limits, as projected, the arithmetic average was 220 mm which is the exact value of the stipulated for the project. According to the parameters determined in ABNT NBR [6] and ABNT NBR [1], the procedure used by the work with regard to the acceptance of fresh concrete was considered satisfactory in this research.

#### 4.2 Verification of Compression Resistance Test Results

According to the project of project X, 25 Mpa concrete was requested for wall concreting, on the day the specimens were cast, the molds were removed for some concrete curing times, being 24 hours, 7 days, 28 days. and against proof, according to table 1, the results obtained through the compressive strength test were evidenced:

Table 1: Results of specimen disruption

Test	Molding Time	Slump (mm)	N.F	FCK	Part / Structure	Age (Days)	Date of the test	Voltage (MPA)
59519	21:16	220	1290	25	1st Pav. Block 2	1	15/08/19	3,7
59519	21:16	220	1290	25	1st Pav. Block 2	1	15/08/19	3,6
59519	21:16	220	1290	25	1st Pav. Block 2	7	22/08/19	17,4
59519	21:16	215	1290	25	1st Pav. Block 2	7	22/08/19	17,1
59519	21:16	220	1290	25	1st Pav. Block 2	28	12/09/19	23,1
59519	21:16	215	1290	25	Out of Expectation	28	12/09/19	23,6
59519	21:16	220	1290	25	1st Pav. Block 2	63	17/10/19	23,9
59519	21:16	220	1290	25	Out of Expectation	63	17/10/19	21,1



Source: Prepared by the Authors, 2019.

As shown in the figure above, a 24-hour break was performed for the quick release of the forms that are reused in a concrete wall. After this disruption, the 7-day disruption occurred, and the same subjected to the healing tanks technique, the two specimens of this age were ruptured, the highest value found was 17.4 Mpa, so the struts were released.

After curing and disruption of the specimens during the first 7 days, the remaining specimens were cured for a further 21 days, totaling 28 days, considered the final age, and the two specimens of this age were ruptured to Verification of resistance, as shown in Figure 10, the result was 23.6 Mpa, below the established in the project, in this case the evidenced resistance is out of expectation, it must be followed by the breakdown of the control according to ABNT NBR [13].

The batch is accepted when  $f_{ck}$  is greater than or equal to project  $f_{ck}$ . When smaller, precautions should be taken to check for strength or structural reinforcement if necessary.

Due to the 28-day disruption is below the specified, therefore the 63-day control disruption was necessary for the possible approval of this assay and to avoid possible structure pathologies, the result obtained at the age of 63 days was 23.9 Mpa, the that matches this piece is out of expectation.

#### 4.3 Discussions on Resistance to Compression (Work)

The search for the cause of the problem occurred with the evaluation and investigation from the hiring of the company responsible for concreting services to the rupture of the specimen in order to highlight possible failures that may have caused low strength of the concrete.

According to Table 2 and Figure 11 below, concrete Y is the closest to the project which provided a great advantage over others that were in the quotation.

Table 2: Concrete distance to site x Duration in minutes

POWER PLANT	DISTANCE	DURATION
<b>Concrete Y</b>	5,8 Km	Approx. 10 min.
<b>CONCRETE D</b>	6,6Km	Approx. 13 min.
<b>CONCRETE G</b>	16,9 Km	Approx. 27 min.

Source: Enterprise Executive Module, 2019

According to (table 1) above, the quotation was made of three concrete companies in which the distance traveled from each one and the forecast arrived at project X were evidenced. It was shown above that Concreteira Y had a dominance over the competitors.

Figure 11 presents the satellite map of the project, facilitating the visualization and exposes the advantage of Concreteira Y over the others, clarifying the choice of the work and complementing the (table 1) already exposed. After this process was quoted by the cost of each concrete to diagnose which was cheaper to close the contract with the work.

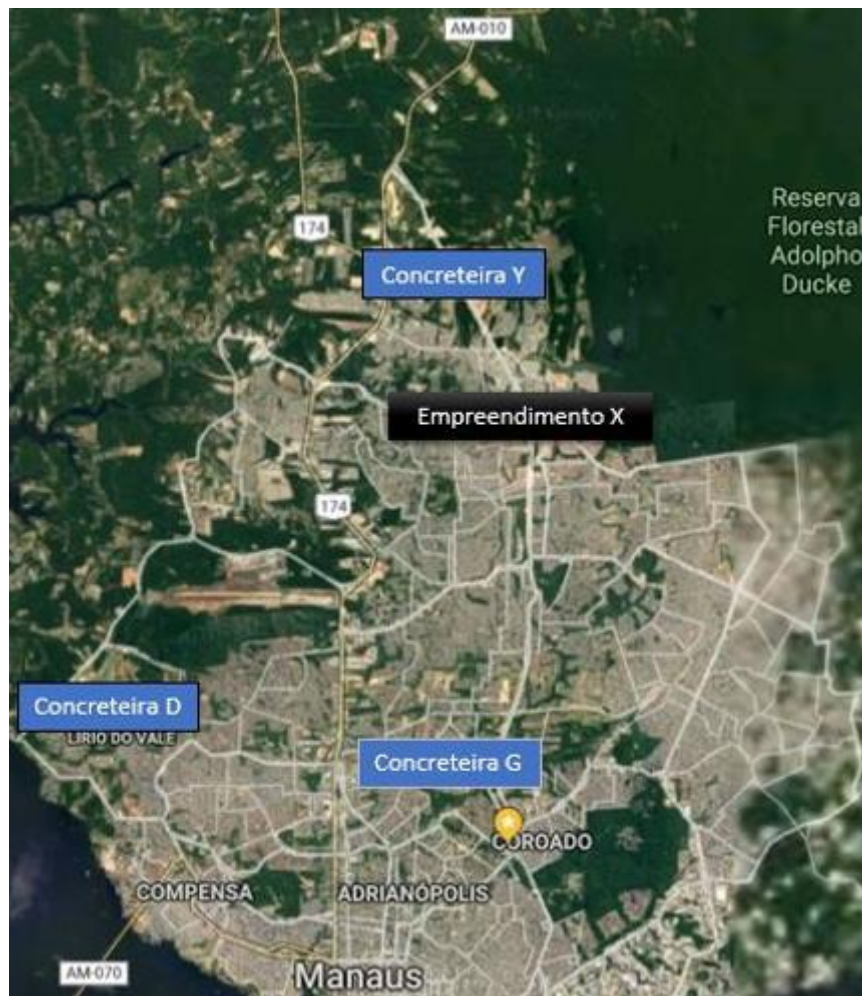


Figure 11: Satellite Map of Project X and the listed concrete companies.

Source: Prepared by the Authors, 2019.

In accordance with figure 12, analyzed three companies to perform the concreting service, it was seen that the unit price had differentiation in reais, and that the final budget varied significantly in the cost of the work. Among the quotations above, concreters Y stood out due to its lower cost, shorter waiting time on arrival of trucks and greater proximity to the jobsite.

Concrete Budget Y					
Item	Description	Items	Qty	R \$ Unit	R\$ Total
01	FC 14h> 3 Mpa Wall Concrete, Fck 25 Mpa, Gravel 0, Slump $22 \pm 3$ cm, with polypropylene fibers, w / c 0.60	M <sup>3</sup>	457,00	R\$ 377,00	R\$ 172.289,00
Concrete Budget D					
Item	Description	Items	Qty	R \$ Unit	R\$ Total
01	FC 14h> 3 Mpa Wall Concrete, Fck 25 Mpa, Gravel 0, Slump $22 \pm 3$ cm, with polypropylene fibers, w / c 0.60	M <sup>3</sup>	457,00	R\$ 380,00	R\$ 173.660,00
Concrete Budget G					
Item	Description	Items	Qty	R \$ Unit	R\$ Total
01	FC 14h> 3 Mpa Wall Concrete, Fck 25 Mpa, Gravel 0, Slump $22 \pm 3$ cm, with polypropylene fibers, w / c 0.60	M <sup>3</sup>	457,00	R\$ 388,00	R\$ 177.316,00

Figure 12: Budget of Concrete

Source: Budget Worksheet Supplies, 2019

It is important to note that at the time of hiring according to the technical visit made in the project, it was reported that there was no inspection of the chosen concrete before the hiring to verify if it met the needs of the work.

As reported, it can be noted that the choice of Concreteira Y had only concern with the final cost of the concrete service and with the savings in this activity, in contrast there may have been a neglect with the quality of services and have significantly influenced the result. lower than expected described in (table 1) of this work.

#### 4.4 Discussions on Compressive Strength (Concrete)

In a technical visit, it was found that the concrete company does not have its own laboratory, which enables the reduction of the efficiency in the process, and it is extremely important that the concrete company has the particular result to ensure the reliability between contractor and construction company. It is also possible that this irregularity may have caused the low result in the disruption, because with technological control in the concrete the reports could ensure the expected resistance of this specimen, not requiring the designer activation, after which it was stated that the reliability of the test. concrete has been reduced.

It is important to argue that there was difficulty in accessing the documents used in the dosing of trucks, because of this it was not possible to investigate the trace produced in the concrete or the methodology used to go deep and show that possibly the trace may have been one of the causes for low resistance obtained.

#### 4.5 Discussions on Compression Resistance (Lab)

The NBR [15] prescribes that the calibration of the test machine under normal conditions must have intervals no longer than 12 months. However, it is recommended that a calibration be performed whenever you suspect an error, or when performing any maintenance, or when the machine is moved. Evaluating laboratory Z, if it was complying with NBR [13] (Concrete - Cylindrical specimen compression test), it was identified that the calibration certificate was expired. The laboratory provided the report clarifying that the manual hydraulic press was out of date which may have caused the wrong measurement of the specimens, as shown in Figure 13:

EQUIPMENT	Manual Hydraulic Press, with Digital Controller			
	Brand	Model	N.º	Capacidade(Kgf)
	PAVITEST	I-3025-D	138	100000
PRESSURE GAUGE	Manômetro			
	Brand	Scale (Kgf)	Sub-Div(Kgf)	N.º
	NOVUS	0 à 100000	10	138

ACCORDING TO NM- THIS 7500-1	SHELF LIFE
DATE: 23/08/2018	DATE: 23/08/2019

<b>TEMPERATURE:</b> 29,0°C	Under normal circumstances, according to the standard
<b>HUMIDITY:</b> 99,0 %	NM-isso-7500-i ITEM 9,0

Figure 13: Press Calibration Report

Source: Laboratory Z, 2019.

As shown above, it is possible to verify that the laboratory did not perform its annual inspection on the compressive strength equipment, showing a process failure that could have been one of the probable causes for the 28 and 63 days specimen not to have expected. , since the calibration due was 08/23/2019. It should be noted that in laboratory Z there was no new inspection of the equipment to ensure process quality and a new technical visit was not allowed to conclude if this problem was the cause for the highlighted error.

## 5. Final Considerations

The main purpose of this article was to evaluate the technological control of a work in Manaus. Several topics were studied about the whole procedure regarding the technological control of concrete.

It cannot be concluded from this study that the reason why the compressive strength test gave less than the fck determined by undertaking X. The concrete that is supplied to the work is a material with a low level in relation to its strength. The preliminary acceptance criterion of the concrete, performed by the slump test was considered satisfactory.

The main reason for providing an inferior concrete is the final receipt criterion used by the work, which allows acceptance of batches with strength below the projected value and does not survey their suppliers to ensure reliability in the three environments, which are concrete, work and laboratory, which could thus improve the process.

According to HELENE; TERZIAN [16], points out that the factors that influence the compressive strength of concrete may be the variability of cement, aggregates, water, additives and the relative proportion of these materials; quality and operation of dosing and mixing equipment; efficiency of testing and control operations.

Quality is a hotly debated issue today to ensure compliance in the executive process, because of the error in achieving the expected resistance shown in the article, it is important to emphasize its importance in the process, as faulty farias were diagnosed in three locations that could have If the application of technological control to the prescribed standard were avoided, small practices could have a significant impact on the final stage of the process.

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# **A Sinergia entre Cidadania e Participação Ativa Catalisando a Articulação do Empoderamento Feminino: interconexões necessárias com a subsidiariedade**

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## **Abstract**

*it is essential nowadays to discuss about the new institutional arrangements that are being formulated to seek a true democratization of the state bases, which shows that the debate on public policies is increasingly gaining momentum. It is through the articulation of local power with citizenship that new paths of appropriation of the public space can be crossed by the subjects, especially by women. Biasing in this sense, this research, of qualitative nature and theoretical character, intends to analyze the necessary interconnections with subsidiarity, aiming to rethink the existing synergy between citizenship and active participation as catalysts of effective social empowerment at the local level. It is assumed that in the local space, due to the proximity to the subjects, it is possible that there is substantial empowerment articulated with citizen participation.*

**Keywords:** democratization; emancipatory; feminism; power; public policy; politicization

## **1. Introdução**

No diálogo contemporâneo entre cidadania e participação ativa, é fundamental que seja considerado o princípio da subsidiariedade enquanto um mecanismo imprescindível na inter-relação entre Estado e sociedade. Vislumbra-se essencial, na atualidade, discutir a respeito dos novos arranjos institucionais que estão sendo formulados para se buscar uma verdadeira democratização das bases estatais, o que demonstra que o debate atinente às políticas públicas está, cada vez mais, adquirindo força. É mediante a articulação do poder local com a cidadania que se pode perpassar novos caminhos de apropriação do espaço público pelos sujeitos, especialmente pelas mulheres.

Enviesando nesse sentido, a presente pesquisa, de cunho qualitativo e caráter teórico, pretende analisar as interconexões necessárias com a subsidiariedade, visando repensar a sinergia existente entre a cidadania e a participação ativa como catalisadoras de um efetivo empoderamento social em âmbito local. Parte-se do pressuposto de que no espaço local, em decorrência da proximidade com os sujeitos, é possível que haja substancial empoderamento articulado com a participação cidadã.

## **2. Ressignificando o espaço local: autonomia e subsidiariedade**

À medida que se pretende avançar na reflexão a respeito do empoderamento social, não se pode esquecer que o espaço local é um elemento fundamental na busca pela autonomização dos sujeitos. A partir desta hodierna concepção, pode-se afirmar que este é o *locus* propício para que as inter-relações entre os

indivíduos sejam fortemente solidificadas em uma base de cidadania participativa. Em tais ambiências é que se mostra possível desenvolver, efetivamente, uma verdadeira inclusão social.

Nesse sentido, adentra aqui o princípio da subsidiariedade enquanto um mecanismo que possibilita instrumentalizar a edificação de um poder local menos atomizado e mais coeso, notadamente mediante uma subsidiariedade horizontalizada. Ao romper com determinadas oligarquias locais, pode-se engendrar, substancialmente, canais de comunicação, de politização e de participação cidadã. Visualiza-se, assim, a necessária intersecção entre autonomia, subsidiariedade e empoderamento.

Por intermédio de suportes teórico-metodológicos, o princípio de subsidiariedade é considerado como instrumento utilizável pelos governantes, na procura de equilíbrios necessários a definir as novas mudanças procuradas. Para tal efetivação, surge os questionamentos acerca das fronteiras de ingerência e da não-ingerência, que variam de acordo com a capacidade e as necessidades dos atores sociais. Apesar de ser expressão, a ideia foi considerada pela Comissão Europeia, recentemente, como “princípio do bom senso”, consoante refere Baracho (1996, p. 57-58).

Sob este viés, o controle político da aplicação do princípio da subsidiariedade consiste, essencialmente, na verificação da estrita observância pelas instituições comunitárias na emanção de atos e que é levada a cabo pelos próprios órgãos que coparticipam nos procedimentos decisórios e no âmbito destes. Trata-se, com isso, de um controle interinstitucional, recíproco, mútuo, com consequências importantes no domínio da produção normativa, como menciona Martins (2003, p. 519).

Nesse aspecto, o princípio da subsidiariedade tem uma função orientadora do modo de exercício das competências da comunidade. Significa que ele não tem a virtualidade de outorgar ou denegar atribuições ao grupo social, não atuando sobre a titularidade de tais capacidades. Atua apenas sobre o exercício das competências e, mais restritivamente ainda, sobre o modo desse exercício. Esta restrição, que se liga à construção como um conceito dinâmico, significa que a aplicação do próprio princípio pode conduzir à comunidade a agir ou a deixar de agir, ainda conforme destaca a citada autora (2003, p. 527).

A tarefa principal do Estado, como enfatiza Baracho (1996, p. 65-76), consiste em estabelecer, como garantia final, o cumprimento do bem comum e da solidariedade. O Estado só deve agir, por ele próprio, quando existe necessidade real, que não tenha sido atendida por qualquer coletividade ou grupo. O Estado não é o substituto eventual dos atores omissos, pelo que deve velar pela garantia daquele, sem substituir as ações possíveis dos cidadãos, capazes de corresponder ao interesse geral. O princípio de subsidiariedade faz, então, apelo à sociedade civil para acompanhar as tarefas de interesse geral, pelo que dá resposta a muitas questões atuais. O princípio pressupõe a redefinição das relações entre o Estado e os cidadãos, não apenas no domínio institucional, mas no âmbito da ação que visa a cumprir o interesse.

A densificação do princípio da subsidiariedade é realizada, desde logo, por interpretação extensiva das suas duas condições cumulativas (a exigência negativa da insuficiência da ação estatal e a exigência positiva da “melhor” realização pelo nível comunitário). Impondo-se, quanto ao requisito negativo, a sua análise à luz do sistema constitucional de cada Estado-membro e, quanto ao positivo, a sua redução à análise de relação de adequação entre os objetivos a prosseguir e a ação, segundo o esclarecimento feito por Martins (2003, p. 528).

O grande lema da novação atuação do Poder Público é o “federalismo cooperativo”, que tenta sintonizar e racionalizar as ações dos diferentes níveis de governo através da construção de um consenso político e

administrativo. Um dos fundamentos deste modelo de coordenação entre os entes federativos é o princípio da subsidiariedade, que dá preferência à prestação descentralizada dos serviços e somente permite uma atuação em nível governamental superior quando o inferior mostrar incapacidade de cumprir a respectiva tarefa de forma eficaz, permitindo uma prestação compartilhada dos serviços básicos, de acordo com Krell (2008, p. 14 e 135).

O princípio inspira inteiramente o sistema federal, de acordo com Baracho (1996, p. 86). Representa a expressão mais clara e formal do princípio federativo, por ser o conteúdo mais significativo para sua elaboração. É, praticamente, o único conteúdo sistematicamente elaborado que propicia configurá-lo. O federalismo, como Estado que comporta em seu seio várias coletividades, exprime a confluência entre Estado central ou a União e as competências consentidas dos diferentes grupos sociais intermediários, sem que abandone ou dificulte as tarefas necessárias à realização do bem comum.

Sob esta perspectiva, deve-se compreender por democracia local o direito dos cidadãos eleitores das comunidades locais (organizadas em autarquias locais, no âmbito do Estado de direito democrático) deliberar diretamente ou através de órgãos por eles eleitos e perante eles responsáveis, sobre os assuntos relativos às respectivas comunidades, concorde ao princípio da subsidiariedade. Efetivamente, a democracia local sempre esteve ligada à existência de comunidades locais, um fato social constante ao longo de todos os tempos, como elucida Oliveira (2005, p. 14-15).

Para esclarecer, a democracia local não é necessariamente uma democracia apenas de pequenas comunidades. Ela não trata dos problemas nacionais ou regionais, mas não se restringe, necessariamente, aos problemas de comunidades com algumas centenas ou alguns milhares de habitantes. Pode afirmar-se até que, quanto menores forem essas comunidades, menor é o significado da democracia local. Esta só se manifesta verdadeiramente em termos de poder dos cidadãos (motivando, inclusive, uma maior participação destes) quando são chamados a resolver, dentro do princípio da subsidiariedade, problemas relevantes de comunidades locais, também em conformidade com o que aduz o citado autor (2005, p. 16). É interessante aqui analisar o direito social condensado proposto por Gurvitch, já que este aproxima a estrutura social de base democrática da ideia de direito social, entendendo que se trata de sistema jurídico emanado por uma comunidade política subjacente, a partir dos diferentes grupamentos locais, constituindo a essência do direito social, como observado por Hermany (2007, p. 39). É na perspectiva de gestão compartilhada e de apreensão do espaço público estatal pela sociedade que deve ser inserida a ideia de um direito social que compatibilize a ampliação do espaço de atuação da sociedade civil nas decisões públicas, mantendo-se, como referencial mínimo, o conjunto de princípios constitucionais e outras estruturas representativas essenciais, ainda segundo aduz o referido autor (2007, p. 41).

O direito social se assume como ordem integrativa, pois está fundado sobre a confiança compartilhada pelos membros do grupo, pelo esforço comum e pela ajuda mútua. É esse direito social condensado no interior de uma norma estatal que poderá constituir uma ordem de integração social, em razão de sua ligação interna com a característica central do direito estatal: a sanção incondicionada, segundo Bolzan de Moraes (1997, p. 53 e 63). Logo, este direito social condensado, que ocupa o espectro da ordem jurídica estatal, se apresenta como um direito social organizado e, como tal, deve exprimir-se através de associações de cooperação. Somente uma organização estatal democrática poderá desempenhar este papel superestrutural indispensável.



Perfilhando esta compreensão, percebe-se que a concretização da subsidiariedade deve contemplar os mecanismos de repartição de competências, tanto administrativas quanto legislativas, bem como as repercussões que o aprofundamento da democracia local podem exercer no que tange ao relacionamento entre Estado e sociedade, consoante assevera Hermany (2012, p. 70). Dessa forma, em espaços locais em que se observa um capital social mais elevado, fomentam-se as possibilidades de construção social das decisões públicas – contemplando o princípio democrático e da igualdade – o que dificulta a atuação das oligarquias.

É na esfera local que se observa uma potencialização do processo de formação democrática das decisões públicas, a partir da democracia administrativa, como fator de apropriação do espaço institucional pela sociedade. Logo, na visão de Hermany (2012, p. 80 e 91), é necessário efetuar-se um raciocínio que contemple a descentralização, a autonomia local, o respeito às instituições nacionais, forte na Constituição, tendo como elemento central a excepcionalidade das restrições ao espaço municipal. É mister que se encontrem formas de aproximação da população na definição das receitas municipais, pois a efetivação da democracia local depende tanto da escolha da política pública, quanto da criteriosa discussão em torno de sua viabilização orçamentária. Vale referir que a subsidiariedade implica critérios de economicidade e eficiência, de forma que a autonomia não pode estar a serviço de posturas clientelistas ou de financiamento de burocracias relacionadas aos partidos políticos.

Focalizando nesta direção, a construção de um conceito jurídico de subsidiariedade envolve operações caracterizadamente jurídicas que também devem ser depuradas, tanto quanto possível, de juízos puramente políticos que não cabem na tarefa judicial de conformação à lei. Daí a relevância de um princípio jurídico não resulta tanto da sua proclamação ou do rigor da sua definição, mas da sua aplicação efetiva. Ora, sempre que a Constituição, o Estatuto político-administrativo ou qualquer lei confirmam atribuições ou repartam o exercício de competências, recorrendo a critérios, princípios, ou regras diferentes da subsidiariedade, esta deixa de ter campo de aplicação, tornando-se inoperante a sua convocação, conforme Martins (2003, p. 539).

Com efeito, a democracia local, seja direta ou representativa, não se esgota em fórmulas, demonstrando-se, fundamentalmente, através da presença dos cidadãos na vida da comunidade local. Os cidadãos, devidamente informados sobre os problemas das comunidades locais, estão em condições de os debater, revelando-se aqui a maior importância com relação à discussão organizada a partir dos órgãos de poder, quer ainda a que decorre através dos meios de comunicação social, bem como as discussões mais ou menos informais levadas a cabo por partidos, associações cívicas ou cidadãos, em consonância com a lição de Oliveira (2005, p. 31-41).

Constata-se, assim que, segundo afirma Hermany (2012, p. 149), é indispensável, sim, um poder local relacional, em que o processo de definição das competências e o federalismo financeiro sejam instrumentos para a consolidação de um espaço municipal que atribua ao cidadão papel de destaque na formação e controle das decisões públicas. Diante disso, o fortalecimento do poder local na perspectiva vertical da subsidiariedade somente se justifica na medida em que sirva, efetivamente, de *locus* para a apropriação do espaço estatal local pela sociedade.

Seguindo esta compreensão, Dowbor (1999, p. 35) ressalta que é no nível local que se podem realmente identificar com clareza as principais ações redistributivas. Estas ações dependem vitalmente de soluções

locais e momentos políticos, e as propostas demasiadamente globais simplesmente não funcionam, na medida em que enfrentam interesses dominantes organizados e complexidades políticas que inviabilizam o projeto. Dessa forma, Baracho (1996, p. 91) afirma que a subsidiariedade concretiza-se no município, desde que o indivíduo não é um ser abstrato, mas concreto, onde aparece como cidadão, usuário, vizinho, contribuinte, consorciado e participante direto na condução e fiscalização das atividades do corpo político, administrativo e prestacional. O princípio da subsidiariedade é, assim, uma garantia contra a arbitrariedade, procurando, inclusive, suprimi-la.

É o poder local que promove a educação cidadã, devendo-se sempre alertar para a necessidade de mecanismos de controle frente aos interesses das oligarquias locais, contrários a uma perspectiva garantidora do princípio da igualdade. Esse cotejo da participação com a existência de instrumentos de salvaguarda em relação a maiorias eventuais é elemento essencial na interpretação da subsidiariedade, evitando raciocínios simplistas e desconectados do entorno sociopolítico, no alerta feito por Hermany (2012).

Infere-se, a partir destas confrontações, que o princípio da subsidiariedade está correlacionado à cooperação, à autonomia e à participação, evidenciando que se deve sopesá-lo com a ampliação de contextos de articulação entre os sujeitos, a fim de que haja um verdadeiro empoderamento, à proporção que há crescimento do capital social. A materialização da subsidiariedade também deve se concatenar à democracia local, sendo um instrumento imprescindível para que se possa potencializar a cidadania, a partir de sua interface com a sociedade. É a partir do entrelaçamento da subsidiariedade à autonomia dos indivíduos que se pode ressignificar o espaço local.

### **3. O empoderamento como estratégia de fortalecimento da participação social**

À proporção que se pretende fortalecer a participação social e, por conseguinte, as bases democráticas, é essencial considerar que o *empowerment* reflete o modo como os sujeitos assumem sua condição de cidadãos por intermédio de conscientização, de politização e de inclusão. O empoderamento é, então, viabilizado pelo capital sociocultural que vai sendo adquirido nas interações com os outros e também com o grupo, trazendo à tona uma nova concepção de poder, assumindo formas democráticas, construindo novos mecanismos de atribuições coletivas, de tomada de decisões e responsabilidades compartilhadas.

A temática do empoderamento, como assinalam Hermany e Costa (2009, p. 85-86), não é nova. O marco histórico que trouxe a notoriedade do empoderamento se vislumbrou no século XX, principalmente em decorrência dos movimentos sociais empreendidos nos Estados Unidos da América, como o movimento negro (*Black Movement*). O *empowerment* começou a ser utilizado como sinônimo de emancipação social, em que a autoestima dos membros dos grupos sociais era ampliada. Desse modo, é em ambientes com maior capital social que se pode vislumbrar uma amplitude de possibilidades de empoderamento social na consecução de ideários sociais frente aos detentores do poder político e do próprio mercado. É através da organização, do associativismo e da ampliação de redes de inter-relação social que as comunidades podem desempenhar melhor seu papel na construção de sua emancipação social.

Nessa perspectiva, o empoderamento procede no sentido de edificação, tanto individual quanto coletiva,

da autonomia por parte dos indivíduos. Foi, e ainda o é, uma conquista gradativa, a qual não se perpetuou em todas as ambiências, sendo necessária que a sua operacionalização se dê de maneira crescente e contínua<sup>1</sup>. Porém, este é um termo polissêmico, comportando várias significações a depender em que contexto é empregado. Em uma conceituação ampla, Baquero (2005, p. 09) elucida que o empoderamento consiste numa transformação atitudinal de grupos sociais periféricos que os capacita para a articulação de interesses, a participação comunitária e lhes facilita o acesso e controle de recursos disponíveis, a fim de que possam levar uma vida autodeterminada, autorresponsável e participar do processo político.

Na mesma linha de pensamento, Pereira (2006) ensina que o empoderamento significa, em geral, a ação coletiva desenvolvida pelos sujeitos quando participam de espaços privilegiados de decisões, de consciência social dos direitos sociais. Essa consciência ultrapassa a tomada de iniciativa individual de conhecimento e superação de uma situação particular em que se encontra até atingir a compreensão de teias complexas de relações sociais que informam contextos econômicos e políticos mais abrangentes. O empoderamento possibilita tanto a aquisição da emancipação individual, quanto a consciência coletiva necessária para a superação da dependência social e dominação política. Enfim, superação da condição de desempoderamento.

Nos últimos tempos, consoante asseveram Sardenberg, Capibaribe e Santana (2008, p. 01-02), tem-se tornado comum, tanto no discurso acadêmico, quanto no de órgãos governamentais e não governamentais, falar-se do empoderamento. No entanto, não existe consenso quanto ao que venha a ser exatamente este empoderamento, tampouco no que se refere aos processos e ações que, de fato, contribuem para tanto, como se pode ser mensurado e se é possível “concedê-lo”. O debate, nesse caso, é esperado, uma vez que não se trata apenas de divergências de cunho teórico-metodológicas, mas, sobretudo, de ordem política, o que implica em perspectivas bastante distintas, senão conflitantes, na abordagem do problema.

Contemporaneamente, Baquero (2012, p. 175-176) menciona que o empoderamento se expressa nas lutas pelos direitos civis, no movimento feminista e na ideologia da “ação social”, presentes nas sociedades dos países desenvolvidos, na segunda metade do século XX. Nos anos 1970, esse conceito é influenciado pelos movimentos de autoajuda e, nos 1980, pela psicologia comunitária. Na década de 1990, recebe o influxo de movimentos que buscam afirmar o direito da cidadania sobre distintas esferas da vida social, entre as quais a prática médica, a educação em saúde, a política, a justiça e a ação comunitária.

Perfilhando esta compreensão, Schmidt (2006, p. 1774) destaca que o empoderamento se expressa pelo senso de que é possível derrubar as “muralhas”. No seu alcance mais amplo, resulta na criação das condições psicoculturais que habilitam os indivíduos à conquista dos direitos de cidadania. A participação popular nas decisões que os afetam, incluindo a esfera política, é o meio por excelência do processo de empoderamento das comunidades. Ao participarem dos processos decisórios, os cidadãos tornam-se protagonistas da sua própria história, deixam de ser objetos das iniciativas de outros e tornam-se sujeitos do seu futuro.

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<sup>1</sup> Segundo Stromquist (1997, p. 95), os parâmetros do empoderamento são: construção de uma autoimagem e confiança positiva; desenvolvimento da habilidade para pensar criticamente; a construção da coesão de grupo; a promoção da tomada de decisões; e, a ação.

É exatamente aqui que se coloca o momento do empoderamento: a “tomada de consciência” confere determinado poder às pessoas (e grupos), gerado a partir dos próprios sujeitos-agentes, por um lado. Ele não é outorgado, pelo contrário, é resultado de uma *práxis* de reflexão e de inserção crítica dos indivíduos, provocadas pelos problemas ou pelas perguntas problematizadoras, que os colocam em ação. Em outros termos, é a reflexão consciente e prática de que o agente tem poder para decidir os rumos de sua vida por meio de ações e participações que conduzem ao protagonismo.

É relevante frisar que à proporção que o empoderamento se torna termo de uso corrente, apresenta-se como um guarda-chuva conceitual, que se presta a vários usos, por diferentes perspectivas intelectuais, políticas e de intervenção social, como alertam Horochovski e Meirelles (2007, p. 488). No contexto empregado, empoderamento traz como resultado o aprofundamento da democracia, por várias razões. Para que este signifique sujeitos e comunidades sendo protagonistas de sua própria história, são prementes o aumento da cultura e da sofisticação políticas, o adensamento do capital social e o aperfeiçoamento da democracia representativa, incluindo, em seu desenho institucional, instâncias diretas e semidiretas de participação e de deliberação.

Acompanhando tal entendimento, aduzem Santos e Lemos (2011, p. 410) que é no bojo das lutas entre estes discursos que práticas sociais são acionadas e ganham visibilidade, como no caso das concepções de empoderamento. Dito elemento se tornou uma diretriz para a formulação e a execução de políticas públicas, assim como uma prática no processo de intervenção social desenvolvida, principalmente, por organizações não governamentais e movimentos sociais. Tais grupos assumem a tarefa de fomentar a politização de outros sujeitos.

A ideia de empoderamento, para Pereira (2006), representa importante papel na mobilização social em torno de ambientes específicos, como o de desenvolvimento sustentável local orientado não só para a emergência de projetos e ações de fortalecimento de grupos sociais tradicionalmente negligenciados dos processos políticos, mas também significativo espaço institucional de articulação e emergência de novos atores envolvidos na transformação democrática da relação Estado-sociedade.

O problema central é, portanto, o da recuperação do controle por parte do cidadão, no seu bairro, na sua comunidade, sobre as formas do seu desenvolvimento, sobre a criação das dinâmicas concretas que conduzem à agradabilidade ou não da vida social, como refere Dowbor (1999, p. 10). Nesse caminho, o contexto local é justamente o espaço em que a cidadania é construída e, cada vez mais, fortalecida, pois gradativamente os sujeitos participam das decisões. No entanto, Dowbor (1999, p. 16) enfatiza que estas são tomadas muito longe do cidadão, correspondendo muito pouco às suas necessidades. Assim, a dramática centralização do poder político e econômico leva, em última instância, a um divórcio profundo entre as necessidades e o conteúdo das decisões sobre o desenvolvimento socioeconômico.

A percepção do espaço local como elemento chave está diretamente associada ao processo de democratização, em que se configura a compreensão e constituição das formas administrativas municipais e descentralizadas enquanto espaço público e institucional das políticas públicas, consoante Draibe (1990, p. 36). Também é esta a compreensão de Alcântara (2001, p. 10) quando menciona que o poder municipal é a esfera privilegiada de governo e mais próxima do cidadão, capaz, em conjunto com sua população, de equacionar e prestar serviços, conduzindo processos de articulação e entendimento entre o grupo social, promovendo o desenvolvimento em nível local.

Nesse ponto, Hermany (2007, p. 251) esclarece que Dowbor, ao definir as estratégias de articulação é enfático ao destacar a necessidade de controle social, ou seja, a cidadania ser efetivamente fator ativo do processo desenvolvimento. Entretanto, condiciona claramente a recuperação do controle social às estratégias próprias da democracia local, em função das dificuldades constatadas nos demais cenários.

Quando os sujeitos tornam-se partícipes na (re)construção de uma nova sociedade, promulgam a sua emancipação social local – através do empoderamento e da cidadania ativa – gerando em seus membros um sentimento de pertencimento e reconhecimento das necessidades humanas e básicas suas e do outro, em consonância com a visão de Hermany e Costa (2009, p. 31-33). Como resultado, pode-se entender que o empoderamento social local está vinculado ao capital social, não sendo, contudo sinônimos, já que este é um dos catalisadores passíveis de interagir na construção de um maior empoderamento social.

O empoderamento, ainda segundo os referidos autores (2009, p. 30-32), como mecanismo de “autopoder” capaz de influenciar as decisões que afetam diretamente os indivíduos, é indispensável dentro de uma política pública que busque a emancipação social local, em uma atuação horizontalizada em rede, como é o caso das políticas públicas do Orçamento Participativo e da Governança Solidária Local. Afinal, em ambientes em que haja dirigismos coativos, não haverá a devida expressão da vontade dos atores sociais que compõem o tecido formativo das redes sociais. Esta participação efetiva na construção de maior vínculo associativo capacita os sujeitos para que, de modo seguro e autônomo, possam estabelecer conexões em redes sociais. Redes com relacionamentos eivados de ideários democráticos, participativo e de cidadania ativa.

Empoderar, aqui, então, significa conquista de espaço, vez e voz, por sujeitos, organizações e comunidades, de modo que estes tenham elevados níveis de informação, esclarecimento, autonomia e capacidade de fazer suas próprias escolhas sociais, culturais, políticas e econômicas. À medida que se conscientizam, vão se tornando, paulatinamente, mais empoderados e isso se reflete em maior participação política e cidadã. Pode-se inferir, portanto, que o empoderamento social é sim uma ferramenta que torna funcionais transformações na própria afirmação identitária enquanto sujeito social igual potencializado pela participação em ambiências locais.

#### **4. Potencializando a condição de sujeito mediante a cidadania ativa**

A partir das bases democráticas, pode-se inferir que a cidadania é mais do que vindicar direitos, é, efetivamente, salvaguardá-los, não podendo ser resumida apenas ao conjunto de direitos sociais, políticos, civis e culturais, mas também à possibilidade de utilizá-los como ferramentas para potencializar a condição de cidadãos. Nessa direção, a cidadania é, pois, um meio de instrumentalizar a efetivação dos direitos já garantidos e os que ainda serão conquistados. É uma aspiração nobre com uma longa história. Embora tome diferentes formas em inúmeros lugares, é frequentemente reivindicada como um ideal universal de contemporaneidade, conforme explica Walby (2004, p. 169). Necessário enfatizar, de antemão, que democracia, cidadania e direitos estão sempre em processo de construção.

A concepção de cidadania remonta à Aristóteles, para quem o homem é, por natureza, um animal político e a cidade é um fato da natureza. Cidadão é, portanto, aquele que usufruiu os direitos e cumpriu os deveres definidos pelas leis e costumes da cidade. Ela é, antes de mais nada, o resultado de uma

integração social, de modo que “civilizar” significa, em primeiro lugar, tornar cidadão. Para os gregos, então, o ser político significava que tudo era decidido mediante palavras e persuasão, e não pela força ou violência. Assim, a cidadania relacionava-se com o surgimento da vida na cidade e com a capacidade de os homens exercerem direitos e deveres de cidadãos. Mais recentemente, um dos marcos teóricos para a ressignificação da ideia de cidadania grega é a conceituação estabelecida por Marshall (1950), para quem os direitos sociais desempenhavam papel primordial na minimização da tensão entre capital e cidadania, e a possibilidade de que a igualdade de *status* pudesse sobrepujar as desigualdades materiais de classe social.

Embasado na premissa de que não há cidadania sem a consciência de filiação a uma coletividade política, Touraine (1996, p. 30) ressalta que a cidadania fundamenta o direito de participar, direta ou indiretamente, na gestão da sociedade. Todos os grupos subalternizados socialmente empreenderam lutas para assegurar seus direitos, o que demonstra que a cidadania não é apenas um conjunto formal de direitos e deveres, mas a prática cotidiana para garanti-los e vivenciá-los. Razão pela qual a ideia de cidadania é de tal modo indispensável para o pensamento democrático: baseia-se na separação entre sociedade civil e sociedade política, garante os direitos jurídicos e políticos de todos os cidadãos, seja qual for a sua origem social, religiosa ou étnica.

Sob tal enfoque e conforme Silva e Silva (2005, p. 47), a cidadania é, sobretudo, uma ação política construída, paulatinamente, por homens e mulheres para a transformação de uma realidade específica, pela ampliação de direitos e deveres comuns. Assim, negros, indígenas, mulheres, imigrantes, grupos étnicos e nacionais, homossexuais e excluídos de modo geral são atores que vivem fazendo a cidadania acontecer a cada embate. Por conseguinte, o conceito de cidadania envolve um leque amplo de direitos, sendo extremamente complexo chegar-se a uma significação única, pois tanto a cidadania como os direitos estão sempre em processo de construção e de transformação<sup>2</sup>, de acordo com o que assinala Santos (2000, p. 311).

Analisando nesse aspecto, Vieira (2001, p. 224-225) constata que não há cidadania sem participação nas decisões políticas e sem solidariedade entre seus membros. Ora, participação e solidariedade são dois elementos que estão sendo enfraquecidos, mas há novas formas de ativismo e militância política. Verifica-se, dessa maneira, que a cidadania pode ser compreendida sob vários ângulos, de acordo com as condições históricas, jurídicas, econômicas, sociais e culturais, englobando em seu conceito elementos de diversos matizes ideológicos, surgidos no decorrer da história. Logo, não existe um conceito correto de cidadania, mas sim uma teorização que melhor se coaduna com as ideologias, objetivos e interesses de quem o usa, apresentando apenas contornos gerais comuns, na elucidação de Silva (2009, p. 45).

É por tais fundamentos que ainda se luta para efetivar, sobejamente, a cidadania ativa. Com suporte nestas premissas, Vieira (2001, 121) é enfático ao assegurar que o Estado deve certamente não só garantir a igualdade de oportunidades aos diferentes projetos de institucionalidade democrática, mas deve também

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<sup>2</sup> Hoje, a noção de cidadania envolve, em geral, três sentidos: a cidadania é um estatuto (um conjunto de direitos e deveres); é também uma identidade (um sentimento de pertencer a uma comunidade política definida pela nacionalidade e por um determinado território); e, finalmente, é uma prática exercida pela representação e pela participação políticas – estas últimas traduzem a capacidade do indivíduo para interferir no espaço público emitindo um julgamento crítico sobre as escolhas da sociedade e reclamando o direito de ter direitos, como refere Marques-Pereira (2009, p. 36).

assegurar padrões mínimos de inclusão, possibilitando que a cidadania ative na criação, acompanhamento e avaliação de políticas públicas e projetos de governo. Uma sociedade plural e multicultural só pode manter-se unida se houver o exercício da cidadania democrática de forma ampla e efetiva.

A cidadania, na ótica de Leal (2006, p. 13), passa pela responsabilidade social e pela conscientização da qualidade de cidadão gestor. A novidade, portanto, da qual brota o paradigma da responsabilidade social é a emergência deste novo ator social que é o cidadão consciente, comprometido com a sobrevivência e o bem-viver de si próprio, de sua família, de sua comunidade e do planeta, voltado para as grandes causas públicas com que se debate a humanidade neste período de transição.

Dito cidadão gestor que exerce atividades públicas em sua comunidade, rompendo com a velha dicotomia entre Estado e mercado, e conclamando a todos para assumirem responsabilidades pelo destino comum que une, é a essência da concepção e da prática de governança solidária local. É ele que convoca a todos para exercerem sua responsabilidade social, criarem ambientes participativos e solidários, ao constituírem redes sociais de cooperação voltadas para a melhoria de vida e convivência entre os humanos em sua comunidade, consoante este autor (2006, p. 15).

Tal fato decorre da assertiva de que, se as pessoas sabem que existem oportunidades para participação efetiva no processo de tomada de decisões, elas acreditarão que a participação vale a pena. Sendo assim, provavelmente participarão ativamente e provavelmente considerarão que as decisões coletivas devem ser obedecidas, tudo isto dependendo, é claro, de condições objetivas e subjetivas viabilizadoras da participação, como ressalta Leal (2008, p. 194).

Tais manifestações comprovam que a cidadania é um elemento determinante na conjuntura social. É por isso que, na abordagem aqui realizada, utiliza-se como sustentáculo a conceitualização trazida por Touraine (1992, p. 881), segundo a qual o conteúdo da cidadania, em seu significado mais geral, correlaciona-se com a consciência de pertencer à sociedade, com a capacidade do indivíduo de se sentir responsável pelo bom funcionamento das instituições e com a obrigação destas em respeitar os direitos dos sujeitos. Infere-se, pois, que a cidadania ativa se configura em efetiva estratégia para potencializar a condição de cidadãos.

## **5. Considerações finais**

Alicerçando-se nos cânones democráticos, é possível compreender que para ocorrer um verdadeiro avanço social em termos qualitativos, mostra-se essencial que na inter-relação com os indivíduos, o princípio da subsidiariedade se faça presente. É com a efetivação da subsidiariedade que se pode constituir um ambiente local não atomizado, à medida que vão sendo eliminadas as oligarquias locais que ainda fazem parte de determinados contextos mesmo na contemporaneidade.

Ao ampliar o espaço de articulação comunicativa, reabrindo estes canais de comunicação, estar-se-á fomentando, substancialmente, espaços de compromissos efetivos com os cidadãos, operacionalizando a subsidiariedade horizontalizada. Nesse sentido é que se pode reconstruir uma conjuntura mais relacional e dialógica entre as ambiências públicas estatais e a sociedade civil. A partir desta integração, é que se pode articular políticas públicas que tornem efetivos os direitos fundamentais, já que se promove o poder

local aproximando os indivíduos da tomada de decisões.

Sob esta perspectiva, o poder local e o empoderamento social são instrumentalizados pela condição de cidadãos, de identidade coletiva, de pertencimento a uma comunidade aglutinadora. A cidadania, então, se constitui em um elemento crucial na direção de viabilizar o equilíbrio público-privado. É neste contexto que ocorre a articulação do poder local enquanto um campo privilegiado capaz de propiciar o fortalecimento desta condição de sujeito-cidadão.

Ilações tais demonstraram que para que haja, sobejamente, o exercício da cidadania, é mister engendrar o processo de empoderamento, que consiste em um fenômeno autonomizador, emancipatório e politizador. Como corolário, verifica-se que os mecanismos que catalisam a concretização do empoderamento social são a cidadania e a participação ativa. Depreende-se, portanto, que as reformulações da subsidiariedade perpassam, sobremaneira, pelo novo sentido de se repensar a intersecção entre espaço local, empoderamento, participação e cidadania.

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# **The Relevance of Information Security Policy in the Logical Part of the Company**

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## **Abstract**

*The objective of this research is to analyze the relevance of the information security policy in the logical part of the company. It will be used data obtained from research conducted within various companies, which demonstrate the level of knowledge of employees and some wrong measures they taken which ended up harming the company. It will be possible to check not only the weight that an information policy has within any economic sector, but also to point out which areas of the company are most prone to data loss/theft. One of the most valuable assets in any business, is information, that is, data that is generated through trades made, revenue generated, productivity, etc., and however small the information seems, to the market it can be extremely relevant and the leakage of this information, due to a failure or lack of security, can lead to the bankruptcy of a company.*

**Keywords:** Information Security Policy, Information Security Management, Data Loss;

## **1. Introduction**

The information security policy (PSI) is of significant importance within companies, no matter what economic sector it is in, as well-enforced, can prevent and prevent data loss and / or theft, which without them companies can simply let go. to exist.

According to ISO / IEC 17799 information is considered an asset (it comprises the organization's Assets and Rights set, having economic values and can be converted into money), i.e. it is of vital importance for the survival of corporations.

Over the years, a dependency on technology and information systems has emerged, and along with that dependency has come data vulnerability, creating a need to protect the corporation's knowledge and information.

Even with the rise of hackers, viruses, and other existing media that are used to harm companies / corporations, few companies in Brazil are concerned about information security, and many do not even know the relevance of data from A company has.

Thus, the purpose of this article is to demonstrate the relevance that the Information Security Policy (PSI) has in the logical part of a company.

## **2. Methodology**

In the methodology were used bibliographical research such as, Information Security Policy, Information Security, The Importance of Information for Business, Damages in the Lack of Data Protection and Data Trafficking, this content will be extracted from articles, magazines, books, sites and study of ISOS.

We conducted bibliographic searches of ISOS regarding information security.

A quantitative survey was conducted, which consists of a questionnaire that must be completed by users of various companies, who consume a high number of information.

A PSI suggestion has been elaborated according to the best ISOS topics listed in this article.

## **3. Security Policy (PSI)**

Information Security Policy (PSI) is a document that should contain a set of standards, methods and procedures, which should be communicated to all employees, as well as reviewed and critically reviewed at regular intervals or when changes become necessary. It is the ISMS that will ensure the viability and use of assets only by authorized persons who really need them to perform their duties within the company. (SOURCES, 2008).

It is increasingly important for an organization, even in its early stages, to formalize a document with its risk analysis, which provides top management with an indicator of the company's own future, in which assets that will be protected with investments will be listed. appropriate to their value at their risk (LAUREANO, 2005).

“Despite all care in defining security perimeters, this action will not produce positive results if employees are not in tune with the information security culture. This culture should be dispersed throughout the organization and especially consolidated within critical security areas. Information relevant to work

within these areas should be restricted to the area itself and only during the performance of activities where it becomes necessary. These activities should always be performed under supervision to ensure safety. When there is activity, these areas must remain validly closed, such as through the use of security seals, and regularly supervised (Campos, 2077, p.169) ”.

#### 4. Information Security

One of the most valuable assets in any business is information, that is, data that is generated through negotiations, revenue generated, customer registration, price formation, productivity, finance, etc.

As small and insignificant as information may seem to the market, it can be extremely relevant and the leakage of that information, due to a failure or lack of information security, can lead to the bankruptcy of a company.

Information security is made up of three pillars, confidentiality, integrity and availability.

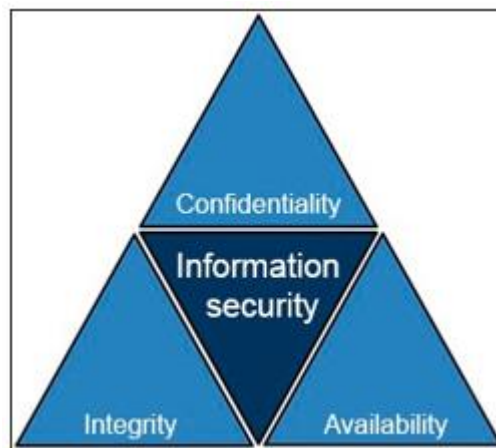


Figure 1: 3 Pillars.

Source: ISO27001: 2013

As shown in Figure 1, confidentiality is one of the three pillars of information security, which is the guarantee that information will only be accessed by authorized persons, preventing documents from being available to everyone.

If access by an improper person occurs, even if unintentional, it may cause future problems.

The second pillar is integrity that ensures that information will not be modified or corrupted by third parties for the purpose of no data divergence. An example of a breach of integrity would be to change values in a seller's commission to a nonexistent higher value.

Availability, which is the third pillar, ensures that this same information is available to all users at any time without interruption. Maintaining the availability of information ensures continuous work on data provision.

#### 5. The Importance of Information for the Company

The information is of paramount importance in an organization, because it is through it that the decision will be made, because without information would not have as the company conducts surveys, statistics

and improvements that will contribute to its growth. For OLIVEIRA (1992), information helps in the decision making process, because when properly structured is of crucial importance to the company, it associates the various subsystems and enables the company to postulate its objectives.

In the past, information was stored in a variety of ways: as in papers, archives, in the mind of a trusted employee or business owner, in large filing cabinets in folders and boxes. Today the information has gained so much value that it needs to be safely stored, because it will often depend on the useful life of the organization.

So, to have a protection, it would be necessary to have information security, with procedures, rules and standards that would have to be obeyed by all who represent the organization. This way the company will have great results by keeping the organization and its operation in perfect order and its successful business. For, one cannot have information as an end product, but the starting point that will lead to decision-making processing.

## 6. Loss in Lack of Protection of Information

The lack of an information security policy or its misapplication has serious consequences in both the business and even the world scenario. An example that demonstrates these consequences and the value an information has is the case of ransomware, which occurred in 2017 where 74 countries were invaded by this rogue software.

This malware acts as follows: it can first enter a corporate network disguised as a Word document and exploit networks that are misconfigured and have weak passwords, after gaining access it seeks valuable information for the corporation as a database of an ERP and kidnap it.



Figure 2 - Ransomware cycle.

Source: Analysis Informatic (2019).

With the encrypted database the company loses all information of years, customer registration, accounts receivable, accounts payable and etc. So there is no alternative but to pay the ransom to get the data back, the payment is charged in cryptocurrencies where it is impossible to track the fate of money and the values vary a lot, but they are always high and yet the company has no guarantee that you will get your files again after payment of the ransom.

## 7. Information Trafficking

According to the UN, in 2018 more than half of the world's population currently uses the Internet, which is equivalent to almost 4 billion people, in developing countries they are 45% of the population while in developed countries more than 80% of people.

Hootsuite surveyed the number of people using social networks and reached the following numbers: 3.1 billion (42%) people are active users of social networks, 2.9 billion (39%) use social networks via smartphones. In Brazil alone, over 96% of internet users are on some social network according to Social Media Trends.

Do you know that cell phone that was researched the price on the Internet and then began to see these same products on all sites that visited in the form of advertising? Cookies are to blame for this happening, they are files created by the browser for every website the user visits and can be used by hackers for web scam applications.

Policy writers in an organization will need to choose appropriate policies based on their companies' environment and business objectives. Each organization, with its different security requirements, based on the needs, legal requirements, organizational culture, and information systems used, will establish the policies presented and omit the rest. You also need to make choices about the rigidity of policies in each category. A smaller company located in a single facility where most employees know each other need not be too concerned that the attacker calls and impersonates an employee (although, of course, an impostor may impersonate a vendor). Similarly, despite the greater risks, a structured company with a more liberal and loose corporate culture may want to adopt only a limited subset of the recommended policies to meet its security objectives.

Facebook is currently involved in some scandals involving the sale of data from social network users, one of the accusations being the sale of data to Cambridge Analytica, which is a data analytics company for political campaigns, and has provided service to the campaign team. current President of the United States Donald Trump in 2016. According to the New York Times, the company had access to data from more than 50 million Facebook users, it happened even though Facebook itself was against and forbid the sale and sale of this data.

## 8. Iso Technical Standards

### 8.1. ISO / IEC 27001

ISO / IEC 27001 is a standard that establishes the premises for an Information Security Management System (SGSI).

In accordance with ISO / IEC 27001 the main requirements are:

- Organizations should establish, implement, operate, monitor, critically analyze, maintain and improve a documented Information Security Management System (ISMS) within the context of the organization's global business activities and the risks it faces.
- Select controls within the process of implementing an ISO / IEC 27001 based ISMS;
- Implement commonly approved information security controls.
- Develop their own information security management guidelines.

## 8.2. ISO / IEC 27005

ISO / IEC 27005 provides information security risk management instructions, including guidance on risk assessment, risk treatment, risk acceptance, risk communication, monitoring, and critical risk analysis. Controls may be selected from this standard or other sets of controls, or new controls may be designed to meet specific needs as appropriate.

The standard defines the assessment, considering the likelihood of the threat and ease of fragility of controls and prioritizing actions over risks, considering impacts.

## 9. Questionnaire Analysis

1 - To access the computer of your work you need to enter a password?  
If so, how often do you usually change your password?

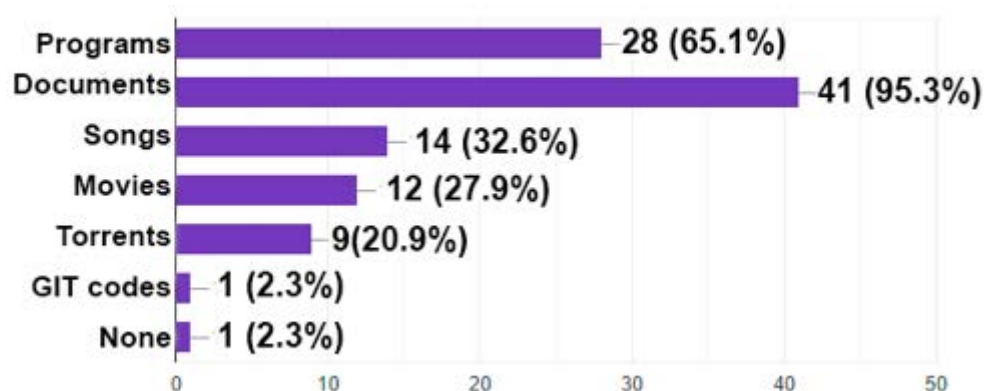


Graph 1 - Information security - exchange - 2019

SOURCE: Own questionnaire development on google platform Forms, based on responses from users of organizations in general.

According to graph 1, it was found that there is still a high number of approximately 50% of users which leaves the organization information vulnerable, where 27.9% never changed the password of the computer they work in and 20.9% It does not require a password to access the company's computer, having vulnerability and giving the visibility of information to unauthorized persons having irregular definitions as to the confidentiality of information access in accordance with ISO / IEC 27002: 2005.

2 - What types of files can you download using your work computer?



Graphic 2 - Information Security

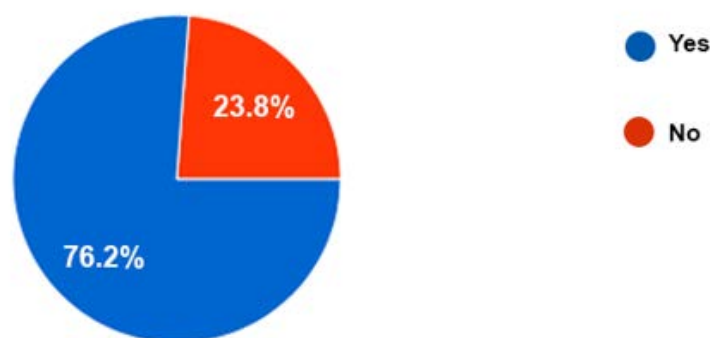
SOURCE: Own elaboration of questionnaires in google forms platform, from answers of users of



organizations in general, 2019.

According to graph 2, a high number of 65.1% can be seen where the user can download any type of program opening a range for various threats, according to ISO / IEC 17799: 2005 the threats related to security. information, are increasingly frequent, ambitious and sophisticated, and may therefore cause greater damage to organizations that do not have an adequate security policy such as a filter to download which may bring infiltrated hosts.

3 - Does the computer you use for your work support Pen drive?

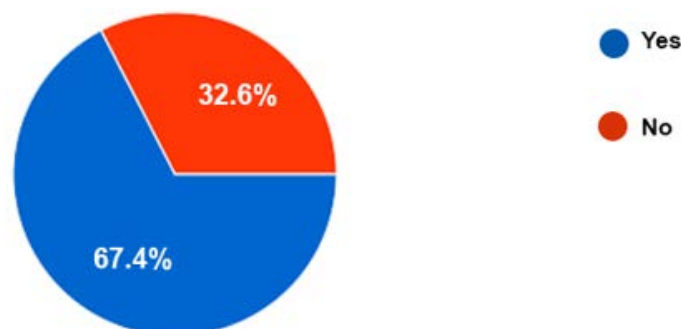


Graph 3 - Information Security - Pen drives - 2019.

SOURCE: Self-made questionnaires on google platform forms, based on responses from users of organizations in general.

The visualization in graph 3 is clear as to the danger it applies to about 76.2% of users according to the graph showing authorization to insert pen drivers on corporate computers, according to researchers Karsten Nohl and Jakob Lell released in G1. .com, there is a huge chance of attacks through these devices, one of them being the badUSB technique, modifying the firmware of a USB to malicious achievements.

4 - To access the internet at your place of work is it necessary to enter a password?

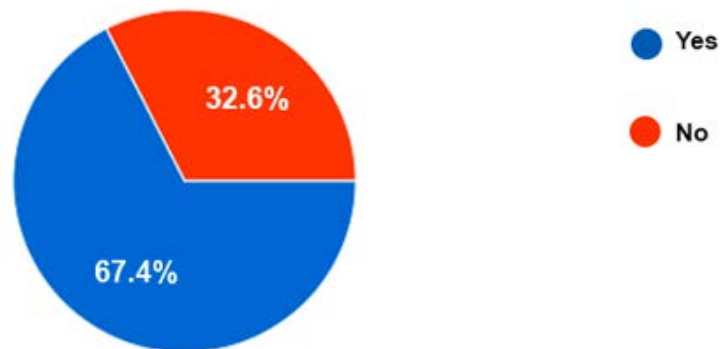


Graphic 4 - Information Security - Internet Passwords - 2019

SOURCE: Own survey on google platform forms, based on responses from users of organizations in general.

According to Graph 4, we have 67.45% of users who do not need to enter a password to access the internet, so any unauthorized person can have access to information and data on the company's internal network.

5 - Can you use company wifi on your Smartphone?

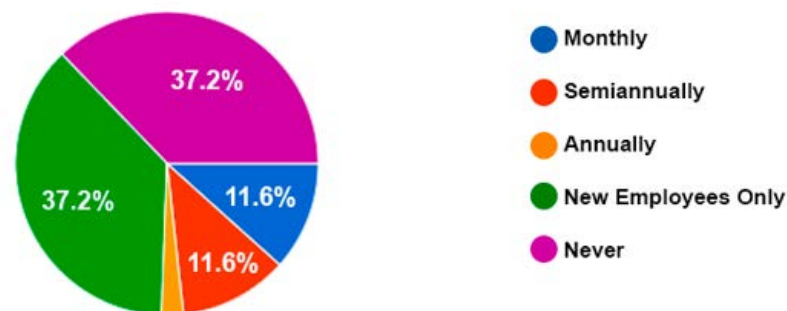


Graph 5 - Information Security - Enterprise Wi-Fi - 2019.

SOURCE: Own survey on google platform forms, based on responses from users of organizations in general.

According to Graph 5, it is observed that 67.4% of users interviewed use the company's WI-FI without any kind of restriction or network divisions, so there may be data hijacking, confidential and important in the organization. One of the requirements of ISO / IEC 27001 is that the organization must carry out information security risk assessments, implementing a risk management plan.

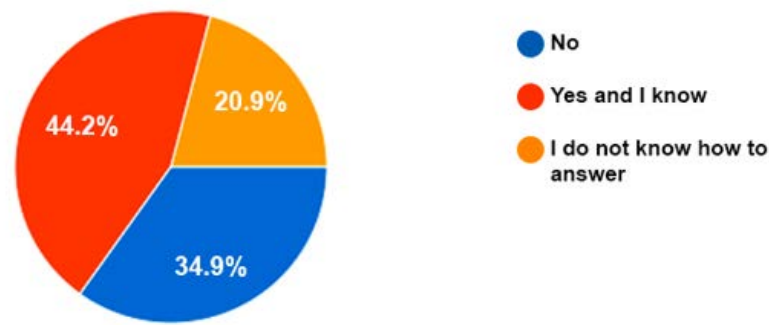
6 - How often does your company conduct training, information security instructions, or good practices for using systems or the Internet?



Graph 6 - Information Security - Training and Good practices - 2019. SOURCE: Own questionnaire elaboration in the google forms platform, based on responses from users of organizations in general.

According to graph 6, it is noted that 37.2% never had the user trained or received any kind of training for the handling of corporate equipment. According to ISO / IEC 27002: 2013, information security management requires at least the participation of all employees in the organization so that users can understand how to proceed with any given data.

7 - Is there an information security policy for your company?



Graph 7 - Information Security - PSI - 2019.

SOURCE: Own survey on google platform forms, based on responses from users of organizations in general.

According to graph 7, by merging the two negative responses it is concluded that almost 50% do not know your company's security policy, putting at risk and exposing sensitive data. NBR ISO / IEC 17799, suggests the creation of a document entitled “information security policy document”, with management approval, making it available and disseminating to all employees, considering its relevance to the organization, should be easy. understanding by the target audience and accessible.

## 10. Administrative Guidelines and Standards

The guidelines and standards cited are based on the recommendations proposed by the standard ABNT NBR ISO / IEC 27002: 2005, recognized worldwide as a code of practice for information security management.

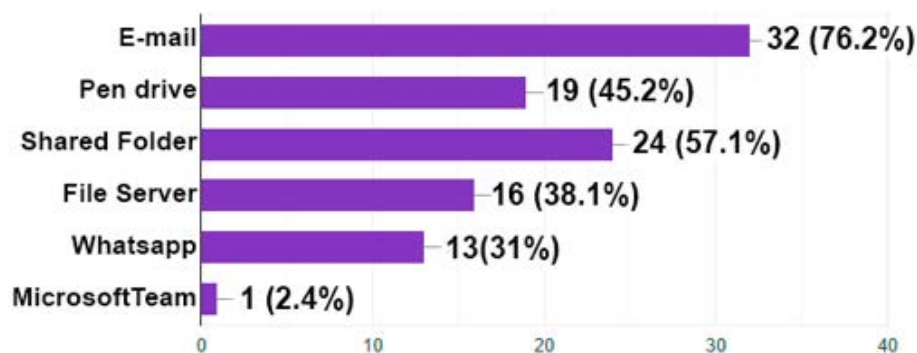
- Information technology (IT) officers within the company can access other users' files and data, but only when needed to perform operational activities such as maintaining computers, making copies of security, audits, deployment / installation of systems and applications.
- Every employee must have his or her own account or device to access computers, systems, databases and any other information assets, being identified by full name and social security number.
- Each employee is responsible for their login and password. Passwords are for personal and non-transferable use, and the holder is prohibited from sharing or providing them to third parties.
- Adopt a password expiration standard, i.e. program that every 30 days, for example, the user is required to renew their passwords, and cannot repeat any previously used.
- Identify the administrative and operational functions of each sector in order to restrict the powers of each user and reduce or eliminate the existence of individuals who can exclude logs and histories from their own actions.
- Inform through a formal request, which may be via email, the blocking of access for users who have been disconnected from the company or for any other situation that requires restrictive measures to safeguard the company's assets.
- For the use of private equipment such as smartphones, laptops and pen drivers, as well as access to the internet, it is necessary to have a prior authorization from the manager / director of the company.

- Deploy workstation, server, e-mail, internet network, mobile or wireless monitoring systems. Information generated by monitoring may be used to identify users and their access, as well as material manipulated.
- Create an automated backup routine at set intervals according to the generation and flow of business data.
- The storage of this information must be in geographically distinct locations, because if something happens with the main backup has the "reserve".
- Always administer, protect and test the integrity of copies.
- Backups should be performed, preferably, before or after business hours, as the system can be slow, impairing the operation of the company.
- Use of corporate email is for work-related activities only and may not be used for personal purposes, or as a sign-up for commercial websites, social networks or any other platform for particular interests.
- Work information cannot be transmitted using personal emails.

## 11. Conclusion

In the data collected it was found that basic security procedures are not respected, as shown in graph 11, which asks what are the file sharing methods within the corporation, and the second most used method, representing 45.2% was the pen drive for information exchange. Using USB storage devices, such as a USB flash drive, poses a significant risk and can aggravate problems not only with information loss, but with information leakage and virus spread between corporate stations.

8 - How do you share files with your coworkers?



Graphic 8 - Share Files - PSI - 2019.

SOURCE: Own survey on google platform forms, based on responses from users of organizations in general.

According to graph 9 (topic 3.3) most of the users interviewed have had their work hampered by loss of document, and almost 50% lost their files due to viruses.

A company with a well-deployed PSI becomes a safer environment and reduces the risk of being infected with viruses, and if so, there will still be a data backup policy where a secure copy of company documents will be stored.

Given these facts, it was possible to highlight the relevance that information security policies have for the

proper functioning of companies. In addition, research has shown that security and / or concern for company data is not yet considered a priority and that a lack of knowledge of the importance and value that information carries with it interferes with the company's future.

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# **Introduction of Basic Computer Programming Logic in Elementary and High Schools Using Logic Block**

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## **Abstract**

*This document analyzes factors that make it difficult for computational programming logic to consolidate itself as a subject to be taught in schools and how to introduce it into the academic environment through a hypothetical curriculum based on studies and also including the logical block programming language, Scratch. Studies are conducted to create the basis of an experimental school grade. Said grade describes in detail the age groups it will reach and what knowledge will be taught to them. With a better understanding of programming and programming logic in mind, not only individuals who choose to work in the field will already have a larger knowledge base than today, but people who*

*choose not to work in the field of computer technology will benefit of a more logical and cohesive line of reasoning.*

**Keywords:** Computational programming logic; Elementary and high schools; Experimental curriculum; Logic block programming language; Line of reasoning.

## 1. Introduction

Computers and technology everywhere in today's world, a very visible fact, and quite obvious in recent decades since the breakthroughs of technology initiated by the World War II technology race and, later, the Cold War space race, the later presenting mankind with great achievements, ranging from wireless (Wi-Fi) connection to the countless orbiting satellites of our planet. Ironically, even with its obvious importance to today's highly technological world, the area of programming is still obscure and relatively far from the reach of younger minds, specifically high school students, ie individuals that are choosing the path they want to take in the job market, leaving the programming area to be discovered by the most curious minds and taught by online portals and forums.

Simplified programming teaching is far from a recent topic: In 1968, Wally Feurzeig, Seymour Papert, and Cynthia Solomon created the programming language known as Logo, which is entirely devoted to education, famous for its use of a cartoon figure of a turtle, where users enter commands to move said turtle around the screen, being quite simple and accessible to almost every type of user, and even with such simplicity, it is still considered as a sophisticated language (PRADO, 2000).

Not only there are tools to learn from, most of the public approves the teaching of programming to the younger generation, as an example, former US President Barack Obama commented about his support programming in schools because, in addition to being important to everyone's future in general, it is important to the country's future (referring to the United States), and adds: "Don't just buy a video game, make one. Not only download the latest app, help develop it. Don't just play on your phone, schedule it!"(OBAMA, 2013). As we can see, there is certainly fresh soil for programming on the educational fields, with public's support and many tools to use, but sadly, from a realistic point of view, it's "easier said than done".

Recently, in 2018, a study performed by Code.org Advocacy Coalition and the Computer Science Teachers Association (CSTA), collected data from the United States of America's progress towards the implementation of Computer Science on high schools, the result being slightly worrying.

Table 1: Public High Schools Teaching Computer Science (CS): Overall, by Community, by Underrepresented Minority, by Free and Reduced Lunch

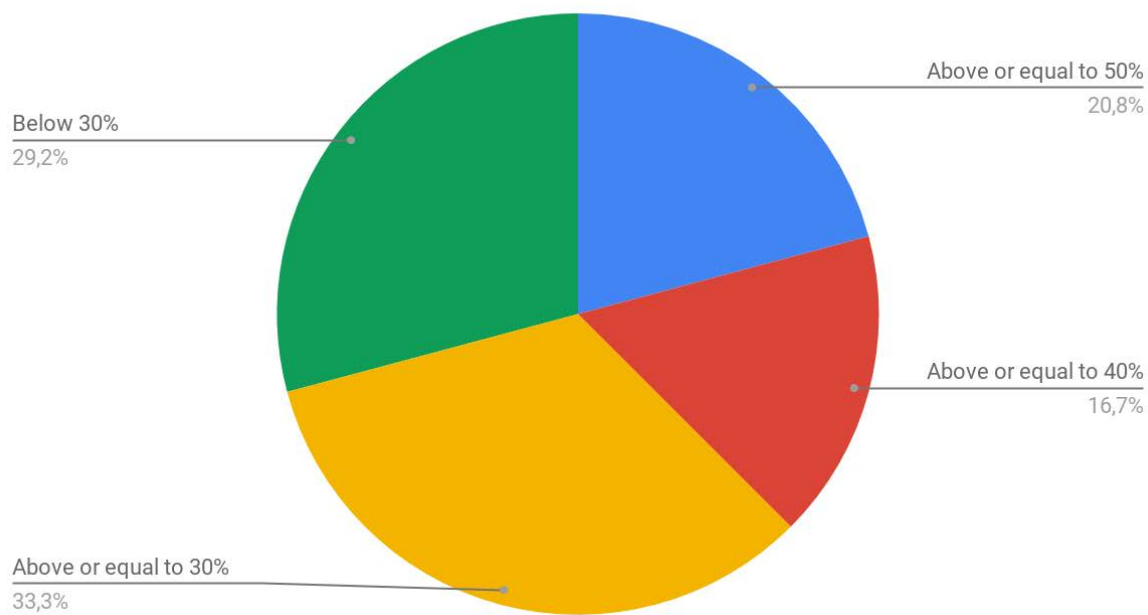
State	Overall Implementation	By Community Type		By Percent Underrepresented Minorities		By Percent Free and Reduced Lunch	
	Percent Teaching CS	Urban	Rural	Under 50% URM	Over 50% URM	Under 50% FRL	Over 50% FRL
Alabama	27%	49%	32%	38%	42%	57%	30%
Arkansas	65%	67%	68%	69%	61%	67%	68%
California	32%	35%	28%	44%	31%	48%	30%
Florida	19%	23%	15%	24%	21%	22%	23%
Georgia	49%	47%	45%	58%	42%	79%	39%
Indiana	51%	56%	50%	55%	49%	58%	46%
Iowa	45%	53%	42%	47%	56%	49%	38%
Kansas	23%	38%	14%	22%	38%	26%	18%
Kentucky	33%	34%	35%	35%	33%	46%	30%
Louisiana	16%	19%	9%	18%	14%	31%	10%
Massachusetts	49%	51%	41%	55%	36%	59%	35%
Mississippi	18%	24%	29%	34%	21%	39%	26%
Missouri	30%	37%	26%	33%	40%	41%	27%
Montana	40%	57%	37%	43%	22%	46%	27%
New York	34%	33%	29%	42%	26%	44%	27%
North Carolina	39%	40%	37%	42%	35%	48%	30%
North Dakota	22%	43%	18%	24%	8%	24%	14%
Oklahoma	24%	34%	18%	23%	29%	27%	23%
Oregon	30%	35%	20%	33%	22%	41%	26%
Rhode Island	78%	76%	88%	76%	81%	81%	76%
South Carolina	39%	47%	40%	51%	35%	56%	36%
Utah	54%	58%	39%	58%	35%	59%	45%
Virginia	59%	66%	53%	65%	51%	65%	52%
Wisconsin	32%	37%	30%	37%	21%	40%	23%

Source: Code.org, 2018 State of Computer Science Education. (2018).

The graphic above represents the data collected from almost all high schools from 24 north american states, and worrying results set in, as it becomes clear that the amount of high schools that do teach computer science barely reaches 50% on most states



### Percentage of high schools teaching computer science



Graphic 1: Percentage of high schools teaching computer science, based on table 1.

Source: Made by author, data from Table 1.

On Graphic 1, made for simplicity's sake, shows that barely  $\frac{1}{4}$  of the north american states on the study conducted by Code.org have more than 50% of their high schools teaching computer sciences on site, and while only half of the north american states were studied, this data can picture that, while general public certainly has approved the idea, as said before, "it's easier said than done".

## 2. Methodology

In the study conducted, apart from general concepts and arguments taken from a variety of sources, concepts and bases were acquired from the current "experiment" carried out in the United Kingdom, which imposes programming as a compulsory subject in schools, and the appropriate academic grid that it applies. In order to meet the need for a block language that is intuitive and easily accessible and easy to use, it's used the tool widely used in teaching programming in the pedagogical environment called Scratch.

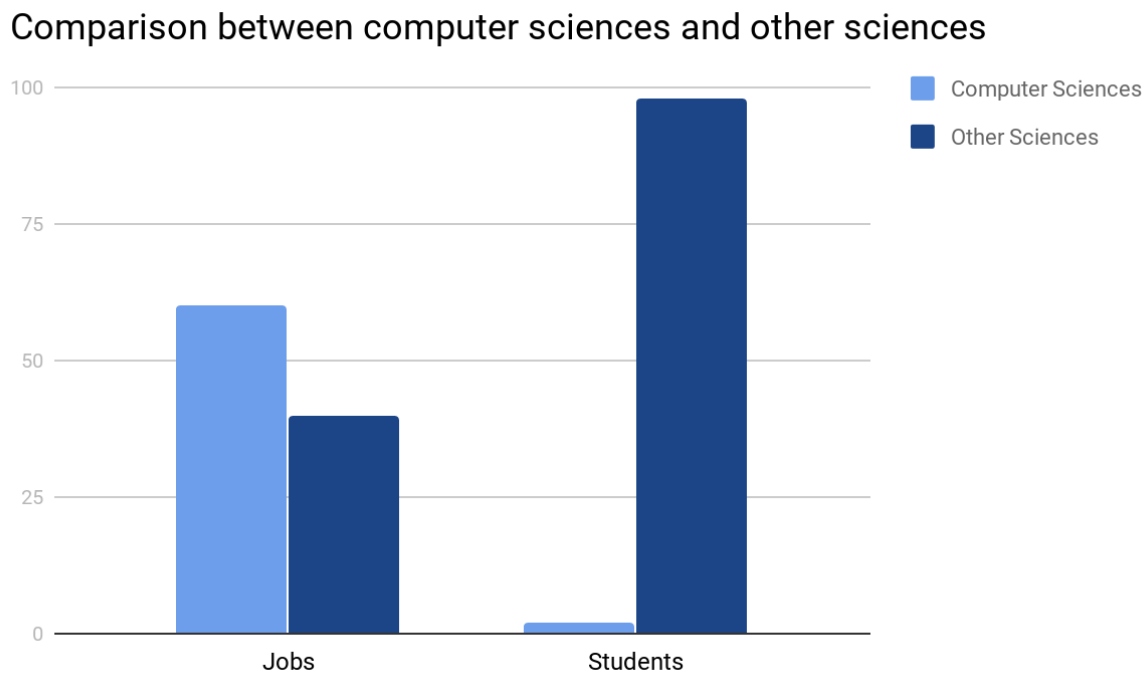
## 3. Development

### 3.1 Theoretical Reference

#### 3.1.1 Why Teach?

It is of popular knowledge that today's society has computational technology as an extremely important base, not only for entertainment, but also for economic and social purposes. In view of this, the labor market has expanded according to the technological evolutions of recent decades, opening up countless opportunities for those interested in the area, while obscuring them for those who were not even aware of

such opportunities.



Graphic 2: Comparison between Computer sciences and other sciences on the professional market.

Source: Made by Author, based on code.org's data.

In 2016, the famous social network LinkedIn posted on its blog a list of “10 skills you will be hired for in 2017”, citing data and cloud computing as dominant on the list, as well as statistical analysis and data mining, which are in high demand for being cutting-edge technology skills, with contractors having a need to have employees with such skills to stay in the market competition (IGNATOVA, 2016), reinforcing the point that failing to present the computing world as a school subject results in a huge shortage of skilled professionals in the field of work, simply because no one has ever received encouragement or even knowledge of the field and its possibilities.

In addition to the financial benefits that come with teaching computer science, teaching concepts of computer programming logic would greatly benefit individuals with a more logical and cohesive line of thinking, even if they choose to work in other areas of the labor market.

A point to be emphasized would be, as mentioned earlier, the greater support and interest that has been developing in the public for programming, providing the teaching of programming logic with greater acceptance by the masses both students and their parents. In 2004, Thai students offered programming classes to 81 students from 3 elementary schools, featuring 3 different software over a 2-week period. At the end of the experiment, it was found that 43 of the parents (78.18%) support teaching programming languages in schools, while 50 parents (90.9%) said their children spent more than an hour working on programming activities at home, and some kids spent even whole afternoons trying to add more sophisticated features and aspects to their programs. (LIN, et al 2004).

Finally, one of the most important aspects of today's software would be ease of use. We are all familiar with the classic black screen with white or green letters, where the programmer enters each command line

individually without any indication of what will or will not happen, this classic stereotype reinforced by movies and TV is no longer as realistic as you might think. With the many advancements and upgrades that today's software introduces, many already have intuitive, easily accessible interfaces, informing the user of bugs, misused components, missing packages, going so far as to even introduce interface building to the program being developed automatically, requiring only screen assembly by dragging and placing components with the mouse while the software itself takes care of the coding process.

### ***3.1.2 How to Teach the Teacher?***

The most obvious question in this equation is the first step in the great transition presented by the proposal, it should be clear that the teacher is not there, initially at least, to teach and explain lines of codes and how they work, the main point should be to teach kids programming logic, as in, teaching them how to think in a most logical and cohesive way, usually common to professionals of the computational area. In short: if a person knows the basics of programming logic, they can understand almost every programming language.

The next topic at hand is: how to prepare teachers? Let us take the following example: in 2013, the UK officially included computer programming in its curriculum, serving as a “guinea pig” in an ambitious experiment to introduce public elementary and high school youth to programming, and even before the experiment came into play. One of the biggest problems was already under consideration: how to teach teachers how to teach programming, which led the British government to raise about 1.1 million euros in December 2013 for the teaching of primary school teachers, and about 500,000 euros in 2014 to attract business to help train teachers (DREDGE, 2014). The point here is: such a monumental move obviously won't be cheap, since the teacher themselves suddenly will have a need to know how the basic concepts of programming logic, how to apply it and, most importantly/obviously, how to properly teach it to younger minds in a way that, not only the students fully grasp the nature of said way of thinking, but also that said logic can evolve along with the student along the years, ever improving and ever helping said individual to take more logical and calculated decisions.

### ***3.1.3 Teaching Programming Logic***

Obviously, trying to teach elementary school children how to program in Java or C ++ even before teaching them multiplication is not a good idea, so at this stage of school life we focus on teaching how to think logically. With that in mind, comes the question: How do you teach computer programming logic? Sophie Deen, leader of the nonprofit group known as Code Club Pro, said in an interview with pri.org that “the biggest change is teaching [computer science] to elementary school kids, [...] sounds harder than which actually is. An algorithm is a simple step-by-step instruction for solving any particular problem”, using for example a teacher named Phillip Bagge, who in turn used the procedure of “assembling” a jelly sandwich, with the teacher being the “computer”, and challenging his students to “program” him to assemble the sandwich. Deen also said that “It's actually quite easy and fun to teach algorithms to 5-year-olds, and make them start thinking that computers are stupid [...]” (WOOLF, 2014). The use of logic in general is a factor to be considered by all, not only computer professionals (MANZANO & DE OLIVEIRA, 2005), therefore, when the child realizes that one of the most important aspects

Programming is understanding how computer programming logic works and how to apply it not only in programming, but in your everyday life, this opens up the potential of the individual to learn to program in virtually any and every programming language.

With the logical line of reasoning formed in the early years of teaching the younger individual, the next step is to apply that line of reasoning practically by introducing the basic programming concepts themselves to the student, which theoretically would have no problem assimilating. Basic commands and lines of code, as well as what they do and how they affect the line of code execution, as the most basic commands (IF, WHERE, WHEN, and others), besides being self-explanatory and easy to remember, have had its aspects broken and assimilated by the previously formed line of logical thinking of students that has been constantly evolving over the years, and even with the constant social stigma that “programming is hard, left only to professionals and super intelligent people”, keep in mind that with the constant evolution of programming and the way an individual programs, in addition to creating new simpler interfaces, programming is no longer an impossible and extremely difficult thing to do as some people still think, programming becomes something simple, resulting in less effort to develop a project in all its aspects (Armstrong, et al 1996). However, even with such simplicity, prudence in such an experiment is more than advisable, so let us consider the following question: how to introduce programming for young people who already have a logical line of thought without overloading them?

### **3.1.4 Structured Language**

Also known as Structured Programming, structured language is a programming paradigm that focuses on repetition structures, subroutines, and other related factors, being the dominant paradigm in software writing for a long time, being succeeded by object-oriented programming. However, even though it is not as widely used in the professional field as it used to be, structured programming has never fallen out of use since it is often one of the primary means by which people learn basic programming concepts due to its general simplicity. This simplicity in certain aspects is an extremely important factor when it comes to teaching not only specific programming languages, but also the programming logic and algorithm concepts themselves for individuals who will delve into the intricacies of programming as a whole, not just restricted to structured programming, mainly because, as said earlier, most people learn the basics from it, using said knowledge to push onward into the vast and fascinating world of programming.

### **3.1.5 Logical Block Programming**

Usually refereed to as “Visual programming language” (VPL), logical block programming languages present themselves to the user with a friendly, simple and easy to assimilate interface, where commands and basic concepts of programming are represented with colorful blocks/panels, properly and well identified, always focusing on ease of use and help the user to meet his goal, giving said user the possibility of programming by a visual and graphical interface instead of the traditional method of typing each and every command line, said work is left to the machine itself, which writes every line of code on the background, leaving an intuitive and easy to use safe zone for the user to learn from, experiment and apply the basics of programming logic early discussed.

### 3.1.6 Scratch in the Educational Environment

Well known in the programming community for young people, Scratch, as defined on its own website, “is a programming language and online community in which children can program and share interactive multimedia, such as stories, games and animations, with people from all over the world”(Scratch).

As stated earlier, young people would arrive in Scratch’s environment with logical thinking in mind and developed since its incorporation into elementary school, and by introducing such a tool for these young people, they would learn how to apply said logic in a simpler, intuitive and safe environment, being free to explore and evolve their programming logic without having to worry about mistakes, errors, or most importantly, walls of texts and lines of codes.

Not only it is already used by many individuals who already teach programming basics to younger minds nowadays, it is also extremely friendly to younger minds with cartoonist graphics, possibilities to create fun little animations and mini-games, and of course, without leaving the programming part in the dark, presenting itself in a very easy to learn/understand way.

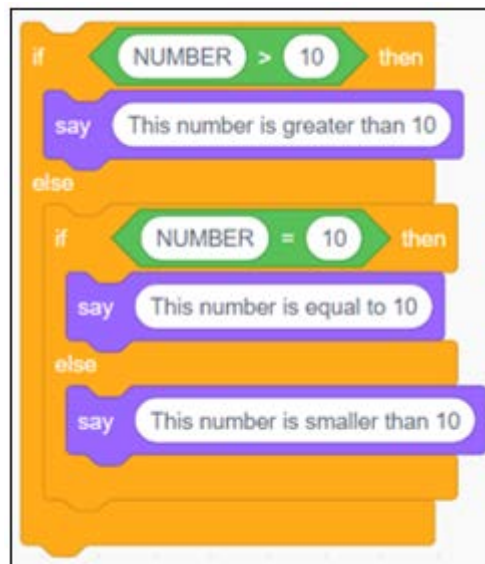


Figure 1 – Example of an algorithm in Scratch.

Source: Made by author.

In the previous image, even having no idea what the project is about, anyone with any or no level of programming knowledge would be able to understand what is going on, and identify basic concepts such as the variable in question (“NUMBER”) and the commands acting on it, and thus identifying a the structure at hand (if, else). Scratch's level of ease of use and understanding not only presents a great tool for people of any age to learn basic programming concepts, but also a great stimulus for developing logical thinking for young people who would not only continue to develop such logic, as they are already becoming familiar with concepts such as variables, commands, repetition structures, eventually matrices, queues, stacks, until they reach the most middle/advanced levels of programming, which would lead to the next step in their academic life: high school.

With basic programming concepts in mind, as well as a logical line of reasoning, young people migrating from elementary to middle school would be ready to shoulder more complex concepts as well as peer languages and programming environments. Even though up to the present point, these young people have

only interacted with block-shaped commands, programming logic itself is already acknowledged and incorporated by said individuals by the time the real coding comes, that is, writing lines and commands manually.

The process of learning more complex aspects of programming, as well as basics of other related areas (for example: databases, computer networks, and others) would go on until the end, that is, until high school, at which point, the students have to decide which area they would want to fully grasp and take as their profession, leaving those who decide not to engage on computer related areas with a cohesive and logical mentality, and those who do decide to engage on computing areas with most of the knowledge they will need already on hands, not having to waste their initials years on college learning basic concepts of programming which they were already supposed to have, giving both the students and colleges the possibilities to dive deeper into more complex and fascinating topics without the need of spending months teaching and learning what a vector is.

## **4. Results**

Based on the experiments of the sources used during the article, more specifically the introduction of programming in schools in the United Kingdom and the experiment of Thai students, a hypothetical school grade based on the studies is presented, being cataloged by the students' age instead of the period/year they are studying for the sake of both simplicity, consistency with the studies performed and the fact that certain educational institutions may or may not operate differently in relation to the teaching of their students.

### ***4.1 Data from 5 to 6 Years Old***

At this stage, the very basics of programming logic are introduced through basic logic exercises and examples of small problems and how these can be solved through logical reasoning, lessons and exercises being treated as small tasks or interactive activities, so the students can grasp said knowledge in the form of little games and fun exercises. In other words, it is taught how to “think in a more logical way”, said logic being exercised and evolved throughout the student's academic life.

### ***4.2 Data from 7 to 11 Years Old***

With a foundation of logical reasoning, it is time to introduce basic programming concepts to the individual. Just as in mathematics the student learns multiplication and division in order to be able to solve more advanced equations in the future, this step introduces the most basic programming concepts that are used by almost if not all of the programming languages: IF WHEN, WHEN, WHILE, among other basic concepts, these being initially presented and exercised outside the computational environment, being reviewed and handwritten on paper, and after this brief presentation, we begin to apply this knowledge using the Scratch programming language, where the student will have easy access to all the commands taught and some additional ones, and you can exercise both basic programming concepts and their programming logic, focusing on these two topics without worrying at the moment about lines and lines of traditional compiler code. Eventually, slightly more complex concepts such as

arrays, functions, among others are introduced, but still maintaining the simplicity of such concepts so that the difficulty helps to evolve and evolve along with the student's logical reasoning.

#### ***4.3 Data from 11 to 14 Years Old***

Consolidated computational programming logic and acquired basic programming concepts, the time has come not only to delve into more advanced programming concepts, but also the need to take a step forward and put Scratch aside, preferably using structured programming languages due to the ease of writing and reading most of them (eg C++ or Python) where the student will apply all the knowledge gained to this point in the real-time writing of simple programs and algorithms, which, again, will advance in complexity with the student, while still having a somewhat safe zone, where trial and error are key to further develop their logic.

#### ***4.4 Data from 14 to 16 Years Old***

Finally approaching the final years of pedagogical education and with university life on the horizon, we focus on “preparing the student to prepare for the labor market”, that is, giving valuable knowledge to the students who want to work in programming, but again, basic knowledge, so that it does not overwhelm students who choose not to work in the area, just as the college is left to develop such knowledge, in short: instead of teaching everything from scratch, giving extremely and dangerously superficial knowledge to the student, colleges would already have students with basic computer skills, not only restricted programming, but could focus on expanding specific areas (database, information security, advanced programming, among others) without worrying about wasting the early college years teaching things the student should already have in mind when entering the course. With this in mind, in the final step of this academic grid, the student learns how to interact and code with object-oriented programming languages, as well as concepts of interfaces and database linking.

Notice the abstinence of the mention of “use case”, “relationship entity” and other concepts which are common and mostly taught in the academic area of programming. As much as these diagrams and documents undoubtedly stimulate and exert the concepts of programming logic and algorithm, they would be best taught in an individual's university life, as these would not only take the time and resources that would be best applied in the teaching of logical concepts, but would also be somewhat of a waste for those who will not follow a professional career in the computational field of work.

### **5. Final Considerations**

Based on the studies performed, this hypothetical academic grade mentioned above certainly proposes a relatively simple way of introducing programming as a school subject not unlike other subjects such as mathematics or physics, presenting programming as simple and easy to learn compared to classic stereotypes that programming is just for a certain niche of super-intelligent people who program on black screens and with various symbols and letters almost impossible to understand, showing the potential and opportunities that the computational field of work presents on the modern society.

Overall, not only would this educational path would prepare individuals for computational related college

courses, saving them from wasting their early college years by learning the concepts of programming over short periods of time and too superficially to even get used to it, but it would also introduce a more logical and cohesive reasoning for the child that would evolve and improve for the rest of his life, even if the individual chooses other areas of education than computing.

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# Hybrid Mobile Prototype for Evapotranspiration Calculation Using Raspberry Pi

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## Abstract

*The hybrid mobile prototype proposes to assist the farmer in obtaining crop evapotranspiration data reducing the effort in calculating them. In warm weather places, it is of the fundamental importance to verify a prototype for the calculation of evapotranspiration, thus favoring sustainable irrigation. To show this important discussion, a study was conducted highlighting the advantages of using the methods for calculating evapotranspiration cited by Hargreaves Samani and the Penman Monteith method. There is the need to use tools that automate the evaporation method, being able to access them on mobile devices with Android and iOS systems, and also notebook, bringing advantages and relevant*

*contributions to the scientific community and potential users. The benefits of using automated irrigation can serve as basis for more conscious and sustainable decision making.*

**Keywords:** Evapotranspiration; Prototype; Hybrid; Calculation, Irrigation.

## 1. Introduction

The damages caused by the few irrigations or its exaggeration are enormous, negatively affecting the farmer and mainly impeding the growth of the crop. The use of water in excess besides to cause the proliferation of fungi that cause diseases in the soil, also raises the water table saturating the soil and preventing the action of nutrients, causing high costs for the farmer, who may need to drain the soil. It can also result in waste of fertilizers, which are run off by water get in the roots reaching the level of river source. All these losses, which are directly linked to farmers, increase production costs, energy and water consumption [1].

The lack of manipulation of the environment to control meteorological indicators in the estimation of crop water calculation has made it difficult to handle irrigation, especially in farmers' families with small farms. Farmers do not have the financial capital to invest in a place equipped with electronic sensors to gather data for measurement and storage of environmental variables. The installation of a professional weather station has a high cost, as well as complex operation of equipment, making it impossible for small producers to acquire [1]. There is a limitation of existing software models to improve the calculation of evapotranspiration and consequently the irrigation. Calculating evapotranspiration to know how much water should be used to irrigate requires manual effort. It occurs because there are two simultaneous water outlets, one from the ground and one from the plant [2].

It is important to verify the need for proper irrigation to avoid damage to the environment and financial losses to the producers. Irrigation is an essential factor for the cultivation of all kinds of agricultural production. An important alternative for controlling a crop's water expenditure is the sustainable irrigation, which allows measuring the amount of water consumed according to the needs of each plant.

The knowledge of daily evapotranspiration rates is very useful for determining water needs in agriculture. Thus, evapotranspiration can be defined as the manner in which water on the earth's surface is transferred to the atmosphere in the form of gaseous particles. The portion of radiation that effectively crosses the clouds and reaches the surface is the main form of energy used in evapotranspiration [3].

It is noted the need of the creation of new software that collaborate for this purpose, reducing the manual effort to perform the calculation of evapotranspiration [2]. The irrigation activity calculation methods proposed by Hargreaves Samani and Penman Monteith are the basis for the creation of hybrid mobile prototypes with simple and user-friendly interface [1].

Given this scenario, we realized the importance of investing in research with alternative means to remedy the issues presented. This work aims to develop a hybrid device prototype with the proposal to assist in reducing the manual effort in the evapotranspiration calculation process, to obtain the water balance coefficient in the crop irrigation handling. Presenting its advantages and disadvantages during the process and how it is distinguished based on the Hargreaves Samani and Penman Monteith methods.

## 2. Materials and Methods

For the study of case, it was observed the families of small farmers, who have difficulty in proper handling of crop irrigation, however do not have the purchasing power to invest in obtaining equipment with electronic sensors to collect data for measurement and storage of the variables related to the environment [1]. From then on, the environment indicatives were controlled through the electronic sensor with a hybrid mobile device prototype, which has version for notebooks and mobile phones with Android and iOS systems, besides presenting a friendly and simple interface.

### 2.1 Prototype Javac

For this prototype Javac was used as compiler and a Raspberry Pi board, being this small and portable; We also used the baster version that acts as a file server with the following settings: a Quad Core 1.2, 64 bit, 1 gig ram, with Wi-Fi and Bluetooth connection; It has Ethernet Rj 45, 40 pin, for each pin an input/output that can be used for a sensor, camera support and Etier balena software for writing to the memory card. The environment used for application development was the Windows 10 operating system, drive and write validation on the SSD itself. Raspbian is an operating system that functions as a Debian-based computer for Raspberry Pi [4].



Figure 1: Raspberry Pi board.

Source: Authors, (2019).

### 2.2 Prototype Raspberry

For the Raspberry Pi board, a thermal paste has been added to help reduce high processor temperatures. It is the constituent part that is between the heat sink and the processor, increasing the junction between these components, so that more efficient cooling can occurs [5].



Figure 2: Gloves, thermal paste, cotton swabs, heat sink and Raspberry Pi board.

Source: Authors, (2019).

### 2.3 Control the Environment

To control the environment data was used the humidity and air temperature sensor - DHT22, which makes measurements through 4 digital pins, having 5v supply voltage. It can measure air temperature between -40 and 125°C. Later, with a friendlier image, this information is projected into an interface, so that the user can read it [6].

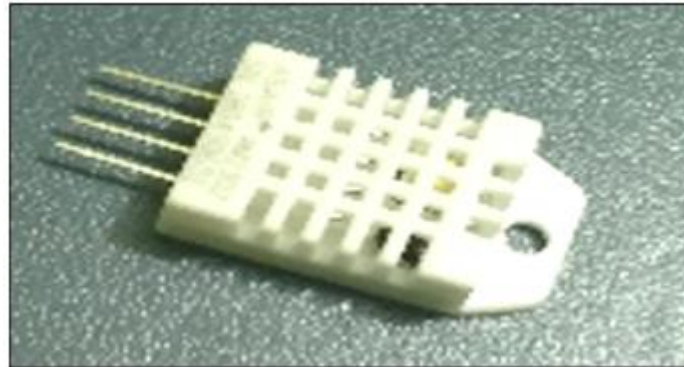


Figure 3: Humidity and air temperature sensor - DHT22.

Source: Authors, (2019).

### 2.4 Data Presented

Data were presented using a 7-inch Raspberry screen, Touch Pi2 LCD display with 1920x1080 resolution, HDMI, VGA support and AV video input. The screen can also be used as a computer monitor [7].

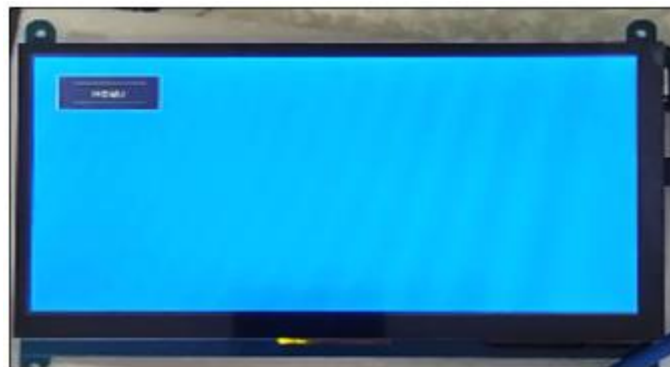


Figure 4: Presentation of the interface through the display.

Source: Authors, (2019).

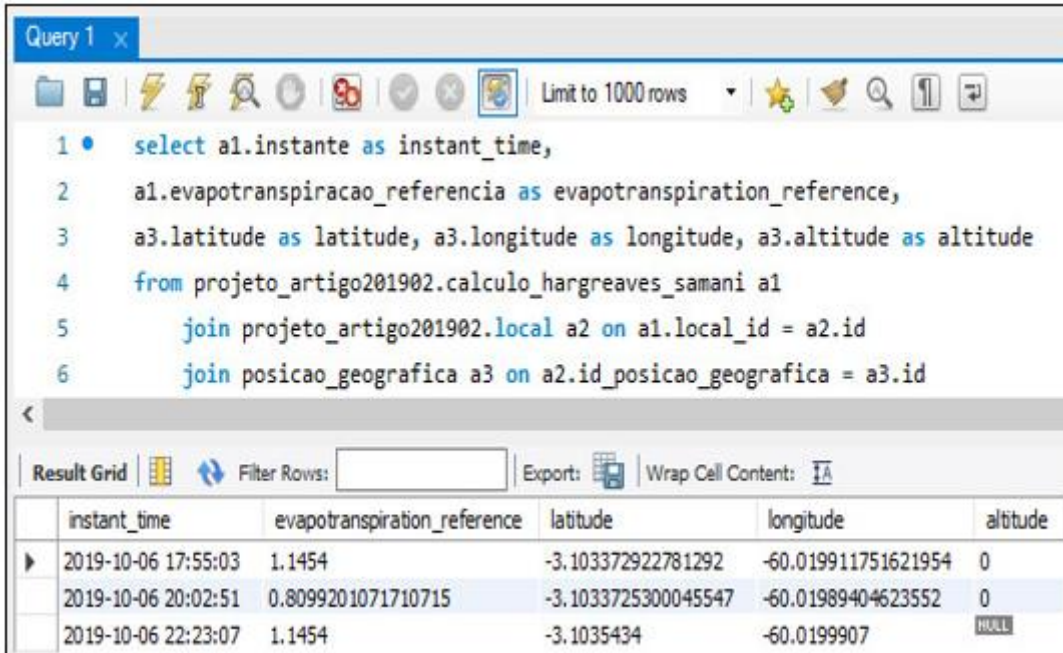
Secondly, we applied the bibliographic researches that were performed through digital scientific articles, books and e-books to understand about proper irrigation. With the evapotranspiration calculation methods, it is able to reduce the complexity of obtaining the value of the water level that leaves and returns to the ground [1]. The main studies about development of mobile hybrid devices were analyzed, and a prototype hybrid mobile device was developed to control the indicators, which can be accessed

through Android and iOS phones or notebooks. Finally, it displays the evapotranspiration calculation process based on the Hargreaves Samani and Penman Monteith methods. Then, the results of the observations and the case study discussion were presented.

### 3. Theoretical Reference

Raspberry Pi is used to explore an alternative wireless communication platform, such as a server by connecting to the smartphone as a client on the same network. The work explored the following scenario: client-server communication using Wi-Fi. The Router is used to create a connection through the remote, wireless network file sharing environment between devices [4].

The prototype hybrid mobile device receives the variables of the main factors that control the evapotranspiration process, highlighting solar radiation, altitude, air temperature, wind speed, relative humidity, atmospheric pressure and rain precipitation [8]. The device is then able to store measurement data in software called MySQL workbench database. The choice of the software used in the development of the work was motivated by the excellent storage performance, its easy usability and because of the free distribution of the software [1].



The screenshot shows the MySQL Workbench interface. The top pane displays a SQL query (Query 1) that selects data from three tables: `projeto_artigo201902.calculo_hargreaves_samani`, `projeto_artigo201902.local`, and `posicao_geografica`. The query joins these tables based on `local_id` and `id_posicao_geografica`. The bottom pane shows the 'Result Grid' with 3 rows of data. The columns are `instant_time`, `evapotranspiration_reference`, `latitude`, `longitude`, and `altitude`. The first two rows show data for the date 2019-10-06 at different times, with altitudes of 0. The third row shows data for 2019-10-06 at 22:23:07, with an altitude of 11454.

instant_time	evapotranspiration_reference	latitude	longitude	altitude
2019-10-06 17:55:03	1.1454	-3.103372922781292	-60.019911751621954	0
2019-10-06 20:02:51	0.8099201071710715	-3.1033725300045547	-60.01989404623552	0
2019-10-06 22:23:07	1.1454	-3.1035434	-60.0199907	11454

Figure 5: MySQL workbench database.

Source: Authors, (2019).

Regarding the functional qualities of the software, they are accessible to common users so that they can query the data, including filtering previous periods for data calculation [3].

These values are provided by the sensors or through data collected by INMET (National Institute of Meteorology of Brazil). After displaying the collected data, the device calculates these variables using the Hargreaves Samani and Penman Monteith methods and in turn displays the calculated value, which results in the evapotranspired water level. From this result, the farmer will know the appropriate amount that he should irrigate the crop. To increase user convenience, the hybrid device prototype can be

accessed from a computer or from a smartphone.

Hybrid devices have several advantages over pure native devices, especially in support. The platform reduces complexity, code size, development time, maintenance expense and requires less knowledge about API, as well as easier development and increased market share [9].



Figure 6: Preparing the machine to run the build for iOS.

Source: Authors, (2019).

The Ionic framework is for mobile application development in Html5, focused on hybrid development. Angular is a JavaScript framework, and it will be used by the Ionic framework. Angular 2 is a webpage script language developed by Google that has a code interpreted by the web browser. The Ionic framework was chosen for hybrid applications due to its free distribution, and because it is based on the Angular 2 framework. Apps that are developed with Ionic framework behave like native Apps, and they have support of various platforms as Android and iOS [9]. For the services layer, Java EE (Enterprise Edition) and Python language were used to communicate with the sensors. To develop the user's screen the Angular 2 was used.

RESTful defines the quality of the architecture that makes applications communicate. Being obtained by the principles/ rules/ constraints that when observed allow the creation of a project with well-defined interfaces [10].



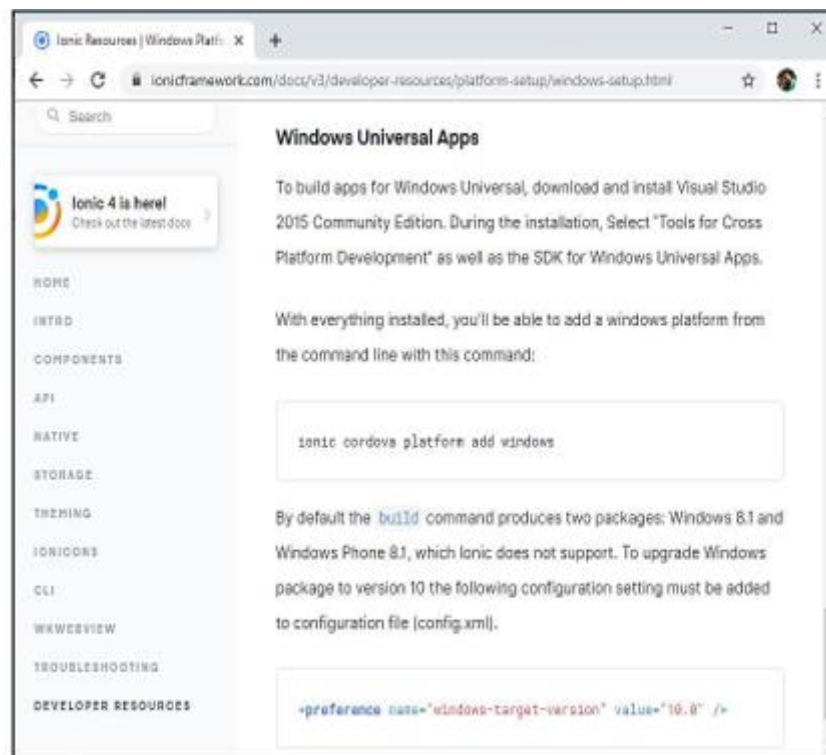


Figure 7: Build Windows documentation, Ionic Framework.

Source: Authors, (2019).

Microservices are small service modules that act independently. Even working together, each module is like a separate entity that can be run isolated of a service platform. There is an alternative to manipulating different internal technologies of each service and this is an advantage when using the microservices architecture. Communicating via Application Programming Interface (API) and Hypertext Markup Language (HTML) resources, the hypertext markup language is the most basic part of the web, which performs its function by defining the structure and basic content of the web page, thus allowing to properly choosing the tool for each type of work [10]. The Java framework called Spring Boot 2 is widely used and well-known due to its ease in setting up and delivering application content to the public. The purpose of the framework is to quickly get the project up and running, simply by informing the software of the preference modules [10].

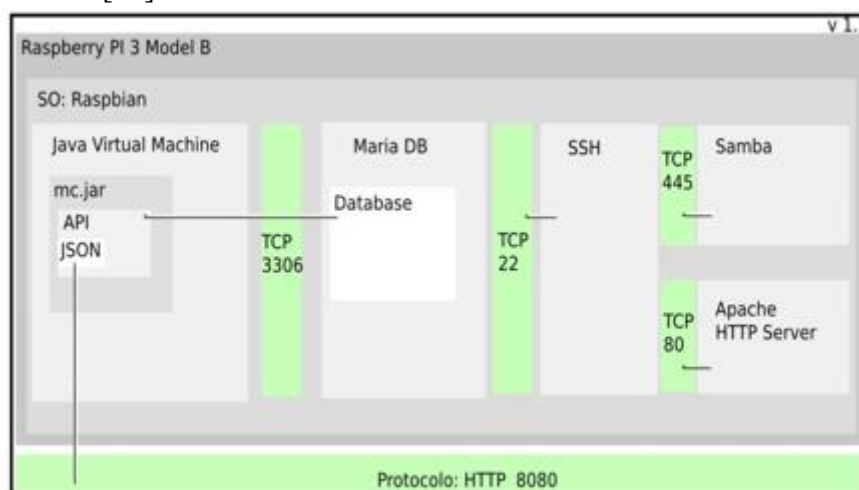


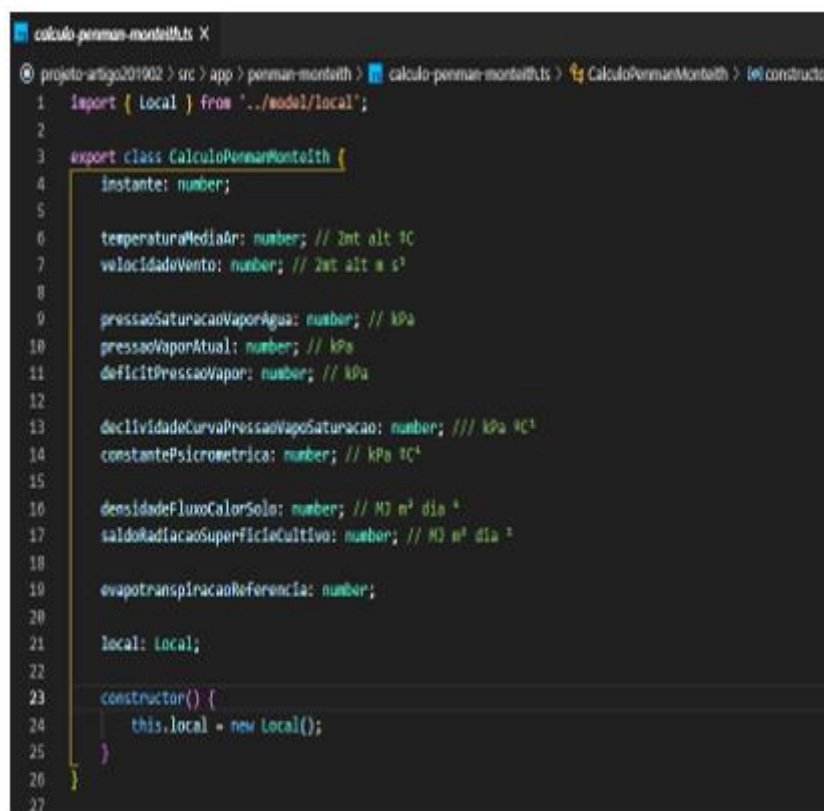
Figure 8: Platforms that communicate via HTTP.

Source: Authors, (2019).

## 4. Results

The set of web technologies, such as HTML5, CSS and JavaScript, added to the native mobile application platform results in hybrid application theory. Hybrid apps are configured to work just like other native apps on digital app distribution platforms (Play Store, Apple Store, and Windows Phone Store). The installation and configuration of the NodeJS software was performed and also the installation of the Ionic CLI and Cordova packages through the Node Package Manager (NPM) which consisted of the process of designing. For the Process of Building stage, the project was created through the Ionic CLI interface, based on the “side menu” template included in the Ionic documentation. CSS was implemented to customize the visual structure of the application and the necessary markings were added through the HTML language [11].

The Model View Controller (MVC) was used, which was consisted on the separation of the domain classes (model), and on the separation of the use of components and markup languages, and the controllers that join the model with the visualization layer [12].



```

calculo-penman-monteith X
@ projeto-artigo201902 > src > app > penman-monteith > calculo-penman-monteith > CalculoPenmanMonteith > @constructor
1  import { Local } from '../model/local';
2
3  export class CalculoPenmanMonteith {
4      instante: number;
5
6      temperaturaMediaAr: number; // 2nt alt tC
7      velocidadeVento: number; // 2nt alt m s⁻¹
8
9      pressaoSaturacaoVaporAgua: number; // kPa
10     pressaoVaporAtual: number; // kPa
11     deficitPressaoVapor: number; // kPa
12
13     declividadeCurvaPressaoVaporSaturacao: number; // kPa °C⁻¹
14     constantePsicrometrica: number; // kPa °C⁻¹
15
16     densidadeFluxoCalorSolo: number; // MJ m⁻² dia⁻¹
17     saldoRadiacaoSuperficieCultivo: number; // MJ m⁻² dia⁻¹
18
19     evapotranspiracaoReferencia: number;
20
21     local: Local;
22
23     constructor() {
24         this.local = new Local();
25     }
26 }
27
  
```

Figure 9: Prototype version for Android.

Source: Authors, (2019).

For the testing and debugging process was built the application for the Android platform, and was digitally signed the file with the extension "apk". For the execution and publishing process, the application was installed on a smartphone with the operating system Android 9.0 [13].



The prototype is a system that collects environmental data through sensors and devices in real time. The prototype performs evapotranspiration calculations using Hargreaves and Samani and Penman Monteith methods. It is noteworthy that for the exposed work the function is aimed at helping small farmers to help evapotranspiration calculation, seeking to reduce the effort to obtain the value of the evapotranspiration process. The formula developed by Hargreaves Samani needs only solar radiation and the average, maximum and minimum temperatures to generate the result, according to equation 1 [1].

(Eq. 1)

$$ET_0 = 0.023(0.408) (T_{mcan} + 17.8) (T_{max} - T_{min})^{0.5} R_{\alpha}$$

In Hargreaves Samani's method (Figure 10) the user does not need enter weather station results [1]. The prototype performs the calculations using the value that comes from the DHT22 air temperature sensor to estimate the temperature value of equation 1.

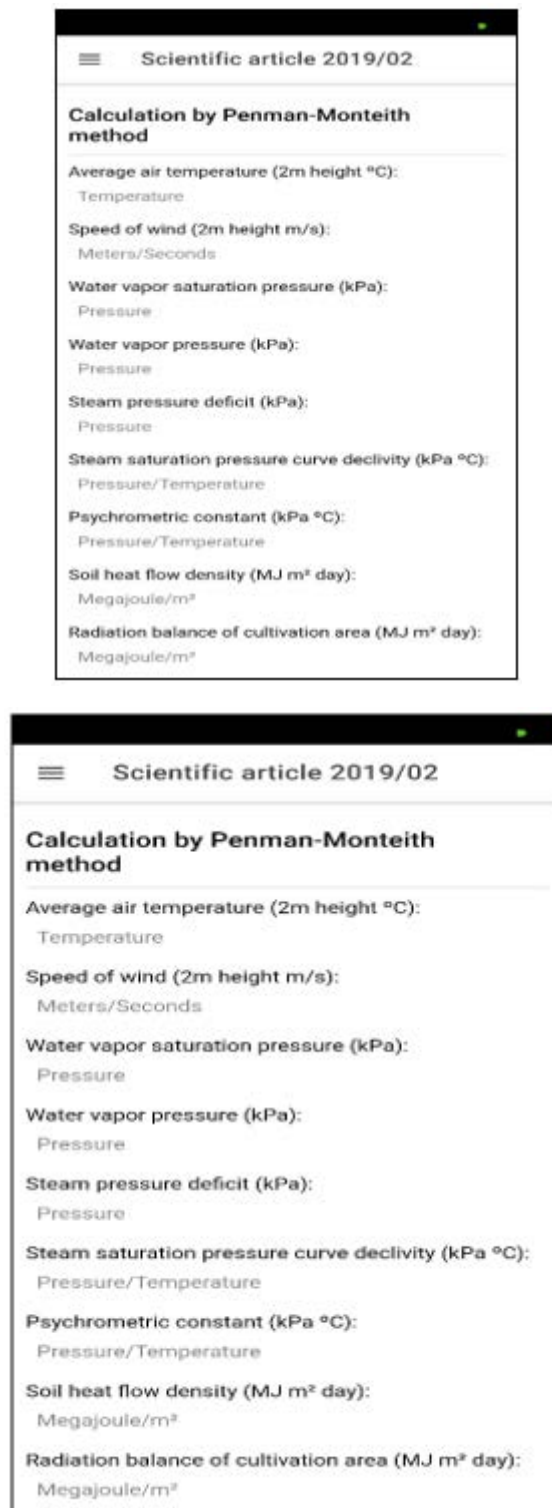
Figure 10: Presentation of the calculation by Hargreaves Samani method.

Source: Authors, (2019).

If the user prefers to verify the evapotranspiration result by the Penman Monteith method (Figure 11), it is necessary to enter the information in the hybrid mobile device to calculate, according to the data collected by the local Meteorological Station [13].

(Eq. 2)

$$ET_0 = \frac{0,408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (\epsilon_s - \epsilon_a)}{\Delta + \gamma(1 + 0,34u_2)}$$



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### Calculation by Penman-Monteith method

Average air temperature (2m height °C):  
Temperature

Speed of wind (2m height m/s):  
Meters/Seconds

Water vapor saturation pressure (kPa):  
Pressure

Water vapor pressure (kPa):  
Pressure

Steam pressure deficit (kPa):  
Pressure

Steam saturation pressure curve declivity (kPa °C):  
Pressure/Temperature

Psychrometric constant (kPa °C):  
Pressure/Temperature

Soil heat flow density (MJ m<sup>2</sup> day):  
Megajoule/m<sup>2</sup>

Radiation balance of cultivation area (MJ m<sup>2</sup> day):  
Megajoule/m<sup>2</sup>

Figure 11: Presentation of the calculation by the Penman Monteith method.  
Source: Authors, (2019).

Date	Time	Temperature (°C)			Humidity			Dew (°C)			Pressure (hPa)			Wind (m/s)			Radiation	Rain
	UTC	Inst.	Max.	Min.	Inst.	Max.	Min.	Inst.	Max.	Min.	Inst.	Max.	Min.	V.	direction	Squall	(KJ/m <sup>2</sup> )	(mm)
20/10/2019	00	26.6	27.5	25.6	74	74	68	21.5	21.7	21.1	1004.1	1004.1	1003.2	0.5	353	1.4	0.000	0.0
20/10/2019	01	25.8	26.7	25.8	83	83	73	22.7	22.7	21.4	1004.7	1004.7	1003.9	0.6	2	2.0	0.000	0.0
20/10/2019	02	25.6	26.0	25.6	81	84	78	22.0	22.9	21.7	1005.8	1005.9	1004.7	0.5	312	2.6	0.000	0.0
20/10/2019	03	25.4	25.7	25.3	80	82	80	21.7	22.2	21.7	1006.0	1006.2	1005.8	0.5	355	2.3	0.000	0.0
20/10/2019	04	25.2	25.4	25.2	80	82	79	21.5	22.0	21.5	1005.6	1006.0	1005.6	0.5	351	1.3	0.000	0.0
20/10/2019	05	24.8	25.2	24.8	90	90	80	23.1	23.1	21.5	1004.9	1005.6	1004.9	0.5	6	1.7	0.000	0.0
20/10/2019	06	24.6	24.9	24.5	83	91	82	21.5	23.2	21.5	1004.1	1004.9	1004.1	0.6	330	2.4	0.000	0.0
20/10/2019	07	24.7	24.8	24.4	83	85	83	21.6	21.8	21.5	1004.1	1004.2	1004.0	0.4	285	1.6	0.000	0.0
20/10/2019	08	24.7	24.8	24.4	81	84	80	21.2	21.7	21.1	1004.2	1004.2	1004.0	0.9	281	2.1	0.000	0.0
20/10/2019	09	24.4	24.9	24.4		100	81		24.3	21.2	1004.7	1004.7	1004.2	0.8	277	1.9	0.000	0.0
20/10/2019	10	25.2	25.2	24.5							1005.1	1005.1	1004.7	1.7	229	4.0	13.84	0.0
20/10/2019	11	26.3	26.4	25.2	84			23.3			1005.7	1005.7	1005.1	0.9	259	3.5	375.4	0.0
20/10/2019	12	27.0	27.1	26.3	81	85	79	23.6	23.9	23.1	1006.4	1006.4	1005.7	1.0	185	3.0	925.2	0.0
20/10/2019	13	28.3	29.2	27.0	73	81	69	22.9	23.9	22.8	1007.2	1007.2	1006.4	1.7	227	3.2	1811.	0.0
20/10/2019	14	29.8	30.3	28.3	68	75	66	23.2	24.2	22.9	1007.1	1007.3	1007.1	1.8	290	4.5	2284.	0.0
20/10/2019	15	29.3	30.4	29.3	69	70	64	22.9	23.9	22.6	1006.2	1007.1	1006.2	2.4	254	4.9	1815.	0.0
20/10/2019	16	30.6	31.1	29.3	63	70	63	22.8	24.1	22.6	1004.7	1006.2	1004.7	1.9	242	5.9	1706.	0.0

Figure 12: Automatic query station data of the city of Manaus, AM, Brazil.

Source: [14].

## 5. Discussions

It is important for farmers to obtain knowledge about the necessity of adequate irrigation, and thus improve crop yields by benefiting from new technologies. There are several devices on the market that calculate evapotranspiration through sensors, but not with the same proposal of the developed prototype. According to this work, the proposal is to show the viability of the hybrid mobile device prototype, which can work on with Android and iOS smartphones, and also notebooks.

Therefore, considering the results, it can be described that the use of Hargreaves Samani method presented greater viability due to the simplicity of the information, which in this case uses temperature sensors to measure the data that will be used in the calculator. The result of calculating evapotranspiration in this method is simpler, faster and easier to achieve. To use the Penman Monteith method, the user would need a high financial cost to have a weather station or obtain the information through the National Institute of Meteorology [14].

## 6. Conclusion

According to the work presented, there was a need to develop a hybrid mobile device prototype, with benefits from which it is viable to use a mobile device to assist in the calculation of evapotranspiration. It is possible to control the process data and offer convenience and practicality to the user in decision making through its indicators. In the market, there are already tools with this type of functionality and display of indicators, but the prototype presented stands out for having a hybrid mobile application, which can be accessed from smartphones with Android or iOS systems, also by notebooks. From the

comparative mentioned, it was observed that this work contributes positively to the scientific community and to the possible users of the prototype, aiming at reducing the effort for those who need to calculate evapotranspiration data, thus favoring the farming management.

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# **Analysis of the Off-Grid Solar Energy Implementation in the Aracari Community in Novo Airão - Amazonas**

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## **Abstract**

*The challenges of bringing electricity to isolated communities in the Amazon are extremely complex, especially due to their large territorial extension. However, photovoltaic solar energy technology becomes a viable alternative for electrification of isolated regions. In view of this possibility, the concessionaire responsible for the distribution of electricity in the state of Amazonas, Amazonas Energia, prepared a project and implemented photovoltaic generation and distribution systems in twelve communities, located in six municipalities in the Amazon. Therefore, this research aimed to present the analysis of the off-grid photovoltaic system project, which aims at serving the Aracari community in Novo Airão - AM, as well as its positive and negative impacts after the project implementation, considering the tripod variables of sustainability. The analysis of the results showed that the installed system presents major problems in relation to maintenance, a situation attributed to the lack of resources forecasting and disarticulation of this initiative with public policies aimed at social, economic and environmental sustainability. Consequently, the installed system cannot meet the potential demand of the community, since due to the lack of maintenance and operation services, it caused the system to be interrupted, in which there was a power outage in the mini plant, rendering it inoperative.*

**Keywords:** Photovoltaic system; Isolated communities; Sustainability Tripod.

## **1. Introduction**

Given that Brazil is one of the richest countries in natural resources in the world, there are still countless families living on the margins of social inclusion, even without using basic resources, especially electricity. The state of Amazonas, in the northern region of the country, has a large number of communities in this situation, characterized by small groups of people, with low commercial activity, in areas difficult to reach due to the geographical peculiarity, making conventional energy interconnection impracticable.

For the improvement of citizens' quality of life, the availability of electricity through public services and equipment is of utmost importance. In rural communities, electric power facilitates access to public social, educational and health programs, thus providing opportunities for human development, health and family income.

Considering this need, Amazonas Energia, an energy concessionaire in Amazonas, in conjunction with the Ministry of Mines and Energy - MME, elaborated a project that aims at serving households located in remote regions of the interior of the State, using energy generated in photovoltaic systems as an inducing component of economic, social and environmental development.

The deployment of solar power generation systems has numerous advantages compared to other energy sources, making it a viable alternative for energy viability in communities without access to energy, aiming to respond to the tripod of sustainability. Solar energy has the facility of being installed anywhere, being able to generate electricity at the point of consumption. In addition, unlike other energy sources, it can be installed throughout the national territory, being rural and urban areas.

Many Brazilian homes have been serviced by the Luz para Todos (Light for All) Program, established by the Federal Government in 2004, through the creation of MME Ordinance No. 60/2009, which enabled the development of electrification projects using renewable energy and new technologies. , mainly targeting isolated Amazon communities.

Isolated communities, according to [1], are on the margins of Brazilian economic life and socially excluded. Most of them suffer from a lack of essential services and other basic conditions for citizenship and its members, such as access to energy and its benefits.

These communities live in isolated places in the Amazon region, which makes it impossible to receive resources, such as electricity, not enjoying the various services offered by this condition [2]. It is estimated that more than two million people in the Amazon live without access to electricity [3], where most of the places where there is electricity only exist through social and environmental alternatives that do not come from the conventional means provided by large distributors. power.

An important alternative that has been considered to guarantee electricity to isolated communities and to provide better quality of life, allowing the valorization of life in the rural environment and economic development, is the implementation of electricity systems from local resources, having as example the harnessing solar resources [1].

The first applications of space and satellite technology occurred between the 1950s and 1960s. Subsequently, applications in the telecommunications sector emerged in the 1970s, and finally in the 1980s solar energy began to become interesting given the decline price, to provide electricity to users far



from conventional electricity infrastructure.

Thus, in the 1990s photovoltaic systems were consolidated as an economically viable technology to supply energy in isolated systems [4]. It is noted that the alternative to supply electricity using photovoltaic systems in isolated systems is interesting due to the high costs incurred in the construction of electrical infrastructure to distant places and, in most cases, places with low charge density [5].

The direct conversion of solar energy into electrical energy occurs by the effects of radiation on certain materials, particularly semiconductors. These include thermoelectric and photovoltaic effects. The first is characterized by the emergence of a potential difference caused by the joining of two metals under specific conditions. In the second, the photons are converted into electricity through the use of solar cells [6].

Among the various processes of harnessing solar energy, the most widely used today are water heating and photovoltaic power generation. In Brazil, the first is found most in the South and Southeast Regions due to climatic characteristics and the second, in the North and Northeast Regions, in communities isolated from the power grid [6].

The use of the solar source in the generation of electric power provides benefits, cited by [7]. From an electrical point of view, the author cites the contribution to matrix diversification, increased security of supply, reduction of losses and relief of transformers and feeders. From an environmental point of view, there is a reduction in greenhouse gas emissions, the emission of particulate materials and the use of water to generate electricity. Regarding the socioeconomic benefits, photovoltaic solar energy generation contributes to the generation of local jobs, increased revenues and increased investments [8].

The photovoltaic power system, also known as solar energy (off-grid), is a model in which its components work to capture the sun's energy, converting it into energy to be used in places where conventional electricity is used. not enough or in back-up systems, the main applications are: water pumping system, rural electrification, fence electrification, lampposts, telecommunication systems, radars, health clinics, vaccination refrigerators, among others [9 ].

Therefore, the objective of this study is to analyze the deployment of off-grid photovoltaic solar energy in the Aracari community in Novo Airão - AM. Considering also the description of the experience of Amazonas Energia - AmE and Guascor / Kyocera Consortium in the implementation of mini plants and mini grids through solar panels in isolated communities, in order to evaluate the positive and negative impacts on social, economic and environmental aspects. after project implementation.

## 2. Material and Method

The analysis was performed in an isolated rural locality, called Aracari community, about 125 km away from Manaus, located on the left bank of Rio Negro, municipality of Novo Airão - AM, with coordinates (S) 02 ° 22 '. '7.8' and (W) 61 ° 05' 08.3 " (Figure 01).



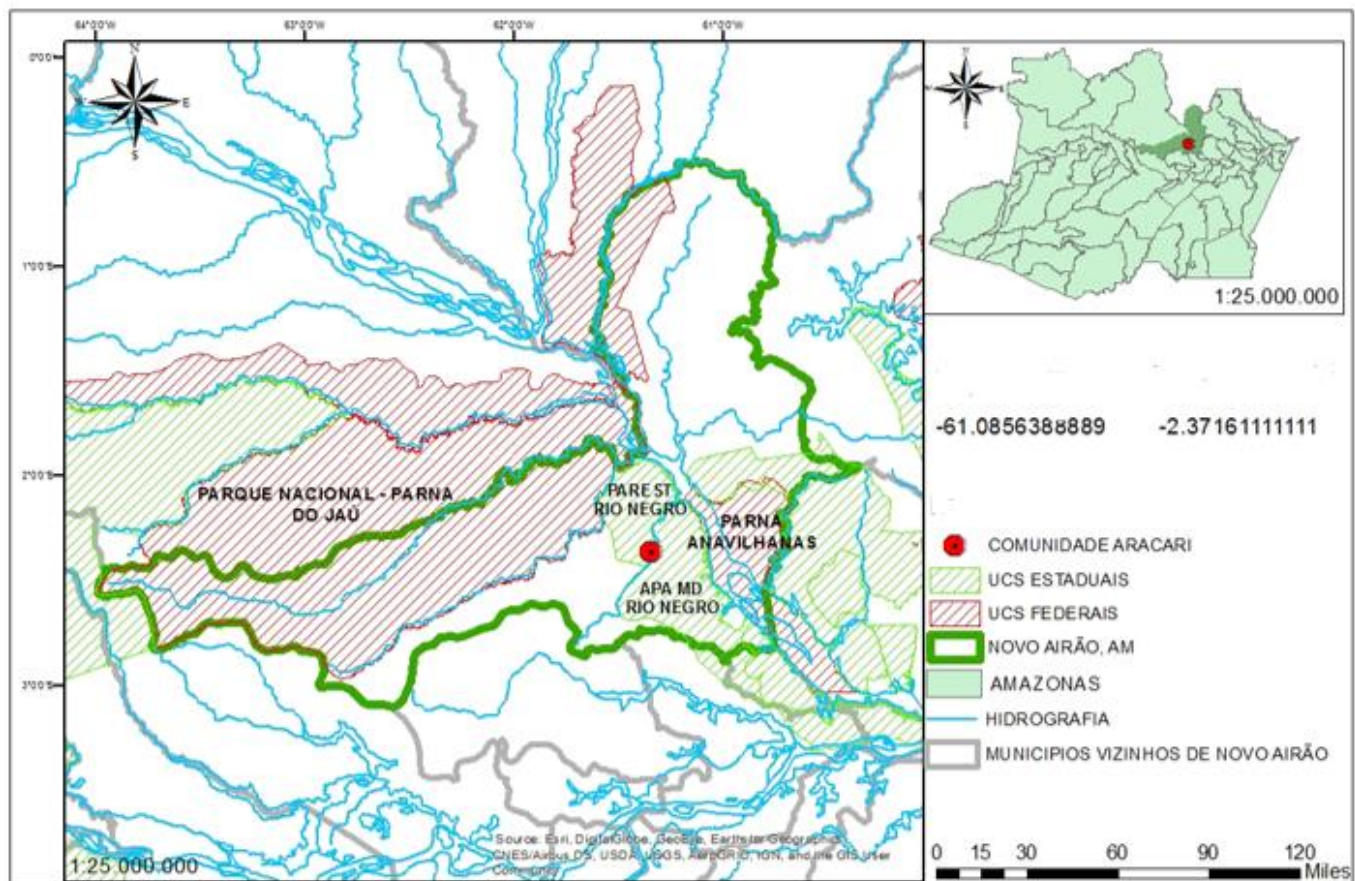


Figure 1 - Aracari community location map

Source: Own authorship, 2019.

The descriptive methodology was used, using the elaboration of an analysis, considering the variables of the sustainability tripod. According to [10], descriptive research seeks the cause-effect relationship between phenomena, facilitating the power to describe the complexity of a given hypothesis or problem, as well as analyzing the interaction of variables, understanding and classifying dynamic processes, presenting contributions in the price of the problem. changing the system, creating or forming opinions of a particular group and allowing the interpretation of the particulars of the behaviors or attitudes of individuals.

The analysis aimed at the relation between the project conception, using the photovoltaic energy in the referred community and the monitoring of the system functionality. The “Luz para Todos” program, instituted by the Federal Government in 2004, has been seeking alternatives to bring electricity to families living in isolated regions, providing minimum living conditions for the population.

### 3. Results and Discussion

The creation of Ordinance MME (Ministry of Mines and Energy) No. 60/2009 - Manual of Special Projects of the Luz para Todos Program, led to the elaboration of electrification projects using renewable sources and the use of new technologies. From the creation of the referred Ordinance, the Ministry of Mines and Energy - MME, having the survey of some rural communities without electrification selected

30 communities, to verify the possibility of implantation of the project that consisted of the implantation of mini solar panels networks, being verified at the end observed the impossibility of implantation due to technical characteristics.

Amazonas Energia, which had participated with the MME in the 15th visit of the 30 communities, suggested a new listing to the MME to verify the implementation of special projects, defined in 13 communities at the end. These communities were distributed in six Amazonian municipalities. After the selection were sent to the MME necessary information for the development of the special projects, authorized by the MME the project development.

Amazonas Energia made formal requests to the financing agent of the "Light for All" Program, ELETROBRÁS, and forwarded the necessary documents, obtaining in November 2009 the financing approval. In that same period, ELETROBRÁS obtained from ANEEL through Resolution No. 2,150 / 2009, authorization to implement, in a pilot service character, the 13 isolated communities with the adoption of billing in the prepayment system of solar energy mineders.

The technicians of the National Light for All Program and AmE, reached this number of 13 communities that would be served, given the budget amount, which was available at the time. Visits were carried out and one was finally excluded, located in the municipality of Barcelos, called Democracy, once the community dispersed.

In order to serve these communities in remote regions, where the supply of energy through conventional distribution through transmission lines is not feasible, the proposition was due to the innovation in the system of generation and commercialization of energy, with environmental commitment, besides digital inclusion with the availability of internet access in the schools of each community.

The 12 communities were distributed in 6 (six) municipalities of the state of Amazonas: Barcelos - Terra Nova; Autazes - São Sebastião do Rio Preto; Beruri - Our Lady of Carmel; Eirunepé - Mourão and Santo Antonio; Maués - Our Lady of Nazareth, Saint Luzia, Saint Mary and Saint Joseph; Novo Airão - Aracari, Bom Jesus do Puduari and Sobrado.

With the authorization of the regulatory agent ANEEL and the financing, ELETROBRÁS / Amazonas Energia, started the elaboration of the projects for the implantation of the 12 photovoltaic generation systems with minired distribution, where in July / 2010 it was hired the executing company, winner of the bidding process, the Guascor / Kyocera Consortium.

After data collected by AmE, a public power system was implemented with the following components: a) photovoltaic mini-plant for generation and storage; b) distribution network; c) remote monitoring system; d) prepaid energy sales system.

The base survey was conducted in the municipality of Novo Airão - Aracari community, sizing the generation system to serve the 14 Consumer Units - UC's, of this location.

The criteria used to create the project was based on: Communities with difficult physical access; high cost of O&M - Operation and Maintenance, in these communities, distance to be covered by the sector responsible for system maintenance; few consumer units within the system's range; lower long-term cost given the nature of the system; non-significant environmental impacts compared to fossil fuel power generation; and no need for an operator, given its control by the utility company remotely.

The project consists of: a rustic wooden building to be built by the community themselves, with project

resources and guidance from the concessionaire's technicians, in which this building will be sheltered from batteries, busbars, control panels and inverters; area for the installation of photovoltaic modules; low voltage distribution mini-network.

For the planned system configuration, composed of photovoltaic generator blocks, having all electrical parameters available in a power house through a control, storage and inversion system. All this information of the electrical parameters of generation, demand (mini grid), power flow, temperature, humidity, solar radiation and presence sensor are in a Remote Terminal Unit - RTU, which transmits this data via satellite to the operating center of the minis photovoltaic plants located in Manaus (Figure 2).

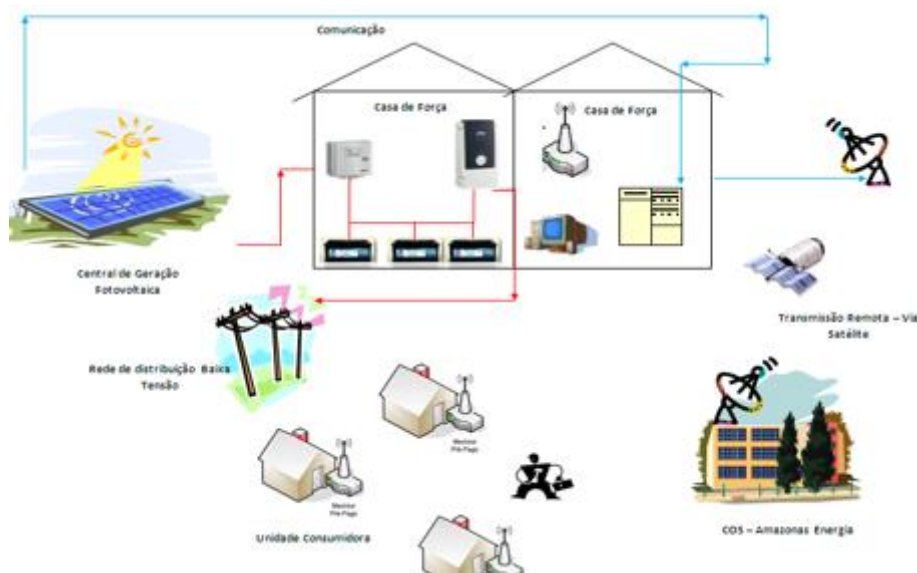


Figure 2 - System Configuration Illustration

Source: Amazonas Energia, 2011

The electricity generated is distributed to the consumer units through a 127 V single-phase distribution network with bare aluminum cables, supported by wooden poles (Figure 3).



Figure 03 - Mini network distribution network

Source: Amazonas Energia (2011)

### 3.1 Description of the Social, Economic and Energy Profile of the Community

The local economy is focused on fishing. There is also a small plantation of sugar cane, banana, pineapple and a cassava plantation where families make flour for their support. There are 06 private flour houses. Electricity has existed for 07 years (1 generator of 07 kVA - artesian well - piped water and 1 generator of 13 kVA - for households - works from 19:00 to 21:00 hours - working poorly). The City Hall donates 100 l of diesel per month to the school and the community, which participates with \$ 10.00 / domicile / month to buy diesel - to supplement the insufficient amount of diesel donated by the City.

The implementation of the mini photovoltaic power plant in the Aracari community had significant social, economic and environmental impacts on the community. The installed system temporarily provided access to information and the possibility of continuing education for young people and adults, because at night time increased access of residents to education and also facilitated distance education, as well as digital inclusion with the use of internet in school.

However, with the system interruption, the indefinite energy consumption became unviable. According to [11], for the project to achieve the proposed objectives, it is necessary to maintain and periodically monitor the operation. Even if the operation is unattended, there is a cost reduction, periodic preventive maintenance must be performed, because the equipment is expensive and this could render them unusable or expensive to maintain, which could make the project unfeasible and frustrate the people who had access. electricity and then back into the dark, as has happened with other projects in other communities. As the mini-plants are in hard to reach places, this is perhaps the biggest challenge for Amazonas Energia, the local energy concessionaire responsible for the project.

Regarding environmental sustainability, the generation of electricity via photovoltaic system does not cause pollution [12], but due to the complex logistics to the isolated community, it caused damage to some equipment, specifically the OPz battery, which resulted in the leakage of electricity. electrolyte, being a threat when disposed on the ground. According to [13], the manufacture of automotive batteries relies on the generation of liquid effluents. Thus, according to CONAMA Resolution No. 430/2011, effluent is the term used to characterize liquid discharges from various activities or processes.

Liquid effluents generated in the battery production process can cause serious damage to the environment if not handled correctly, causing contamination of soil and surface and groundwater, as well as damage to fauna and flora, because relevant effluents contaminated with acid are generated. sulfuric acid with low lead concentrations. It is also considered the need for proper disposal of batteries, since it is a device that causes environmental impact, if not disposed of correctly.

With regard to economic development, the system implemented was found to be economically sustainable - temporarily - and the prepayment system made it possible to make payment without the need to move from the community during its operation period [14].

The joint and articulated work of the various municipal, state and federal government agencies is fundamental for access to energy and other public policies to be of high quality to ensure access to citizenship and to break with inequality of development in the Amazon. Interventions in communities should take place in order to increase the process of social organization, that is, to favor the process of solidarity organization among families, to favor sharing, the economy of reciprocity, the collective use of services and equipment available within the community.

## 4. Conclusion

For the development of a region, the fundamental requirement is to guarantee access to energy through public services and equipment. It enables access to other rights and services, adding value to products.

Access to electricity is a right of the citizen and alternative sources of energy, which have allowed more families to enter electricity, but it is necessary to continue to improve photovoltaic technology associated with the expansion of its use. offer, in the short term, even better social, economic and environmentally sound solutions for power generation in isolated rural communities.

A policy of expanding the distribution of energy must be associated and articulated with other public policies in order to universalize the social benefits and improve the quality of life of citizens living in remote regions of this country.

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# **Diagnosis of the Basic Sanitation of the Prata Lagoon and Maresia Lagoon, Prosai-Maués Project, Located in the Municipality of Maués - Amazonas**

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## **Abstract**

*The discussion about the quality of Environmental Sanitation (ES) services is currently highlighted because it is directly linked to the population's quality of life. Assessing the scope of SA services has become an important tool for the management of municipalities and states, as it allows the adaptation to the reality of the population to improve future planning, foreseeing the expansion of SA services. The Municipal Basic Sanitation Plan - PMSB was established by Law No. 11.455 / 2007 as an important planning tool for basic sanitation services. It consists of programs, projects and actions aimed at improving the conditions of services that constitute basic sanitation: water supply, sanitation, as well as urban solid waste management and urban river water. With the accelerated urban growth in the municipality of Maués and the intense aggressions to the environment, the PROSAI-MAUÉS ES indicators were identified and diagnosed, which propose improvements in the urban, environmental and basic sanitation conditions of the municipality with the recovery of Lagoas do Silver and Maresia, which for many years have suffered from pollution around the lagoons. The lagoons in question were chosen for the implementation of PROSAI-MAUÉS, explained by the occupation of its margins by low-income population installed on stilts, the existence of flood risk points and the need for renewal of this urban fragment of tourist importance. On-site research was conducted using observation techniques and photographic recording to describe the conditions of local sanitation services. The experience of the*



*PROSAI-MAUÉS project indicates that it is necessary to seek the institutional strengthening of the entities involved with the local society since the early stages. from the initial planning and execution to the final phase of monitoring and follow-up of the services provided by the basic sanitation works, thus ensuring the sustainability of the Program for future generations.*

**Keywords:** Water Supply; Depletion; Urban Drainage.

## 1. Introduction

The problems in the urban environment are caused by the expansion of the territorial occupation of cities, because the infrastructure offered is not always able to serve the population with sanitation services, especially in water supply, treatment, sanitation and sanitation management. municipal solid waste.

The absence of sanitation services results from factors such as poor conditioning of urban solid waste, the deficiency of water supply service, the inefficiency of the sewage collection and treatment network, causing problems to the health and quality of life of the population. , added to the difficulty of the Government to manage these aspects.

The discussion about the quality of Environmental Sanitation (SA) services is currently highlighted because it is directly linked to the population's quality of life. Assessing the scope of SA services has become an important tool for the management of municipalities and states, as it allows the adaptation to the reality of the population to improve future planning, foreseeing the expansion of SA services.

According to [1], only 68% of the world's population has access to adequate sanitation and more than two million people worldwide live without adequate sanitation.

As stated, [2], the acceleration of population growth does not go along with economic and social progress due to political and management issues, one of the negative consequences being the absence, insufficiency or inefficiency of water supply, sewage, drainage and garbage collection, which directly affects the society that inhabits or uses it.

According to [3], public policies can be defined as all government actions that favor the public interest. Brazil suffers from the absence of public policies, so there are interferences in the management of sanitation services, as the problems intensify aggravating public health, which directly interferes with the population's quality of life.

For any country, the efficiency, quality and universality of basic sanitation services are fundamental to the quality of life of the population. This sector has direct impacts on a country's public health, environment and economic development [4].

In Brazil, public basic sanitation services are a right guaranteed by the Federal Constitution and defined by [5] and has as one of its principles the universalization of basic sanitation services, so that everyone has access to them. However, there is a large proportion of Brazilian citizens who do not enjoy these services.

The Municipal Basic Sanitation Plan - PMSB was established by Law [5] as an important planning tool for basic sanitation services. It is comprised of programs, projects and actions aimed at improving the conditions of services that constitute basic sanitation: water supply, sanitation, as well as urban solid waste management and urban river water [6].



According to [7], environmental health is the state of health in which the urban and rural population lives, in terms of their ability to inhibit, prevent or prevent the occurrence of endemics or epidemics transmitted by the environment. As for its potential for promotion, the improvement of mesological conditions favorable to the full enjoyment of health and well-being.

Also, according to [7]: environmental sanitation is the set of socioeconomic actions that aims to achieve Environmental Health through drinking water supply, collection and correct disposal of solid, liquid and gaseous waste, urban drainage, control communicable diseases and other specialized services and works. Ensuring quality and universal access to basic sanitation in Brazil is still a major challenge. Like other essential public services, deficits denounce the country's delay in guaranteeing basic rights such as access to water and the safe disposal of waste and solid waste. Exclusion and inequality and the low quality of services is the product of a development model linked to the capitalist mode of production and as such a promoter of contradictions, antagonism and inequities [8].

The City Hall of Maués held, on March 25, 2018, the solemnity event that marks the resumption of the works of the Maués Integral Sanitation Program (PROSAI MAUÉS), 267 km away from Manaus. The project aimed to restore the Lagoon do Prata and Lagoon do Maresia, with urban upgrading, water supply, sewage and urbanization, squares, fairs, exhibitions and bicycle paths [9].

It is a project financed by the Inter-American Development Bank (IDB) in the amount of US \$ 35 million, with US \$ 10.5 million in counterpart funding from the Amazonas State Government (GEAM). The works of PROSAI MAUÉS had been stopped since 2013 and only in 2018 were they resumed by the political articulation of Maués municipal public administration with GEAM [9].

With the accelerated urban growth in the municipality of Maués and the intense aggressions to the environment, the PROSAI MAUÉS SA indicators were identified and diagnosed, which propose improvements in the urbanistic, environmental and basic sanitation conditions of the municipality with the recovery of the Silver and Maresia lagoons, which for many years have suffered from pollution around the lagoons.

The lagoons in question were chosen for the implementation of PROSAI MAUÉS, explained by the occupation of its banks by low-income population installed on stilts, the existence of flood risk points and the need for renewal of this urban fragment of tourist importance.

The study evaluated the basic sanitation actions based on the [7] Manual for the diagnosis of AS in Lagoon do Prata and Lagoon do Maresia, populous areas with greater environmental impact.

From the elaboration of the diagnosis it was possible to identify the improvement data for the Water Supply (AA), the Sanitary Sewage (ES) and the Urban Drainage (DU) of the PROSAI MAUÉS project, detecting the successes and the improvement points of the management. basic sanitation, making the public aware with transparency and listening to the proposals of society with the objective of solving the detected problems [10].

## **2. Materials and Method**

The research is qualitative, descriptive, in which data will be collected from public documents and other sources of collection [11]. They collected information from the Water Supply (AA), Sanitary Sewage

(ES) and Urban Drainage (DU) services in the surroundings of Lagoon do Prata and Lagoon da Maresia, performing the diagnosis of PROSAI MAUÉS works, in the municipality of Maués - AM .

Then, the field work was carried out, with the on-site research, with the visit around Lagoon do Prata and Lagoon do Maresia, in which observation techniques and photographic record were used to describe the conditions of sanitation services. Basic place. In addition, there were visits to public agencies such as the Municipal Secretariat of Environment, Infrastructure, Health and the SAAE Water Company to collect data on water supply, sewage and urban drainage.

The information was tabulated and compared with the works of PROSAI MAUÉS, and the results are presented in tables and figures, for the demonstration of the quality of environmental sanitation around the lagoons.

### 2.1 Study area

The study is focused on Maués, one of the 62 municipalities of Amazonas that is 267 km, straight, from the capital Manaus and has about 63,905 thousand inhabitants. Its headquarters is located in a solid ground area with an altitude of 18 m above sea level [12] (Figure 1).

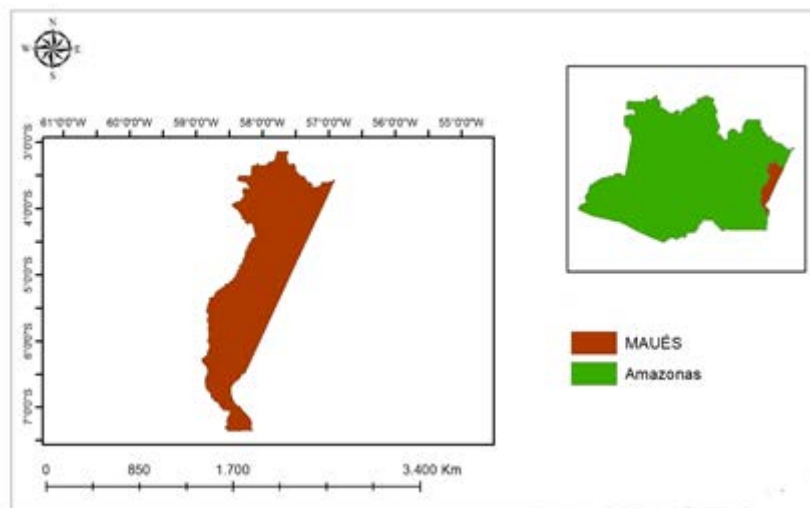


Figure 1 - Location map of the municipality of Maués-AM.

Source: Prepared by the Author Himself (2019).

## 3. Results and Discussion

The urban works of the Maués Integrated Sanitation Program (Prosai-Maués), the interior version of Prosamim, began at Lagoon da Maresia and Lagoon do Prata, in the central region of the municipality's headquarters. PROSAI MAUÉS worked on two of the five largest lagoons in the municipality that face serious environmental pollution problems [13].

The PROSAI MAUÉS project benefited indigenous communities from Monte Salem, Sagrada Familia, Santa Izabel, Boas Novas and Monte Horebe; with the construction of artesian wells and reservoirs with capacity of 10.000 L, having the operation through solar plates [14].

It was necessary to study the diagnosis of basic sanitation around the works of the two lagoons, related to urban drainage works, water supply, sanitation, environmental mitigations and improvements for the local

population, making analysis of the work.

Initially, we highlight the PROSAI MAUÉS work management process, with the project's initial budget in 2013 for 6 years of planning and execution, but it was closed in 2019, contributing to generate solutions for basic sanitation problems. , urban and socio-environmental factors that affect the population's quality of life and the sustainability of the Municipality of Maués (Figure 2).

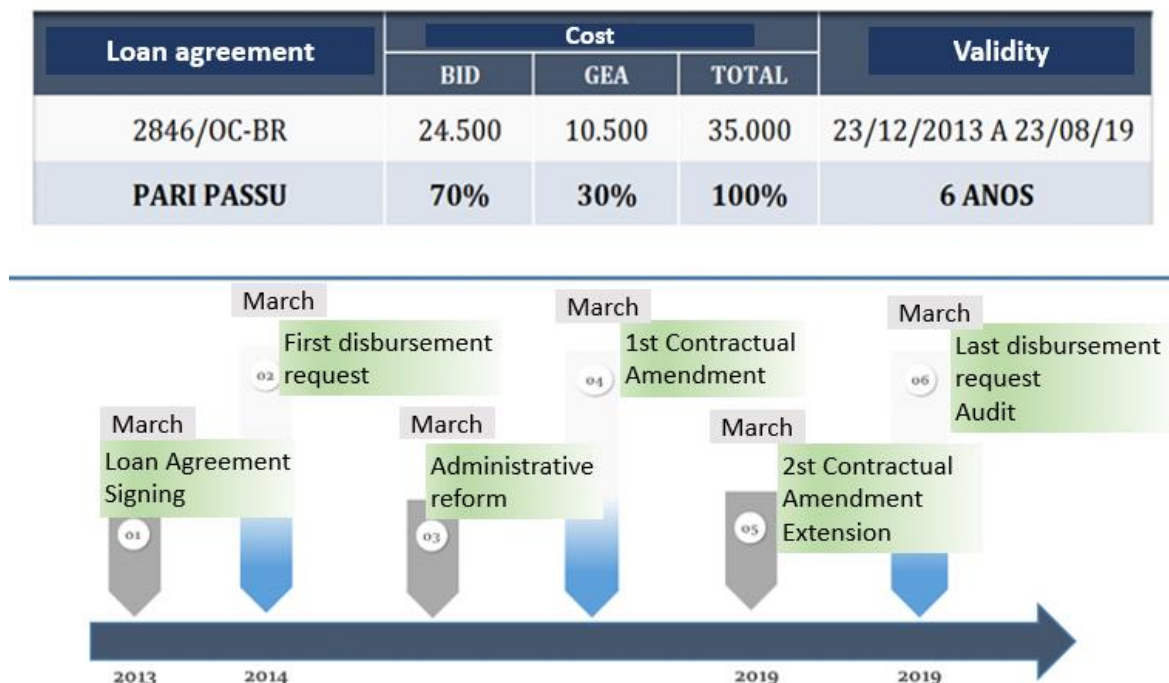


Figure 2 - PROSAI MAUÉS Program Cost Planning.

Source: AMAZONAS (2019).

It is observed that PROSAI MAUÉS was developed to support the physical, financial, accounting and administrative management, providing planning, monitoring and social control with the participation of regulators and supervisors of the public purse. Demonstrating the US \$ application of program components for environmental and urban improvement; social, economic and institutional sustainability; and drinking water and sanitation for indigenous communities (Figure 3).

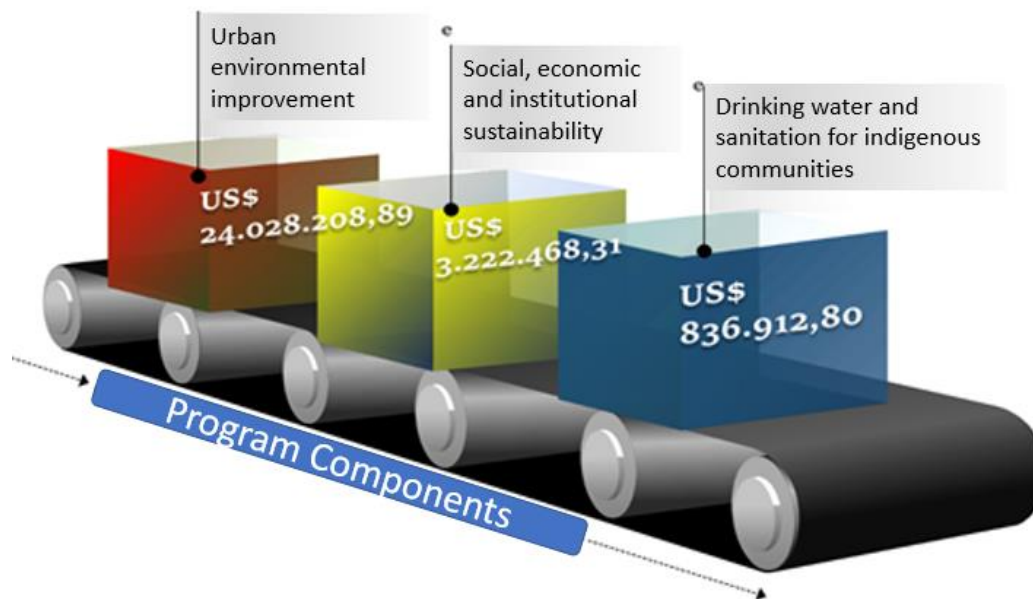


Figure 3 - Investments in US \$ dollars of program components.

Source: AMAZONAS (2019).

In the financial administrative process, on-site audit was monitored by members of the program's financial team, ensuring the release of funds by the IDB for the PROSAI MAUÉS project.

According to Article 3 [5], which establishes national guidelines for basic sanitation, sanitation service sets are defined as follows:

- Drinking water supply: set of activities, infrastructures and facilities necessary for the public supply of drinking water; the capture up to the building connections and their measuring instruments;
- Sanitary sewage: set of activities, infrastructures and operational facilities for proper collection, transportation, treatment and final disposal of sanitary sewage, from building connections to final release into the environment;
- Urban cleaning and solid waste management: set of activities, infrastructures and operational facilities for the collection, transportation, transshipment, treatment and final destination of domestic waste and waste originating from the sweeping and cleaning of public places and roads;
- Urban stormwater drainage and management: set of urban stormwater drainage activities, infrastructures and operational facilities, transport, detention or retention for flood flow damping, treatment and final disposal of drained stormwater in urban areas [ 5].

At the conclusion of PROSAI MAUÉS works in the surroundings of Lagoon of Prata and Lagoon of Maresia, the services of AA, ES and DU were diagnosed respectively, presenting the solutions and challenges of social and environmental impacts with local residents in urban intervention.

The Maués water supply service is currently carried out by the municipal council called Maués Autonomous Water and Sewerage Service (SAAE), which has been without investments for over a decade. The city's water supply was provided through 9 shallow 33 m wells connected directly to the network, with only a 227 m<sup>3</sup> high reservoir that was not sufficient to serve a population of over 30,000 in the absence of electric power.

Another obstacle was waste, which of the 5.4 million m<sup>3</sup> captured annually, 66% was wasted by clandestine connections, residential misuse and lack of maintenance. The index quoted exceeds the national average of 41% according to [15].

With PROSAI MAUÉS interventions, 07 new 80 m deep tubular wells were built; 03 supported tanks; 02 elevated reservoirs; construction of 5,340 m of water distribution network; installation of 2,500 meters, enabling the municipality to serve 92% of the urban population with water treated for human consumption.

With these investments applied, the municipal administration acted on new fronts with the population to set up a council and a Municipal Basic Sanitation Fund, institutional educational campaigns in the city's education channels and official networks, lectures to the municipal education networks and application of inspections of homes and businesses.

Just as the vast majority of Amazonian municipalities Maués did not have an adequate sewage system, it was through septic tanks and sinks. Sinks were common mainly around the lagoons, causing a major health problem during flooding periods where they were submerged for a long time during the rainy season.

A large part of the population, due to lack of knowledge related to the environment, and especially financial conditions, choose this rudimentary environment causing a great impact on the soil and groundwater. The sanitary sewage system seeks to properly dispose of wastewater, that is, sewage or effluents, ensuring proper treatment before final disposal occurs. Thus, it is intended to minimize and even eliminate the risks related to public health and the environment arising from the inadequate discharge of effluents, complying with legal standards in force [16].

Approximately 18.2 million reais was invested to improve sewage sanitation and wastewater treatment. Through the Special Projects Management Unit (UGPE), 13,842 m of collecting network was recovered and an additional 18,598 m was built, totaling 32,440 m. To meet the need for effluent transshipment, 07 pumping stations were built at strategic points, as well as rebuilt an Effluent Treatment Station (ETE) capable of serving twice the urban population [13].

From septic tanks to sinks today Maués has about 3,433 infra-household connections serving about 52% of the population, positioning it as the city of the interior of Amazonas with the largest sanitary sewage network. In a large project that involves the basic needs of the population such as Basic Sanitation, it is necessary that the UGPM and UGPE continue to work together to increase community adherence to the sewage system implemented and create a maintenance plan, ensuring the good utilization and preservation of the implemented works.

One of the major difficulties in implementing basic sanitation in Amazonas is the topography of municipalities. The municipality of Maués was built without any planning, and over time the problems were appearing, the city's urban drainage has macro and micro drainage.

The main streets of the city have gutters, curbs, wolves, some in bad conditions, without railing, being susceptible to the entry of solid waste in rainy weather. It is also reiterated that the diagnosis of this service should also include the entire planning area of the PMSB, namely: the urban and rural areas of the municipality, including the dispersed areas (quilombola, indigenous and traditional communities) and the areas. where the low-income population lives (slums, irregular occupations, precarious settlements,

among other denominations), as determined by the City Council [6].

Some parts of the city suffered from flooding of some streets causing inconvenience to residents, but the problems have already been solved in partnership with UGPM and UGPE. PROSAI MAUÉS 'intervention in terms of Urban Drainage took place around the two lagoons, the macro drainage work was renewed and expanded at the main entrance located in Lagoon do Prata. New wolf mouths, gutters and curb were renovated and built to a total length of 1,597 m.

The surroundings of the Prata and Maresia lakes meet the Master Plan of the Municipality of Maués (2 m wide), where drainage interventions around the lakes met local needs, but it is up to the municipal agencies to expand such needs to the periphery of the region. city suffering from lack of drainage [14].

In the field of drainage, soil occupation, waterproofing levels, the road system, strategies and standards for the protection of permanent preservation areas and for the management of rainwater or flood damping, the protection of recharge areas. among others, were extremely important points for the management of rainwater.

The economic activity of the municipality revolves around the culture of guarana and agriculture, the implementation of PROSAI MAUÉS works may bring positive reflexes in the promotion of tourism, one of the great potentials of economic development of the municipality combined with local sustainability.

PROSAI MAUÉS fulfilled all the requirements imposed by the IDB by conducting environmental studies, complying with conditions, restrictions on environmental licensing, safeguarding of archaeological heritage and the rescue of fauna and flora. It is the responsibility of the Municipal Secretariat of Environment (SEDEMA) to replace native species in the intervention sites.

Over time with the growth of the city irregular occupations became constant around the lakes, requiring interventions to try to restore the environmental quality of the site.

Another dialogue that was essential involved the field of urban planning, an activity foreseen in the Federal Constitution, through the elaboration of Master Plans. The Master Plan is the basic instrument of urban policy and should ensure the social function of the city by addressing citizens' needs for quality of life and social justice.

Technical teams were made aware by families about the benefits of the program and Basic Sanitation. The program implemented 208 resettlement solutions benefiting 1,472 needy families with sewage connections and the construction of 39 toilets (Figure 4).

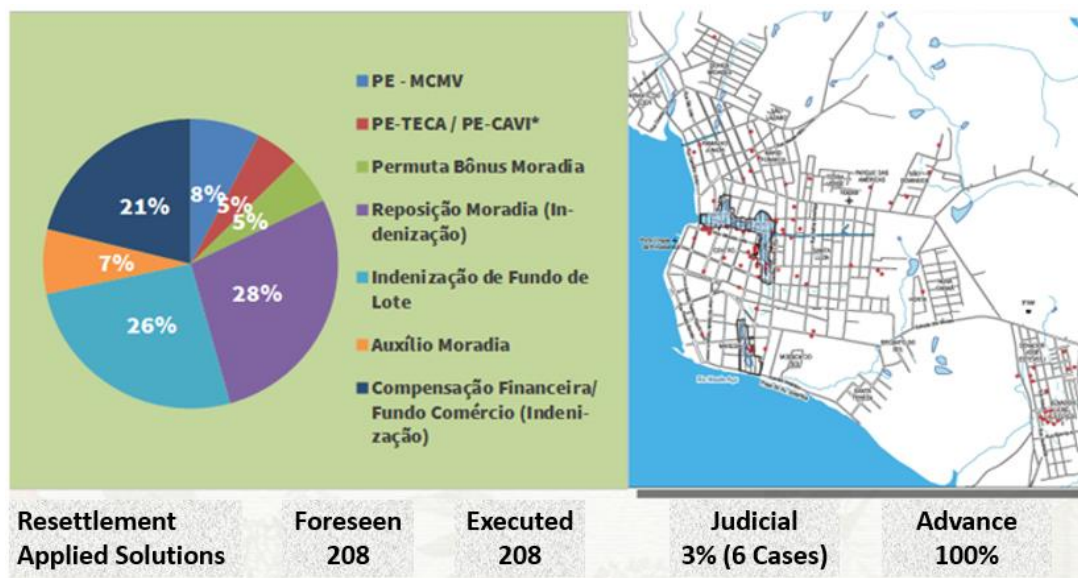


Figure 4 - Resettlement - Housing Replacement and Financial Compensation

Source: AMAZONAS, 2019.

The right to sanitation is one of the guidelines of urban policy, expressed by [17], known as the City Statute. Through the Municipal Master Plan of Maués there was the urban intervention, which assessed the demands throughout the municipality of Maués, including the city sectors, and verified the capacity of sanitary infrastructure in water and sewage installed, in order to identify alternatives to serve the population (Table 1) [18].

Table 1. Diagnosis of the variables analyzed in an urban intervention.

Variables analyzed	Silver Lagoon	Maresia Lagoon
Supply	92% of the population with drinking water	Repair and installation of new plumbing and flow
Burnout	Structure for the collection and treatment of sewage, serving 52% of the urban population	Adequacy of septic tank structures for indigenous communities
Drainage	Micro drainage installation around the lagoon;	Micro drainage installation, with a view to urban mobility of the Master Plan
Cheers	Construction of courts, playground and gym	Reduction of waterborne diseases

Source: Elaborated and adapted [18].

The PROSAI-MAUÉS program has shown the following positive points: The approach for the transfer of works from indigenous communities to the DSEI; the integration between the teams of PREFECTURE / UGPM and STATE / UGPE; the use of the methodology adopted in the review and preparation of studies focused on urban development through: workshops, seminars and public hearings, which gave rise to specific laws with the community.

On the negative points it was identified that the operational structuring of UGPM / PMM, at the beginning of the execution, was inadequate due to the complexity of the Program; advising / consulting program activities through the advisory committee as provided for in the first phase of the project; the installation of water meters without previous awareness campaign of local users; and the full



implementation of the tariff dimensioned in a specific study.

In the social aspect, the population benefited from the resettlement with basic sanitation solutions applicable to families. In Lagoon do Maresia 55 properties were resettled and in Lagoon do Prata 153 properties; benefiting the population with compensation (housing replacement and financial compensation), the land-house exchange, housing assistance and the trade fund.

In the sustainability of the program was implemented the practice of studies designed to increase revenue from City Hall and SAAE; the expansion of operational capacity through training for future operators of the implemented management systems; the creation of the control and inspection committee to ensure the implementation of all plans and actions provided for in the program.

#### **4. Final Considerations**

Water supply, sewage and urban drainage systems provide general health benefits to the population. The effects of sanitation interventions are generally positive, as they are a service that ensures the improvement and well-being of the population.

However, investments in sanitation must meet technical, environmental, social and economic requirements in order to work on the concept of sustainable development, preservation and conservation of the environment and particularly of water resources, reflecting directly on the planning of sanitation actions. .

Since sanitation services are of local interest and the local government has the competence to organize and provide them, the municipality is the holder of the service. Thus, a sanitation policy should assume that the municipality has autonomy and constitutional competence over the management of sanitation services within its territory, respecting the general conditions established in national legislation on the subject.

The experience of the PROSAI-MAUÉS project indicates that as a lesson learned it is necessary to seek the institutional strengthening of the entities involved with the local society from the initial planning and execution phase to the final monitoring and follow-up phase of the services provided by the sanitation works. thus, ensuring the sustainability of the Program.

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# **MWO Line Optimization Applying Lean Manufacturing Methodology: PIM Case Study**

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## **Abstract**

*With the increasing competitiveness in the market and the constant development of technologies, today companies are constantly improving, the managers' concern is to achieve maximum process productivity with minimum losses and waste, thus reducing the value to the maximum. aggregate to the product and taking considerable profit margins from sales, so it is of paramount importance to have a lean production process, with well-balanced production times, a minimal amount of work in process and especially a minimal amount of labor, which has very high costs that generates added value directly in the product. In this study was applied the methodology, observation, quantitative and deductive based on theoretical references in order to maximize the efficiency of the production process, through the use of some Lean methods and quality tools as a way of discourse for process improvement also applying process balancing with the primary purpose of reducing the amount of direct labor. Thus the present study presented satisfactory results increasing the efficiency of the microwave oven production line, with the reduction of a direct operator, bringing a leaner and more efficient process.*

**Keywords:** Lean Manufacturing; Process balancing; Efficiency.

## **1. Introduction**

Faced with a highly globalized market, companies that seek to increase their competitive advantage through systems management, resort to Lean Manufacturing, whose goal is to eliminate losses in the production process becomes a complete production system and is a reference in efficiency and

effectiveness. , bringing cost reduction, higher productivity and quality in the production process, ensuring the survival of companies to respond quickly to customer demand. "How to increase process efficiency using Lean concept tools applied to a PIM Company MWO line?"

For Bhamu and Sangwan (2014) lean provides organizations with positive and competitive leadership by reducing waste and improving productivity, quality and controlling the efficiency and effectiveness of a given process.

The use of quality tools in corporations across a wide range of industries has evolved significantly and methods have improved, giving greater stability and reliability to product operations and service delivery. (BERGER et al., 2012).

The study will use the quality tool Brainstorming, as an aid to the brainstorming, because it is simple and easy to execute, it has become routine in the main companies in the world, this tool consists in generating ideas from a group of people. involved in a particular subject in a pleasant climate that is conducive to breaking taboos and without concern or criticism, this way I will apply it to the project team that involves the Quality, Engineering and Manufacturing areas, as it takes several process views to get the improvements.

This paper aims to apply the Lean Manufacturing philosophy to achieve resource balancing and optimization in a microwave oven production line.

With the implementation of the initiatives we will obtain very relevant results for the microwave oven line, where we will be able to maximize the process efficiency and to resize the activities of the workstations and to optimize some tests performed, and besides we can identify improvement points for future projects in the process.

## **2. Theoretical References**

### **2.1 Lean Manufacturing**

Lean Manufacturing also known as Toyota Production System was created in Japan after World War II where, in the 60's, the market demanded greater flexibility and together with the growth of competitors led to a new production system being developed. by engineer Taiichi Ohno and his team (OHNO, 1997). According to (Carvalho 2014 apud, Henderson and Larco 2000), Lean Manufacturing is made up of various details in procedure format and methods, technique and processes that interconnect and act as a great gear for companies to pursue their continuous improvement. your processes and services.

### **2.2 Lean Tools**

#### **2.2.1 Just in Time**

Just-in-Time is a means of manufacturing management created by the Japanese in the 1970s. According to Monden (1984) JIT's philosophy is: "Produce the necessary units in the required quantities at the required time." For Hamilton Pozo (2010) JIT is "a production philosophy aimed at eliminating waste in the total manufacturing process from distribution shopping".

JIT is usually employed in recurring manufacturing when the same items are produced in sequence. This process shows that stocks hide problems. Therefore, in this practice all problems must arise.

### **2.2.2 Kaizen**

Kaizen is a Japanese word, according to Siqueira (2005), in which Kai means change, and Zen means for the better. The Kaizen system is premised on continuous improvement and its philosophy is an important resource in the constant pursuit of improving productive and administrative processes, making them leaner and faster.

The kaizen cost method seeks to maintain current cost levels for manufactured vehicles and constantly work to reduce costs at all stages of manufacturing to achieve the company's desired values, helping to eliminate the difference between target profits and profits. estimated. (MONDEN, 1999).

### **2.3 Toyota Production System (STP)**

According to Shingo (1996), the central idea of the Toyota Production System is to promote a harmonic flow of materials between workstations, producing components in the quantities and times they are needed. To this end, communication between jobs must be promoted efficiently. According to Ohno, the creator of the system, it can be summed up as “producing in the right quantities and when parts are needed” (OHNO, 1994).

During his visit to Ford companies, Taiichi Ohno formulated what he called "the 7 wastes" called "mounting" by the Japanese (WOMACK et al, 2004). That is: waiting, defect, shipping, handling, overstocking, overproduction, mishandling or over processing.

### **2.4 Mass Production**

According to Johnson (1992) the concept of Mass Production was spread by Henry Ford and was also called Push Production, mass production began with the production of the Ford Model T, with 15 million units produced considering the years 1908. to 1927.

Mass Production is actually one of the possibilities of inline process production, which implies the existence of line flows in which both the products and the services offered follow a standardization.

### **2.5 Lean Production**

It was conceptualized through the Toyoda System which represents a set of interconnected elements that make it possible to produce more with less and less resources, according to James P. Womak and Daniel J. Tones (1990), when he published the book “The Machine that Changed the World”.

According to Taiichi Ohno (1988) social values have changed. Now we can't sell our products unless we put ourselves into the hearts of our consumers, each of whom has different concepts and tastes. Today, the industrial world has been forced to truly dominate the multiple production system in small quantities.

### **2.6 Production Systems**

According to Gerlah (2013) apud Moreira (2002), the production system is a set of activities and operations that are linked together, which together are involved in the production of goods and services. They can be classified into four types: continuous, mass repetitive, batch repetitive and design.

Combining production volume and degree of variety it is possible to assimilate the definition of the type of layout to be chosen in the production system. Several times, based on the level of process complexity,

there may be several types of production systems in a single layout.

## **2.7 Quality Tools**

For an organization to meet a customer's needs, it is necessary to establish a system that integrates different processes within the organization, such as product manufacturing, development, sales, and marketing. This integration and the execution of processes must follow a methodology that reduces risks and increases the efficiency of the results applied (PALADINI, 2002).

### **2.7.1 Brainstorming**

According to Miguel (2001), the Brainstorming tool means brainstorming, that is, thoughts and ideas that each team member can expose without worrying about the assertiveness or acceptance of their suggestion. It can consider, for example, the factor of influence of a specific problem (causes), later discussed by the group itself.

According to Fagundes and Almeida (2004) Brainstorming is a technique that allows group members to feel comfortable recording their ideas using creativity, which helps in the process of identifying solutions, which should follow some steps to formalize and sift the ideas in the discussion process seeks to define: The theme to be addressed; Definition of a leader representing the group; The group and the leader eliminate ideas in duplicate or in synonym; The group and the leader point out the causes related to the problems; Finally the leader prepares the final version of the analysis result.

## **2.8 Productive Management**

### **2.8.1 Production Line Balancing**

The quest to control waste reduction in the production process is the main scope of Lean Manufacturing and the continuous improvement process. Production Line balancing is one such tool that avoids waiting in the process allowing a continuous flow avoiding process stops (ABDULLAH, 2003).

Mapping the production line is the first step to balancing when using the lean philosophy, it is necessary to determine the cycle time, the downtime, calculate the inventory in process and the movement of products, all this survey. data helps to identify results in a future state (ABDULLAH, 2003).

### **2.8.2 Standardization of Methods**

According to Ionak (2016) the standardization of the methods has a positive effect to reduce the losses generated in the production process increasing the quality in production. Implementing standardization for an organization or system is simple and inexpensive, and often only requires several process adjustments through analysis.

The standardization of the methods must be orderly so that the activity is performed as best as possible by any operator always seeking to eliminate non-value added activities. Flow balancing becomes increasingly effective with standardization of methods (Tapping et al, 2002).

### **2.8.3 Productive Capacity**

According to Moreira (2011) is the maximum number of products or services that can be manufactured in

a production system, over a certain period of time, this production system can be considered as a factory, a department or even a simple machine.

In order to calculate the production capacity of a given process it is necessary to have the value of the production rate multiplied by the available time of the operation over a given period of time. The result of this is the quantity of products that can be produced during the period considered. according to equation (1).

$$(1) \text{ Capacity} = \text{Production Rate} \times \text{Available Time} \text{ (Eq.1)}$$

#### **2.8.4 Chronanalysis**

Cronoanalysis is of great importance for the productive sector today, it is a tool that defines the standard time, helps in the organization of processes, being a mechanism that accompanies the continuous evolution of improvements. According to Novaski and Suagi (2002), it argues that Taylor performed a true rationalization of workers' work using the study of times and movements as an instrument.

Anis (2010) noted that companies and organizations are increasingly linked and focused on continuous improvement programs. The applied chronoanalysis results in real parameters by obtaining current and historical comparative data.

#### **2.8.5 Operator Balance Chart (OBC)**

The Operator Balancing Chart is used to define the activities that operators will perform on their jobs, also using takt time as the basis for distributing activities. Activities are defined as operations that add and do not add value to the product (GOMES et, al 2008). With the information, it is possible to distribute the activities and workload of each operator in a balanced way according to the time takt of the balancing graph. Once the graph is filled it allows to analyze possible bottlenecks in the production process of each workstation. job

#### **2.8.6 Work Distribution**

It is the definition of the number of operators. To perform line balancing, the number of operators required must be determined by dividing the total work content by the takt time as (EYNG et al, apud ROTHER & HARRIS, 2002).

The calculation of the number of operators must be done as shown in Equation (2).

(Eq. 2 )

$$\text{Number of Operators} = \frac{\text{Work Content}}{\text{Takt Time}}$$

With the number of operators required to perform the activity, the jobs that will be occupied by the operators are defined (Tapping et al, 2002).

### **3. Methodology**

The purpose of this study is to analyze the production process of a company through the use of

continuous improvement tool and waste elimination in the production line. For this purpose, a field research was carried out with the objective of applying the Lean Manufacturing philosophy and executing it correctly to eliminate activities that do not add value to the final product.

### 3.1 Study Application

We applied the chronoanalysis and GBO tools of a production line in a particular company, it is located in Manaus Industrial Pole - PIM and works in the production of white goods, I chose to study the line that performs The assembly of the microwave oven, we have a line that operates in two shifts in seasonal periods that are from June to December.

The times of each post were obtained for balancing and identification of bottleneck posts for making improvements and suitability for the 14 second takt time.

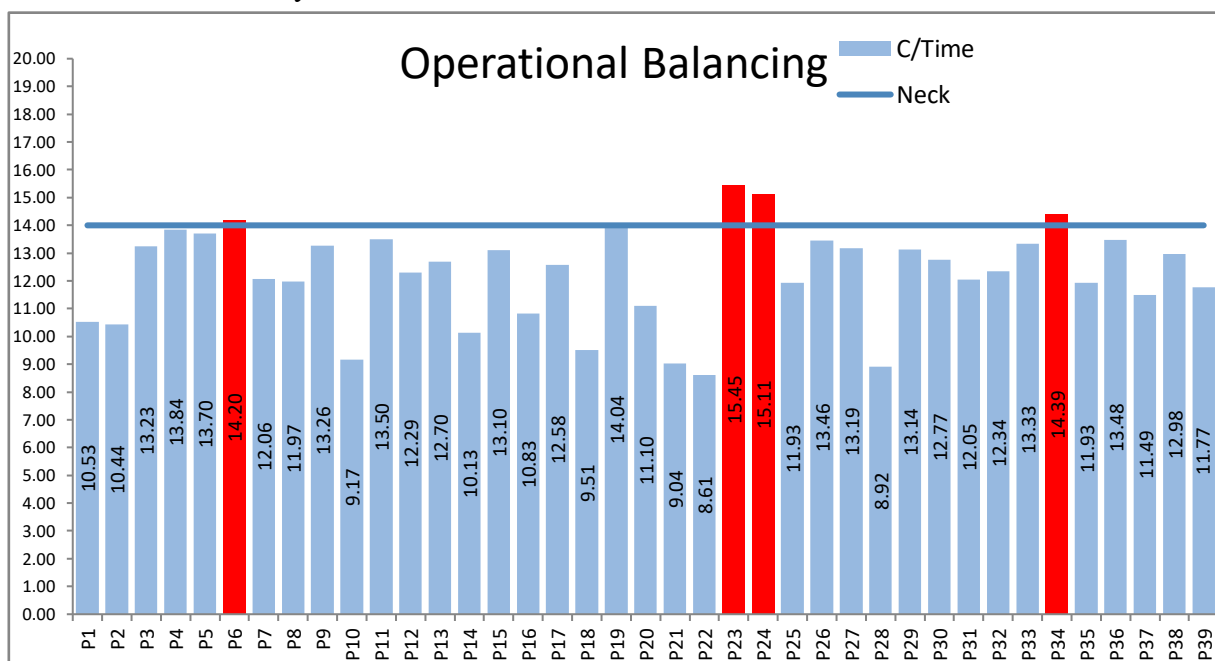


Figure 1 - Operational Balancing Chart (GBO) before improvement.

Source: Company

Below is the line layout, which will be modified if possible, according to the improvements applied.

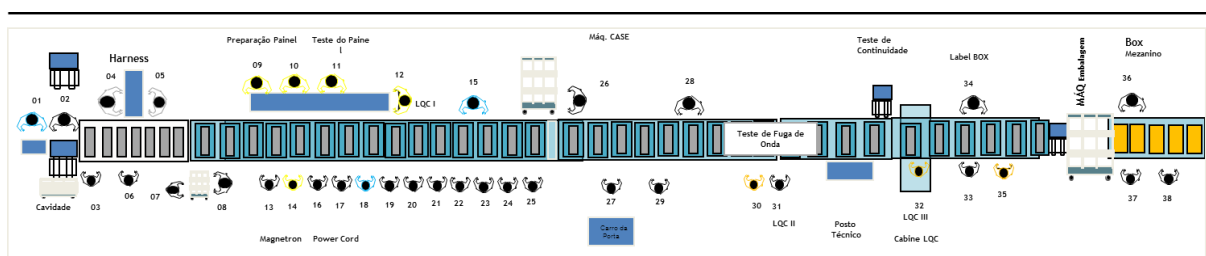


Figure 2 - Production Line Layout

Source: Company

### 3.2 Applied Improvements

#### 3.2.1 Automatic Label Scanning

Manual scanning of the label for insertion of the monitoring and tracing system. In the improvement in

question was installed a scanner to perform automatic reading.



Figure 3 - Process Improvement 1 before x after.

Source: Company.

### 3.2.2 Automation of the packaging process

In the line packing process, an operator was used to transport the box. A conveyor belt was installed from the box to the post that performs the final packaging process. Through this improvement it was possible to reduce one employee.

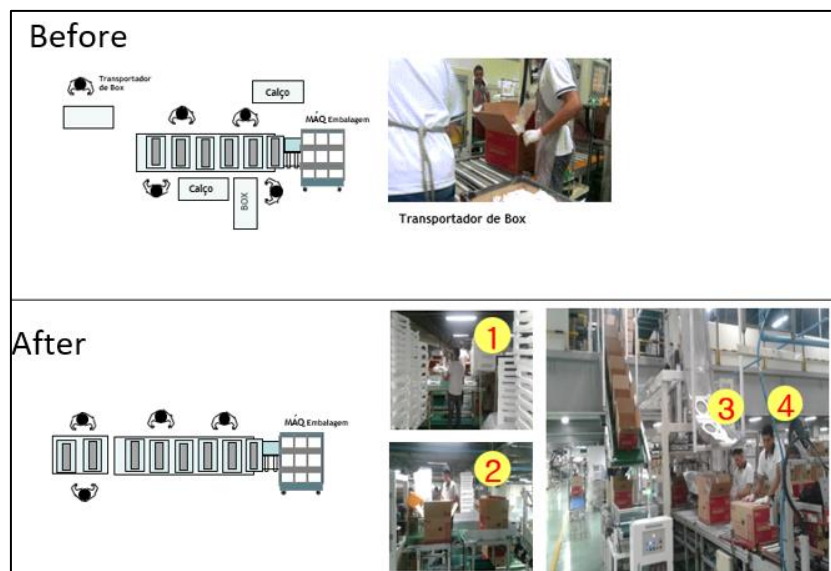


Figure 4 - Process Improvement 2 before x after.

Source: Company.

### 3.2.3 Changing the position of the cover package

The position of the cover package causes unnecessary operator movement. The position of the package in



front of the operator has been modified, the new layout condition eliminated unnecessary movements and improved ergonomics.

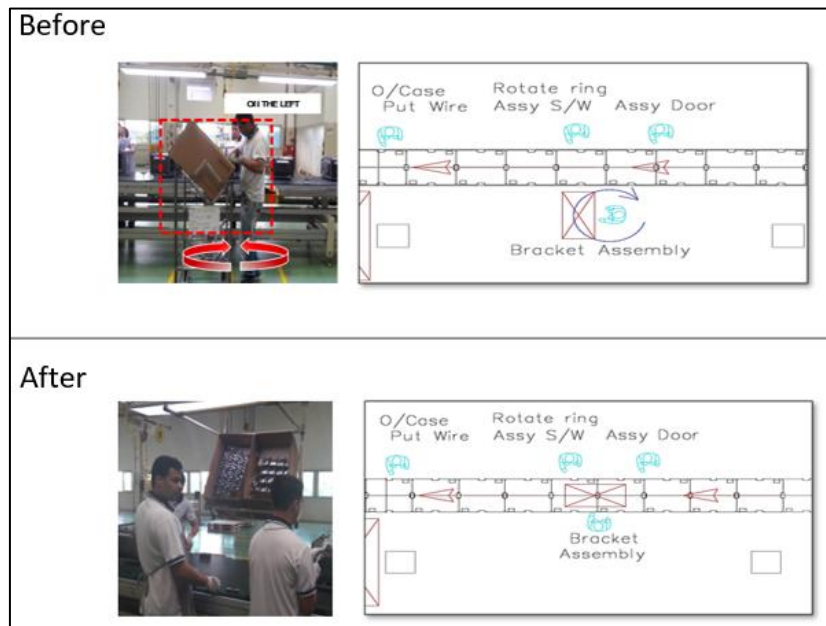


Figure 5 - Process Improvement 3 before x after.

Source: Company.

### 3.2.4 Guide to Product Positioning

In this operation it is necessary to position the product manually on the pallet, causing the plate to break and not triggering the sensor for automatic product packaging. A guide has been added to assist the operator in positioning the product in the correct location.

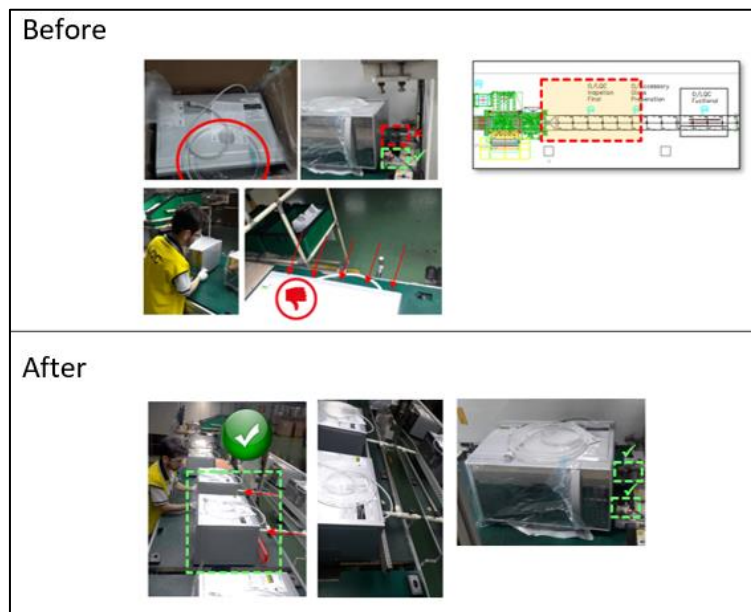


Figure 6 - Process Improvement 4 before x after.

Source: Company.

## 4. Results and Discussion

With the conclusion of data collection and the choice of demands to be defined, which are mostly balancing activities, we will now present in detail the processes performed to obtain the results proposed by the analyzes.

Using the Lean Manufacturing philosophy that also makes use of chronoanalysis to point out in the process where it is wasting time or how to reduce process time (cycle time). Thus, achieving the maximum yield in the industrial production sector, with the least possible investment (REZENDE, SILVA, MIRANDA and BARROS, 2015).

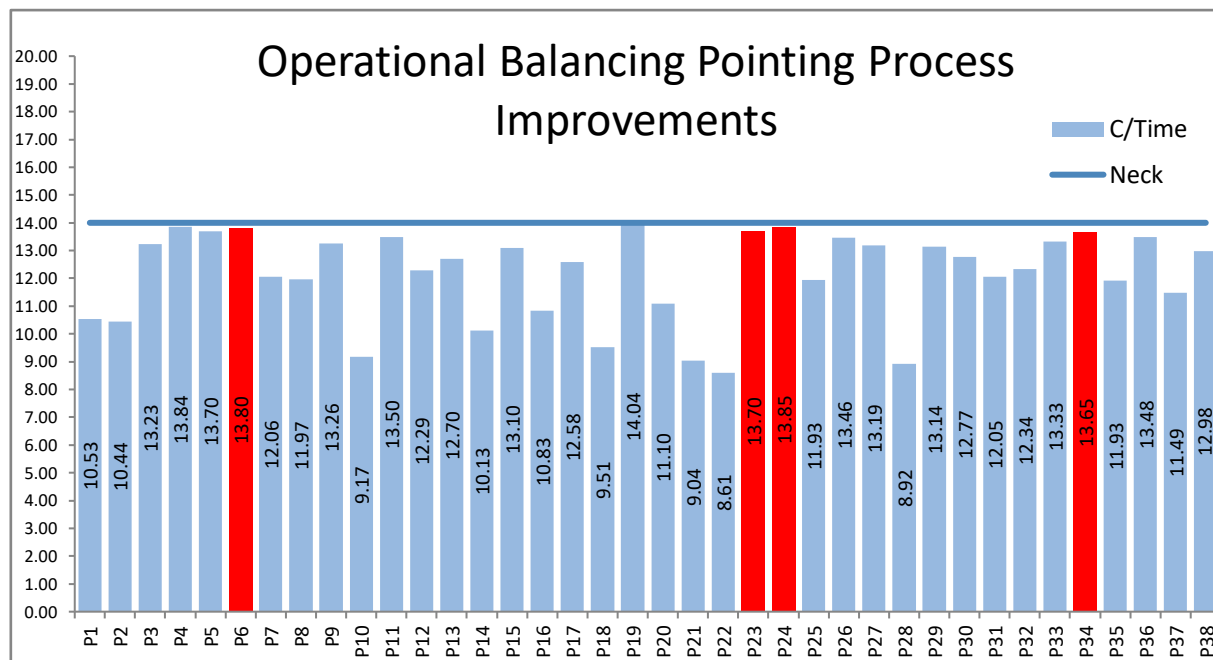


Figure 7 - Operational Balancing Chart showing process improvements

Source: Company

Thus, the initial objective of rebalancing the process by applying the time analysis and presenting in GBO graphs to increase the process efficiency was successfully achieved, since the delivery was performed within the estimated time of six months and not reducing the line hourly target. We already had high productivity and we gained efficiency in the assembly process by reducing the amount of manpower due to the automation of the packaging process.

Junior apud Rocha (2012), explains that the production engineers use calculations to elaborate the best flow of a process, number of stations and reducing line idleness. As well as simplifying losses by avoiding as much as possible, companies become more competitive in the market because they can achieve good productivity and with the lowest costs added to the product.

## 5. Conclusion

The present study aimed to optimize resources in a production line by applying line rebalancing, chronoanalysis and GBO for time wastage analysis and thus improving process efficiency. With this was proposed a study in the process to identify the main bottleneck jobs, which we can consider were the

cycle time and the standardization of the production process, leading to the inefficiency of the line.

Therefore, after identifying the improvements, the process balance analysis was started, applying the GBO, for a better view of the whole, where we had 79.3% process efficiency results, with 39 operators, all due to the implementation of a process without visualization of lean methodology.

It was evident that it was possible to reach an acceptable denominator, keeping the takt of the process that was initially very relevant. With this, it was possible to obtain the expected results through the automation of activities, reducing the takt time of the bottleneck, eliminating such activities that were added to the operator, changing the layout of the station to reduce unnecessary movement and improve ergonomics, reducing fatigue and installation. structures that help the activities. Thus, it was possible to reduce the takt time of posts that were above the maximum allowed point of 14 seconds.

Thus, I was able to achieve results in reducing labor resources from 39 to 38 operators, increasing the efficiency of the manufacturing process from 79.3% to 84.2%, meeting the main objective of the study.

For future studies, I suggest the automation of some process posts. Thus, we can demonstrate that tools such as the seven wastes, line balancing concept and simple actions of how to identify the “bottleneck” post can contribute to the application of low cost improvements and thus result in larger unit of product per hour. producing on a production line optimizing these results.

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# **Implementation of 5S Methodology in Stock Area in an Electronics Factory in Manaus Industrial Polo**

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## **Abstract**

*In companies in the Manaus industrial district, a vision for continuous improvement is obtained, because large companies seek to follow a quality standard in their products and also in terms of organization in their work environment. This article seeks to describe the benefits of deploying the 5S program in a stock sector, where it is one of the shortcomings of large backlogs of manufacturing products in the manufacturing sector, acting with corrections in material allocation positions, as well as the use of appropriate tools and tools. expanding their spaces, having a low cost and also adapting storage of other different models without problems in identification.*

**Keywords:** Improvement, Organization, Low cost, Storage.

## **1. Introduction**

With the tragedies left by the war, Japan created a methodology in which it could acquire a quality of life with an initial focus on industries. In order to achieve their recovery and development, they created the 5S program as the basis for this improvement, in which the country felt the need for everyone to be involved in order to achieve long term results. This method has sought to make progress since the 1950s, when World War II terrorized the whole of Japan. This was designed to combat postwar disasters.

In Brazil it was created for a reeducation base, seeking to maintain an organized and more productive environment, generating the disposal of those that are no longer used, storage for space generation,

cleanliness, standardized areas generating the ease of finding products for work development, the discipline of keeping clean, identified, organized. The 5S that are in Brazil the *Sensos*, translated from Japanese to Portuguese are they SEIRI - Sense of Use; SEITON - Sense of Storage and Ordering; SEISO - Sense of Cleanliness; SEIKETSU - Sense of Standardization; SHITSUKE - Sense of Discipline.

The use of 5S in a company does not mean that you should follow the program as it is implemented in Japanese companies, as it is understood that it needs to be a culture embedded in all sectors that involve the organization, being clear to employees, managers and high importance for the quality of life at work, so that it is not lost after some time, being only a reference.

Highlighting each *Senso* and its importance of implementation in the industrial process, since there is a delay to find certain material, unused raw material, lack of space, disorganization, generating a delay in their release to the productive sector.

## 2. Theoretical Foundation

To carry out the research, we sought to base the use of the 5S Program in a company of the Manaus industrial hub in the segment of motherboard and card machine electronics.

### 2.1 5S Philosophy

The 5S program is a methodology created and devised in Japan in the 1960s, aimed at improving the environment of companies that were very dirty and disorganized, as well as ending waste, reducing the number of personal and impersonal accidents and improving the environment. business productivity. [1]

The program aims to: improve the work environment, reduce waste, prevent workplace accidents, streamline processes, improve employee morale and encourage creativity. [2]

Adopting:

- Seiri: Sense of Organization or Use;
- Seiton: Sense of Storage or Order;
- Seiso: Sense of Cleanliness;
- Seiketsu: Sense of Standardization or Health;
- Shitsuke: Sense of Discipline. [3]

#### 2.1.1 Seiri: Sense of Organization or Use

“O senso de organização ou utilização consiste em analisar os locais de trabalho e classificar os objetos segundo sua utilidade ou frequência de uso e retirar do ambiente tudo o que não necessita estar neste local”. [4]

#### 2.1.2 Seiton: Sense of Tidiness or Order

According to [5] "all materials must have their previously established place, and the most used should be located in a place of easier access". However, this *Senso* contributes to the ordering and tidiness of the department, enabling the location, as well as the gain of new space for storage of raw materials.

Second [6] "is arranging the place where you go to work or perform activities, so as to minimize the

search times for something, which makes the task to be performed more efficient and without risks of accident and less tiring."

The sense of ordering has benefits such as: ease and speed in finding documents and materials; reduces workplace accidents that may occur due to clutter; facilitates communication between employees; avoids the purchase of materials and components unnecessarily; ease of control of purchase orders for stock replenishment and good presentation of the work environment. [1]

### ***2.1.3 Seiso: Sense of Cleanliness***

Cleaning is the most basic activity of the 5S, there is no work that does not involve cleaning. It can also be viewed as an inspection, because with clean equipment and machines it is possible to detect any problem while it is still small, making it possible to repair it immediately. The degree of cleanliness is very important for the safety and quality of the products offered. [3]

The sense of cleanliness has the following benefits: prevention of accidents, reflecting in the reduction of employee absences; cleaner and safer work environments; fight against waste; reduction of pollution and aggressions to the environment and greater control in the conservation of materials. [7]

### ***2.1.4 Seiketsu: Sense of Standardization or Health***

This requirement recommends keeping employees at work in perfect conditions of hygiene, cleanliness and well-being, with health and safety protection measures, including noise, odor, lighting, temperature, ergonomics and protective equipment. For this, safety and workplace protection rules should be established. [2]

The sense of standardization benefits mental and physical balance; the improvement of the work environment and social coexistence within the company; improving the business image to the external public and improving the level of satisfaction and motivation of the people involved. [1]

This sense refers to the union of the 3 previous senses, in a systemic manner, maintaining the disposal, organization and cleanliness, both continuously.

It results in the standardization of the senses, with the goal that all be fulfilled.

### ***2.1.5 Shitsuke: Sense of Discipline***

As expressed [6], "it is that you strictly and continuously comply with the other 4 senses (Seiri, Seiton, Seiso and Seiketsu) without requiring the request of another person (boss or co-worker)".

According to [4] the sense of self-discipline is something personal, because it indicates the moment when people become aware of the need to seek self-development and consolidate the improvements already achieved with the practice of other senses, not neglecting the constant improvement.

It is the most complex sense to achieve because it requires actions and time for everyone to develop it, mainly because this sense interferes with people's culture and behavior. [7]

It is the sense of self-analysis seeking improvement, establishing proper discipline behavior, aiming at personal and organizational growth.



## **2.2 Auditoria Interna dos 5S**

De acordo com [9], Auditoria interna é uma atividade independente e objetiva que presta serviços de avaliação (assurance) e de consultoria e tem como objetivo adicionar valor e melhorar as operações de uma organização.

Ainda conforme [9], a auditoria auxilia a organização a alcançar seus objetivos adotando uma abordagem sistemática e disciplinada para a avaliação e melhoria da eficácia dos processos de gestão de riscos, de controle e de governança corporativa”.

## **2.3 Stock Management**

Companies need a broader view of inventory and management to be able to manage and handle making their business more competitive, as there are gains in management by knowing the importance of limiting their inventory, so there will be no financial waste. It's a waste of time.

As reported [10] Management is a set of activities that aims, through the respective inventory policies, to fully meet the company's needs, with maximum efficiency and the lowest cost, through the largest possible turnover to capital invested in materials.

According to [11], “a company's inventory area is generally responsible for controlling the flow of materials internally, and should therefore balance the needs and availability of the organization's resources, whether human, material, physical and financial space, among others ”.

Companies have the importance of having a well-managed inventory, as lack of products as well as excess materials is detrimental to the overall management of the end product and capital.

## **2.4 Continuous Improvement Process**

In the nineteenth century, on the Ford Motor Company assembly line with its concept, improvement gained relevance. In 1948, in Japan, came the continuous improvement in the processes that would influence the change of productions. Nowadays the thinking of (Lean Thinking) meaning of continuous improvement in Japanese is seen in many companies.

According to [12], improvement is characterized as a process of continuous product and process improvement towards major performance improvements. Continuous improvement is characterized as an iterative, cyclical process. That is, from the evaluation of the obtained results, the research and knowledge acquired with an improvement action on a given object of study, new improvement actions can be proposed, which would lead a virtuous cycle of improvement.

For [13], continuous improvement is the search for better results and performance levels of the company's processes, products and activities. It puts it as an objective to be developed culturally in the company and can be generated by a management action or a suggestion of one or several employees.

As stated [14], the continuous improvement process is influenced by external factors and pressures. He says that if his goal is to create an internal structure that can meet external expectations and nullify forces contrary to business development.

Solutions for a Model That Can Be Used

- The PDCA Cycle
- Kaizen Method

- Lean Thinking
- Six Sigma

Of these four tools, only the PDCA Cycle was used for 5S deployment in the Inventory sector, below is an explanation.

### 2.5 PDCA Concept

In the 1930s it was developed by Engineer Shewhart, the American origin methodology, the PDCA, but it was Deming who publicized the method and made the PDCA known initially in Japan and later worldwide. Based on four words there is a continuous cycle using Plan, Execute, Check, Action.



FIGURE 1 - PDCA Cycle

Source: adapted from [14]

Plan: Identify the problem, analyze and develop the action plan to achieve the goals.

Do: Execution of Action Plans, compliance with standards.

Check: Control the effectiveness of action plans, always following the work, in order to verify the results obtained.

Action: Action Correctly If Needed, Acts with Standardization, Review Activities and Planning

## 3. Tools and Methods

As ferramentas utilizadas para contribuir na melhoria contínua foram planilhas no Excel, Apresentações no Power Point nas reuniões periódicas durante o processo de implantação do 5S. O Gráfico de Pareto, foi a ferramenta para levantamento dos pontos de melhoria. E, uma equipe foi treinada para acompanhamento do desenvolvimento do método.

Na Análise dos Resultados, nos itens de verificação considerados problemáticos foi utilizada a ferramenta 5W2H, na qual consistiu em analisar a causa raiz do problema, através das sete perguntas: What, Why, Where, When, Who, How, How Much.

## 4. Application of Study

The application started through a meeting with the sector manager, responsible for the team. The research

project was implemented through the case study that began with the planning, which defined the execution schedule, the action, the responsible and the execution time.

The Cycle will be approached by explaining each task performed in the deployment.

#### 4.1 PLAN

In the first stage, the definition of the 5S Team was carried out, the team was responsible for planning the deployment, various problems in the sector were evaluated, such as equipment disorganization, obsolete material close to the materials in use, lack of standardization, extremely working table. Messy, working tools out of place, wasting time. After taking several photos of the Sector, a presentation was made to show employees the current status, and the weekly Action plan was set at a meeting with the entire 5S team.

In Figure 1, it demonstrates how the inventory sector was organized prior to the implementation of the 5S Program, with disorganized stored boxes generating a waste of time in delivering materials to the production line.

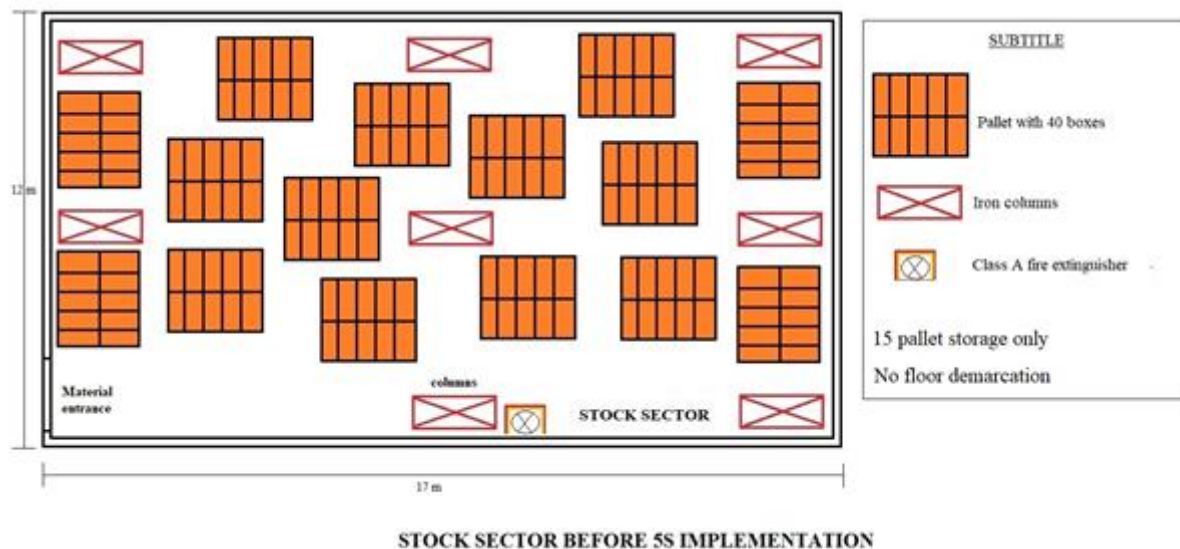


FIGURE 2: Previously the stock was organized in a disorganized and wasted space.

Source: Own authorship (2019)

Subsequently to the implementation of the program, it is clear that the space was used, leaving an organized environment, optimizing time both in the search for materials and their exit.

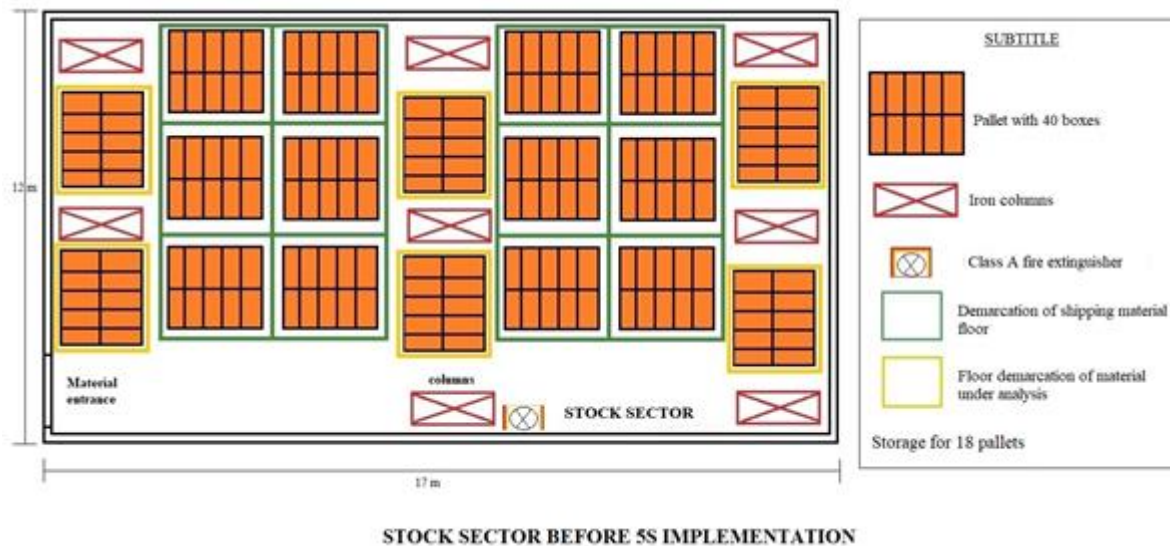


FIGURE 3: After the stock was neatly organized and optimizing the space

Source: Own authorship (2019)

#### 4.2 Implementation (DO)

After the Weekly Action Plan was prepared by the 5S Team, the document was submitted for approval by the Supervisor. a data da apresentação para os sector employees, which would address the 5S Program, demonstrating the current reality of the sector through photographic archives and the Weekly Action Plan, demonstrating to employees the need for change. After this awareness the deployment with the Sense of Use began.

The photographic record of the sector was made, prior to the Program and according to Figure 3 it can be noticed the lack of harmonization in the sector, the dispensing of boxes, which caused a disorganization to the sector, mixed parts, and a heavy environment.



FIGURE 4: Before the stock was always full of boxes with equipment almost always mixed, then there was an improvement, which was garbage went to garbage.

Source: Own authorship (2019)

After the implementation of the Program, the photographic record occurred again, demonstrating the result in the Inventory, leading to the organization of the material, according to what is constantly used and what was not so used, was separated, generating a positive point in the optimization of the material. time, efficiency in finding the right material.



FIGURE 5: Then inventory was organized, with more storage space

Source: Own authorship (2019)

#### ***4.2.1 Sense of Use Week***

In the first week of project execution, the command was to separate what is useful from what is not, to improve the use of what is useful, to keep only what is needed in the workplace, to combat waste. Before week of use, it was possible to find several empty boxes in the industry taking up shelf space, many unused equipment for productive area. In figure 5, an analysis of the equipment was made, and many of them were sent to the sector responsible for obsolete equipment.

#### ***4.2.2 Ordinance Sense Week***

In the second week the Ordinance Sense was performed, the organization of parts, tools and equipment in an order that allowed the best work flow. The equipment was arranged so that it was easily found for later use. The process was performed to eliminate unnecessary movements.

#### ***4.2.3 Cleaning Sense Week***

In the third week, the Sense of Cleaning was applied, and even in the third step, it was already possible to notice the difference. At this stage it is important to perform the cleaning of the environment as well as to keep it clean. It was time to educate not to get dirty, and to look after everything.

#### ***4.2.4 Health Sense Week***

In the fourth week, the next to be implemented was the Health Sense, it brought the challenge of keeping clean and organized, favoring physical, mental and emotional health, with hygiene practices.

#### 4.2.5 Self-Discipline Sense Week

In the fifth week, the Sense of Self-discipline triggered, as the other senses generated this stimulus. One factor was that every week a team was assigned to monitor and organize. There was a meeting to align the actions, improve and modify if necessary, as well as to show the results of the week.

#### 4.3 CHECK

For the maintenance of the 5S Program, a group was defined to perform the training, and thus, to follow up the implementation. Once a month a meeting will be held to align actions and program improvements.

#### 4.4 ACTION

After the implementation, there was a meeting with the 5S Team, Auditors and SGI where it was decided that the follow-up visit would be held once a month so that the program could continue and the employees would adapt to the new reality.

Items identified as problematic would be treated with 5W2H to be closer to the solutions.

The 5W2h is a tool used because of its understanding and ease of use. It consists in answering the seven questions so that all the basic and essential aspects of a planning are analyzed.

According to [15], the 5W2H tool is understood as an action plan, that is, the result of a planning as a way of guiding actions that should be executed and implemented, being a way of monitoring the development of what is established in the planning stage. planning.

With the increasing demand for managing processes and information through simple and objective responses, it enables critical information for planning to be identified. It is due to the use of seven English words: What, Where, Where, Who, Why, When, When, How, and How Much how many).

According to a meeting held with Mr. Rodrigo Frota, Inventory Manager, the tool will be used from the monthly follow-up meetings of the program, if problems are identified. Through the tool, it will be done simply, clearly and efficiently.

Table 1: Then inventory was organized, with more storage space

Step	Answer content	Sample Questions
What	Necessary actions to have analyzed	What should be done? What are the problem inputs? What predicts extract from the process? What methods are used?
Why	Justification of actions	Why does the problem occur? Why do you do it this way? Why act on this problem?
Where	locations influenced by the actions	Where does the problem occur? Where to act to correct the problem?
Who	Responsibilities for actions	Who are the stakeholders? Who knows the process? Which people should perform the action?
When	Set deadlines	When to start or to finish? When to perform each step?



<b>How</b>	Methods to be used	How will the plan be implemented?
		How to record the information?
		How to define process steps?
<b>How Much</b>	Set budget	How much will the cost involved?
		How much will the resources cost?
		How much does it cost to fix the problem?

Source: Own authorship (2019)

## 5. Final Considerations

Implementation of the 5S program took place in the Inventory sector, where employees received parts and had the mission to ship production in an organized manner and in a short time. The application of the 5S Program added to the development of the sector through the improvement of the work environment, generating employees a time gain in the flow of their activities.

During the implementation there were several resistances, especially with the older employees of the company, the thought “I am like this and I will die like this” hit us in many moments. But cultural changes take time and effort, and with the help of everyone on the 5S team, we can change the landscape. Some difficulties were encountered when the team needed to urgently send material to production and there was a delay in finding all the requested materials. It was possible to see this, because employees from other shifts complained a lot about this failure, also when there were product changes in production lines.

The environment after the implementation of the 5S was really pleasant, the sector began to have a lightness in the environment, due to the space it generated, breathing a more clean air. Some difficulties have been overcome, others really only over time. The Program required self-discipline employees from time to time, compliance with standards and procedures was a great victory for the 5S Team, and certainly increased productivity and elimination of various wastes that were occurring in the industry.

## 6. Acknowledgments

I thank God first, my parents who always advised me to move on with choosing the course, my wife who always supported me, my children, friends and teachers for their dedication and affection.

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# Methodology for Indirect Material Control in a White Line Company

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## Abstract

*At the fierce level that companies generally find themselves in, it is no longer allowed to let the missing material off the shelf of a stock, be it material that is part of the product or indirect material that assists in assembly activity. People involved in the item buying activity need to have full control of inventory, whether planning, changing the planned or planning the unexpected. For the preparation of this study, the daily activity of indirect stock operators of a White Line Company was observed. The factory material control system (ERP) has many functions that made control complex. In parallel to the ERP system, a material control worksheet was created and shared in the cloud that allows all necessary information regarding an item to be easily viewed, where the indirect material worksheet manager needs to update daily by downloading every morning information from the ERP system. Getting better inventory supply chain management, better execution of activities.*

**Keywords:** White Line Company; ERP system; Material control; Inventory supply chain;

## 1. Introduction

Good inventory management is not one that allows your inventory to be completely full of the same item, to the point that a certain part risks spoiling or making an item obsolete, but one that has full control of everything it has stocked, in other words also called inventory management and control. And you can safely maintain just what you need without compromising any of your customers.

But it is not enough to have everything written down on a clipboard, as it is very likely that one of the reasons why materials are tracked is because one is remembered and the other is forgotten, so it is necessary to have daily monitoring by those responsible, always having to resort to an electronic system

for better stock viewing and control. Poorly managed stock allows room for a production process to be interrupted due to lack of material that may be in the local, national or international supplier.

The White Line Company uses an ERP system, which controls all the items used in the process. Production auxiliary materials called indirect items are allocated to indirect stock (0003). And all the information that pertains to this part is added to the system. To maintain inventory accuracy (0003), intense time-wasting activity is required to check every item stored, in stock, in transit, or needs to be purchased.

From this principle a Spreadsheet parallel to the main system was gaining body in order to improve the visualization process, making the process much broader, which information can be verified on the same screen, avoiding that several screens are searched, which, often need pre-authorization.

## **2. Theoretical References**

According to Hong Yoh Ching (1999), companies are not making the best use of their spaces, which results in higher costs and higher final prices, both being passed on to final consumers.

The square meter of a business needs to be well utilized and sized to the best of its ability, depending on whether the building is owned or rented, the location should be multifunctional, depending on the need, and usually the largest spaces are those that the lines of production is used and where the material is stored.

For Viana (2002, p. 42), the registration aims to register the products necessary for the maintenance and development of the company, which implies the recognition of their classification, establishment of codification and determination of the specification, aiming at the issuance of catalog for use by those involved in material management procedures. Registering and coding the material is of paramount importance to keep track of who is managing a stock, as usual a stock has many items and all are important to keep the process going.

Gonçalves (1979) says that three operations involve the registration of materials, they are:

Include material item in material register; Change when any material item changes in some of its characteristics; Exclude when an item is no longer on the company bill of materials.

Product storage, handling and control are important and essential components of the logistics system because their costs involve a high percentage of a company's total logistics costs "(POZO, 2001, p. 76).

Each item has its proper form of transportation and storage, such as flammable (solvents, oxygen, nitrogen, LPG and ink), label and Styrofoam.

### **2.1. Material Control**

The control system applied to this stock was systematically a warehouse production operator, a minor apprentice (part-time) and an intern. They are the people responsible for the activities of releasing the materials for the production process, give up, receive and They store the materials that come from the Receiving sector, after the receipt of the incoming invoice is released and also after the release by the quality Inspection.

Arnold (1999, p. 26) states that: Materials management is a coordinated function responsible for planning

and controlling materials. Its objectives are: Maximize the use of company resources; Provide the required level of customer service.

The material comes to stock 0003, and is controlled by the people involved in this sector, and are controlled systemically, where buyers in the area are responsible for purchasing replacement items, devices from all areas of the company and thus taking too much of your time. Activities include various calls, e-mails and other forms of electronic contact to suppliers from various locations, negotiating better prices and looking for new, secure and better sources of supply.

## **2.2. Indirect Material**

At some point during the workday, there may be lecture training, medical consultation, power outages, meeting, computer problems and on-site activities, the days are not equal. Thus, there is a possibility that some productive material may be missing from the shelf due to focus deviation.

On the shelves there is nothing that catches the eye as a way to identify, because the ivory being full or empty, does not draw attention through colors or any other way, signaling "contain or not contain".

The two ways to know that an item is missing is by looking systemically or physically visualizing in the ivory. When it comes to physics, that's when we need to pick up the ivory and pay for process material or weekly audits. "A company without strategy does any business." (Michael Porter, 2004)

Indirect material is material that is not part of the product but is embedded in the cost of the product. They are various materials that help assemble them and spare parts of equipment called spare parts, such as: screwdriver tip, cutting disc, pen, notebook, bubble bag, garbage bag, paper towels, toilet paper, glass disposable, transformers, lamps, USB cable, code reader and epi's. The list is very long and this stock exceeds \$ 500,000.00.

Finally, Indirect Material Inventory is a sector that is totally necessary for the company as a whole, where items are removed and replaced, which can cause line stop and stopping the line, the company stops producing and delivering.

We can define inventory as the stored accumulation of material resources in a production and / or operations system. Broadly and generally, stock can be understood as any stored resource. In this way, a queue would be a stock of people waiting for service; a bank would have a stock of people and ATMs to serve customers; A law firm would have stock of lawsuits.

Generally speaking, inventory is clear and defined by storing certain items in order to preserve them for later use, i.e. to fulfill a demand / order. In some cases, these items will undergo transformations to meet their intended purpose. Every company, whether small or large, has a stock to serve its customers faster, always keeping track of their time, allocation, suppliers, quantity, unit value, total value or whether it is an imported or national part.

Inventory: is a practice used through the identification, classification and counting of stored products in order to check if this information is in accordance with the reality of what was given as goods entry and exit, but is very laborious, it depends size, amount of material to be counted, weighed or sized.

This process requires inventory to be counted at a predetermined frequency (daily, weekly, biweekly, general inventory, or otherwise). In this way, the inventory information is updated in cyclical periods, according to the company's needs to supply a demand.

### **2.3. Stock**

In general, a stock is where the most relevant part of the company is located, even though it is hidden inside two cardboard boxes. If the required flow of items is not met, they risk becoming obsolete or damaged.

Just as there can be no excess, there can also be no shortage, which means that a stock ceases to obey the natural order.

Among the many controls is the Kanban Tool (card) created by Taiichi Ohno after a trip to the US supermarkets, which can be used in many ways. Example: colors, frames and etc.

Specifically speaking of the stock of Indirect Material there was a need to make it even more robust by continuously studying it and creating situations necessary for its strengthening.

To have access to inventory you need to ask the leadership for authorization, authorization that allows you to see information regarding the stocked items that goes from who supplies to who makes the request, which makes the manufacturing system a management / control, even if by Permissible access stages, if you need price, quantity, total value, unit, shelf, vendor, etc., the system can provide one screen at a time.

In the system only you can see the total quantity and other information mentioned above, do not contain safety stock or minimum stock, in a nutshell or have the material in stock or do not have.

Making control somewhat difficult, opening up opportunities for failure, which can maximize a serious problem should an item go unnoticed, creating the view that the system is flawed, and the system relies on human propulsion. to input the information.

If a wrong input happens, a positive or negative stock hole occurs, depending on how the system is fed, so weekly inventory is required; About 576 items in the Indirect Material stock are parts that have quantity, volume, specifications, smaller box, larger box, some take up less space and others take up more space.

### **2.4. Inventory Management**

The amount of material stored is directly linked to the production process and the supply chain and programming made by the company's PCPM. In low periods, commonly called this, it is very natural to meet the schedule made for this time of low production and few employees (resizing).

Demand generally tends to have a gap, either buy or sell. But it still crashes, it just slows down, part of the focus is on buying machine parts, which happens in advance to do scheduled maintenance. Along with the reduction in production, comes downtime and collective vacations, at the same time happens the general inventory, counts all stocks to evaluate possible divergences.

It is time to set up the company internally for the next few months to meet the requirements, without leaving the inventory zero, systematically tracking the items, preparing the inventory for the period of high production.

It is almost a ripple effect that happens, that is, depending on the company's follow-up, the other segments also slow down, the period is cost reduction, saving on water, electricity, telephone, paper, uniforms, food and transport.

Inventory management is focused on planning strategically so that if there is production planned, if there

is no production planned; if there is a reduction in the planned pace a redesign is required. Planning goes on continuously to reduce as many stockpiles as possible. In this white goods company, for some parts Just in time happens, others are bought according to a priority order.

In this sector there are two of the eight wastes that is excess material stock (incoming stock) that can be from parts for production and in the next stock (outbound stock) there can be overproduction that is stock stopped with finished material. If not well observed, a stock that enters and does not produce or produces and has no output can lead to any bankruptcy. Otherwise, any inventory that is well managed and controlled tends to be profitable for the company.

Since what is being dealt with in this article is a white goods company stock, there is no way to make a promotion and zero the stock, as in a clothing store, for example. Therefore, everything that comes in has to be used for production in a short time.

### **3. Tools and Methods**

For the development of this work, the following steps were performed: Analyze survey items from indirect stock; Research the best way to perform daily activities; Chronoanalysis; Create a material checklist in parallel with the manufacturing system; Apply materials control methodology; Verify objectives achieved.

A spreadsheet was created in the cloud to help control indirect materials when the spreadsheet was started, after a while it was shared with people in the industry. Where suggestions were given to make it robust and there were no errors in the execution of the activity or duplicity of information.

Where the Excel spreadsheet is downloaded from the company's main system (ERP), then taken to the cloud where the spreadsheet is on Google drive.

After the upload happens, automatically through the macros and formulas created, all data is updated according to the main system. each properly directed to information previously prepared to be updated.

Making the spreadsheet Dynamic, where you can view all the information necessary for the follow-up of the part (chart). Anyone in the industry or outside (if shared) can understand that the spreadsheet originates from the Indirect Material Stock and concerns the parts used in certain locations of the company and can be found, even the machine of its use and etc.

However, an internal survey was needed to know how the material behaved, also called the manufacturing script (its entry, storage and absorption by the productive demand).

Have shop floor visits been made for a better understanding of the flow, such as the part that is allocated on the shelf in block 1, section A, where this part is used? What is the daily consumption? Weekly? Monthly? And annual?

Among the many information contained in the spreadsheet it is possible to see the location of the supplier, for example, if it is national or international, this information is important for the delivery time of the material, because when the supplier is next to us (Just in Time) the Delay time is not that significant.

Unlike the supplier that is in another country and its delay is three months to deliver the order.

## 4. Application of Study

As shown in the worksheet there are points to note, showing that a particular material requires observation, whether to show that there is material in “stock”, “attention” and “request”.

This becomes one of the first steps for inventory process improvement, line sourcing, and replenishment. It is knowledge that companies must have to control their inventory of indirect or direct and for this it is necessary to manage it, either through an ERP system, a simple material control worksheet or a clipboard to check what it contains, enters or exits. . Good management controls and maintains the sanity of monetary values, stock stopped is money stopped or waste.

Along with this you need to apply just in time (JIT), keeping only the necessary and without leaving the items missing for production. The point of resupply should be continually observed, as a patient who is in a hospital and under observation, there must always be someone on duty who understands the matter, who can remedy if an emergency occurs and who applies the proportion of the measurement. in the correct dosage, so that the patient (stock) is reintegrated into everyday life and 100% healthy (zero waste).

### 4.1. Old process flowchart for part to be searched, information separated by screens.

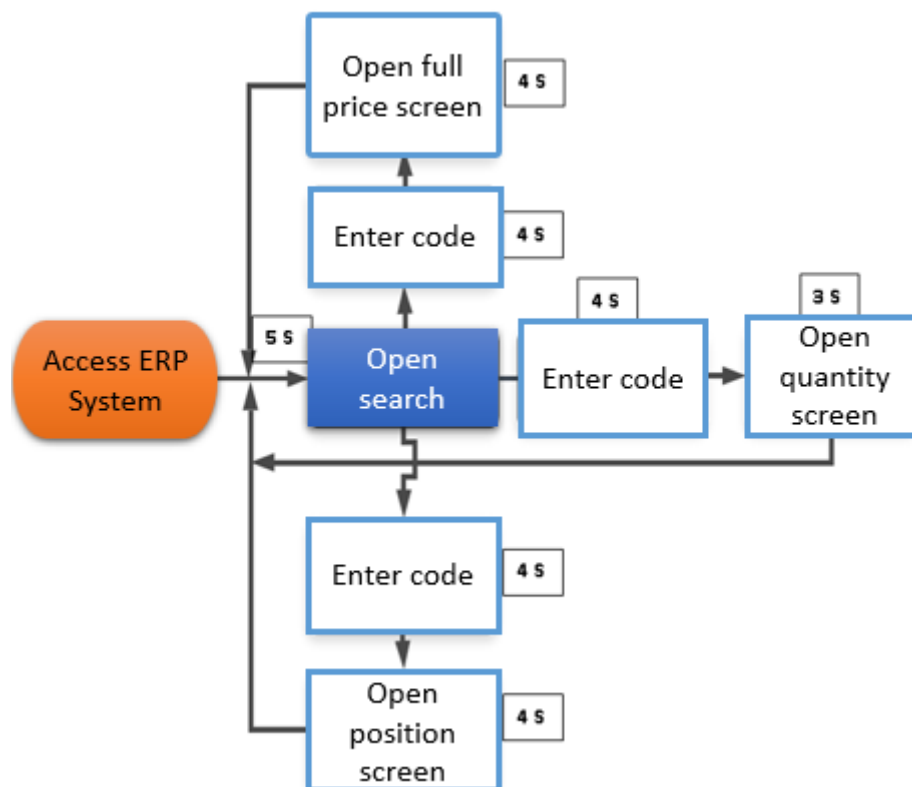


Figure 1 - Old Material Search Process

Source: The Author

All this being thought that one of the items may end and that there is a distance from the supplier to the requesting company, there is a time from the receipt of the order until delivery (delay), i.e. preparation, shipping and delivery.

A large company cannot stop due to mismanagement in its inventory, every second a company goes down, there are millions of products that are no longer being produced, operators stopped, products that are no longer delivered and a dissatisfied customer.

The consumer when looking for a specific brand, be sure to take another for not finding the preferred brand.

When a company stops producing the next competition, it is in full swing, often working 2 or 3 shifts and putting its product on the shelf.

These days, the level of competition between companies is very high and wins the one that is best planned and with a greater focus on internal management, without forgetting to look at the foreign market, which means the level that your competitor is.

The more you apply to lean philosophy, the more likely the reduction is to happen naturally. And in some situations, a case study is needed, so that the project to be implemented is very clear and defined.

This does not mean that a stock should not have anything stored, but rather make the best possible use, remembering that there are numerous possibilities for a material to arrive late at its final destination. That goes from lack of raw material in the supplier to the fall of bridges on Brazilian roads.

Even with spreadsheet deployment, attention to items is required, a large enterprise system can fail, people can fail, and vendors can fail. The spreadsheet is nothing more than just another work tool that helps employees perform their role to the best of their ability.

#### ***4.2. Problem Identification.***

After realizing the possible failure in inventory control and management, it was initiated the study and research in a White Line Company, in order to avoid wasted working hours, inefficiency of operations and facilitate the execution of the activity to This difficulty requires a little more time from the buyer, so the process was analyzed in order to improve the management of this stock.

A new Methodology for Indirect Material Control, visualizing the activity of each Buyer daily and Production Operator.

Given the uptime for a particular item, how many screens it took to get all the information about that single item, and so on.

Since the system generates multiple screens and sequential material access information, it takes some time for materials to be tracked one by one, leading to exhaustion in their search, that is, too much time to check the stocked items.

As for example: quantity in stock, entry into the company, if you returned to supply it, reason for return, total value, unit value, place of use and so on.

### **5. Results and Discussions**

After applying the Indirect Material Worksheet, it was possible to realize the return in the form of benefit (short and long term), which will include: Optimized storage space (especially when a company uses all its manufacturing space); There was no availability of labor; Creation of new safety stock (according to seasonality); Inventory reduction; Reduction of obsolete; Better use of space; Better use of time; Less

downtime; Easy access to information.

Table 1 - Material Control Worksheet

CODE	DESCRIPT.	QNT.	UNIT VAL.	VLR TOTAL	STATUS	LOC.	PROVIDER	SECTOR USED
521.123	Electronic Test Tip	8	200,00	R\$ 1.600,00	Attention	B3/C3	Discharge Electrical Devices Ltda	Polymer
521.160	Extractor	7	8,00	R\$ 56,00	Attention	B4/A3	North American Company of Iron	Tooling
521.189	Expansion Tool	3	48,00	R\$ 144,00	Request	B7/C7	Metal Tooling	Assembly line
521.468	Screwdriver tip	56	13,00	R\$ 728,00	Stock	B1/D9	House of Construction	Assembly Processes
521.566	Plastic bag	400	0,98	R\$ 392,00	Stock	B6/G5	North Plastic Bag Industry	Almox - Collection Support
521.098	boot	98	23,00	R\$ 2.254,00	Stock	B9/F4	Forte - Safety Material	Assembly Processes

Source: Own Author

The Indirect Material Worksheet is still in application, its results are evident in everyday life, but it will become clearer with improvements that may happen.

You can already view multiple information at the same time, and at the same time realize what you need to request or what is in attention. Within the ERP system, information retrieval would take longer, and in order to maintain excellent controls on all materials stored in indirect stock, both parts and activities on the 0003 stock platform.

### 5.1 New Structure

The new structure contains the following elements: Code; Item; Quantity in system; Product situation (stock, attention and order); Unitary value; Amount; Unit of measurement; Location; Entry date; Last Move; Downtime; Sector used; Place of use (machine or workstation); Supplier (national or international).

Another benefit that the Control Worksheet brought was the improvement of rotating inventories, in normal mode you need to download a spreadsheet with name and code, one with positioning and another with quantity, from the spreadsheet you can print all this information at the same time. time.

## 6. Final Considerations

The Ultimate Material Control Worksheet helps you manage your 0003 stock materials while keeping a close eye on everything that goes in and out. At the same time passing the necessary information to the buyer of the part, through macros linked by Google Drive and information that changes color according to the quantity of part stored.

It will serve as a source of research for future academic work, through the richness of its content exposed here, through this course conclusion article.

The simple gains can already be seen through the spreadsheet, as it is no longer a laborious process, but



side by side with the ERP system of the White Line company.

All questions were answered, according to the question for implementation, and is following a deployment flow that were: research, creation, adaptation, macro creation, linking and deployment throughout the process was in the monitoring of the head of the sector.

It is subject to improvement over time, should the process change, it needs to be updated to meet the need for the indirect material area.

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# **Kaizen Philosophy Application as Production Standardization and Process Optimization**

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## **Abstract**

*Market competitiveness has increased and companies are increasingly looking for methodologies that enable them to have higher productivity and organization at work, at low cost. More flexible and innovative processes and products are key to the survival and success of many companies. The importance of a study of Kaizen philosophy is due to the fact that it is based on continuous efforts to improve the system. Therefore, the present study aims to clarify the process of continuous improvement through the implementation of the Kaizen tool so that it can guide the productive improvement of companies in the Manaus (AM) industrial hub. This scientific article was elaborated, based on the bibliographic research resulting from an analysis, which considered the two-axis cross perspective - Kaizen philosophy and continuous improvement. This article demonstrates the Kaizen continuous improvement tool as it emerged and the benefits generated in environments that encourage learning and cooperation among individuals, working on human resource development so that improvement initiatives are truly continuous.*

**Keywords:** Quality control; Kaizen philosophy; process optimization.

## **1. Introduction**

Firstly, the work contemplates some notions through which process improvement strategies can be located through the Kaizen continuous improvement tool. Notes have been taken about its philosophy and benefits it can provide to an organization. These topics are briefly addressed as to how organizational

change through Kaizen can influence production processes and increase the quality of products / services. With the increasingly competitive market, organizations are looking for differentials against their competitors and for this they use tools to continuously improve their processes and thus provide a product / service always with high quality and meet the needs of their customers (OLIANI et al., 2016).

Then comes the continuous improvement activities, which Caffyn and Bessant (1996) defined as a broad business process of evident and intermittent incremental innovation. These activities, whose performance is related to each company's ability to manage its traditional processes - such as developing products, selling, manufacturing, distributing - the literature reports on the relationship between quality program failure and the low level of involvement, commitment of employees and management.

According to Ismael (2015) the success achieved with the implementation of improvement methodologies in different industries led many companies in difficulties to have also chosen to introduce these methodologies in order to achieve sustainable growth and survive the competitive and hostile environment of the companies. current markets.

Among the many continuous improvement tools that are being used by companies as competitive market strategies is Kaizen. According to Imai (1998), in Japanese, Kaizen means continuous improvement. The word implies improvement that involves all people - both managers and workers - and causes relatively little expense. Kaizen Philosophy assumes that our way of life - whether it is our work, social or home life - must focus on constant improvement efforts. This concept is so natural and obvious to many Japanese that they don't even realize they have it.

The Kaizen tool can be considered a simple process, as it can work in all areas of a company, through basic concepts such as organization and discipline, without using large investments, because it works with existing equipment in the company seeking to improve its results (OLIANI et al., 2016).

Pinto (2012) highlights that industries generally concerned with the results of their various segments seek through management tools to optimize processes effectively in order to reduce costs. However, they encounter bottlenecks and waste located in some sectors of the production chain.

There are few published works on the implementation of the Kaizen methodology in the productive chain of the industrial hub of Manaus (AM). The small number of studies found in the literature is indicative that the Kaizen philosophy in factories of the Manaus industrial pole has not been sufficiently studied. Thus, this article aims to elaborate a study based on the literature review with the objective of exploring some notions through which process improvement strategies can be situated, namely Kaizen, presenting successful implementation cases that may guide the process. productive improvement of companies of the industrial pole of Manaus (AM).

## **2. Theoretical reference**

For the study in question that addresses a literature review study on continuous improvement through the Kaizen tool, a better understanding of the concepts and factors related to the subject under study is indispensable. Therefore, the main conceptions related to this theme will be explained in order to better qualify the proposed theme.

### **2.1 Concepts and Approaches for Continuous Improvement**

The term “continuous improvement” has become very popular in recent years, being associated mainly with the Total Quality movement. It is worth noting that the concept has evolved over the years and is currently quite structured (ATTADIA; MARTINS, 2002).

The concept for continuous improvement is based on the definition of Caffyn and Bessant (1996), the authors present a simple, objective and full-scope proposal: “Continuous improvement is a company-wide process focused on incremental innovation and to be continued”.

So continuous improvement means the involvement of all the people of organization, in the constant and systematic pursuit of product and process improvement proposing small changes in organizational habits and major changes with greater planning (BESSANT, CAFFYN; GALLAGHER, 2001).

In an organizational environment, continuous improvement is reflected in the culture of this environment, which demands constant achievement of its individuals by overcoming personal paradigms, usages and customs, in the search for improvement in order to apply available resources, helping to eliminate risks and risks. customer and organization demand.

Process improvement is a necessity present in the routine of all organizations occurring in a structured or unstructured manner. Thus, continuous improvement is necessary for the organization to survive and evolve in a market with intense competition (MESQUITA; ALLIPRANDINI, 2003; DELBRIDGE; BARTON, 2002).

The Japanese model of continuous improvement, involving employees of all hierarchical levels, is called kaizen. Although this model emphasizes the practice of small and incremental improvements, it brings significant results over time (IMAI, 1997).

For Shonberger (1982), kaizen has generated a particular process-oriented way of thinking and an administrative system that supports and recognizes improvement efforts. Through this concept, employees now incorporate continuous improvement into their work routines. The autonomy given to each employee is a motivating factor for the development of these activities. Thus, the model is centered on people, because they perform the activities inherent to the organization.

### **2.2 Kaizen Philosophy**

According to Pinto (2015, p. 15) “of Japanese origin, the word “Kaizen ”means“ change for the better ”and is related to quality management in companies”. The origin of the Kaizen methodology is from the middle of Japan's economic recovery after World War II and its concept has an industrial origin. After the conflicts faced by the country the devastation situation was intense, so the Japanese government initiated several projects in the areas of management and administration, with the institute to resume and restructure the industrial processes so that the Japanese companies to return to the market in a competitive way.

Kaizen (or continuous improvement) was developed by Masaaki Imai in Japan and is now known and practiced around the world. In 1962, Imai founded Cambridge Corp. where he was a consultant and founded the Kaizen Institute in Austin, Texas to help introduce Kaizen concepts to Western companies in 1986 (Murugan, 2005).

Kaizen is born of a study of how workers do their jobs and has become a well-known methodology in the United States. Masaaki Imai, in 1986, first introduced the Kaizen methodology in the Japanese company Toyota to improve efficiency, productivity and competitiveness (Duarte, 2013).

The concept was introduced in America in 1986 from the book written by Masaaki Imai, "Kaizen - The Key to Japan's Competitive Success". Masaaki Imai, known as Kaizen's father studied at the University of Tokyo International Relations and worked for several years at Toyota (SINGH; SINGH, 2009).

Mesquita (2001) reports that Kaizen is a well-known and well-known term, including its definition that it is an improvement involving everyone in the organization - both management and shop floor - generating relatively little expense. This philosophy dictates that our way of life - both at work, in social life and at home - should be focused on continuous improvement efforts.

Imai (1997) believes that this philosophy is already rooted in Japanese culture, and that this may have contributed to Japanese competitive success. However, according to him, any company, regardless of nationality, may be able to benefit from Kaizen.

### ***2.3 Kaizen as Continuous Improvement***

According to Pinto (2015), in recent decades, Toyota's success has led to a huge search for more knowledge related to Kaizen thinking. There are hundreds of books as well as thousands of journalistic articles that explore the subject. Companies, institutes, associations and communities dedicated to study, develop and provide advice on these methodologies and culture have also emerged.

In recent years, other sectors (health, construction, logistics and public service) have been contemplated with the expansion of Kaizen application. Kaizen is no longer seen by organizations as an application tool for continuous improvement processes, but currently encompasses an entire system integrated into the management of an organization.

Pinto (2015 p. 20) points out that "all these changes were accompanied by an evolution of organizations, which also contributed to the creation of the Culture of Continuous Improvement through the change of some paradigms".

MC can be understood as a set of activities that constitute a process of reasoning and intervention that seeks to achieve performance improvement (JHA et al., 1996). It aims, through employee involvement, to create a culture of sustainable improvement and eliminate waste in all organizational systems and processes (BHUIYAN et al., 2006).

In the search for the achievement of organizational success, the immutability and constant performance of the processes do not go through this search, since a constant concern, adaptations and changes in the organization and human resources are necessary. Success to be consistent, though never guaranteeing, is more likely to be in managing organizational processes consistently. For the question is not restricted whether to innovate or not, but how to apply the whole process of innovation successfully, that concrete organizational practices encourage skills and innovation in order to build a true culture of business innovation.

Guimarães et al. (2011) describe that the big difference between innovation and continuous improvement is in the pursuit of perfection, because continuous improvement is concerned with the complete and continuous improvement of products and innovation is concerned with

great progress and rapid growth.

The Kaizen methodology has helped a war-ruined country become one of the world's largest industries. And this is largely due to the mindset that costly investments are not required to promote significant improvements in an organization. Since it is possible to implement small daily improvements and thus achieve good long term results.

Today, more than ever, we need to optimize processes and drive organizations to excellence. Thus, Kaizen can be a tool for creating a new culture in the company. A culture of improvement and growth that puts people in a constant process of improvement and thus more results for the company.

#### **2.4 Kaizen and Productivity**

According to Murugan (2005) Imai, from several studies on US productivity, realized that methods were used by US companies to increase productivity. productivity. These American methods were related to the search for improvements.

Innovations through technological innovation, big investments and good engineers. Already in Japanese companies the most used method to increase productivity was to encourage and engage company people in the search for small improvements at low cost.

The optimization of productive processes has been studied for a long time, being evidenced since Taylor's initial studies, the division of labor and through it the increasing productivity and production capacity of goods on an ever-increasing scale largest (GOUNET, 1999; PINTO, 2015).

The author Hohmann (2002) reaffirms that Kaizen is a technique that involves all people of all hierarchical levels, in order to rethink production processes in favor of increased productivity, decreased inventory, increased quality and employee safety.

Imai (1998) reinforces that productivity is an evaluation and not a reality, that is, it is just a description of the current condition of things and people's previous efforts. This means that kaizen is based on the PDCA cycle, productivity is a result-oriented index, and process-oriented improvement. What is implied is that improvements occur gradually and the return is long term.

Pinto (2015) highlights that to keep up with the constantly changing environment, it is essential to have thoughts and actions aimed at continuous improvement, and thus develop a culture based on it. Its practice facilitates the creation of a continuous learning environment, seeking the best use of existing knowledge in the organization and enhancing the ability to create new knowledge.

Kaizen is a tool of excellence on many levels. This tool involves everyone in an organization; why everyone involved knows the needs of their industries and how each individual can identify the gaps and improvements that need to be made. According to Santos and Pierre (2016) success in increasing productivity involves flexible manpower and continuous improvement tools. Therefore, members of an organization must always be involved in their responsibilities and feel that they are a fundamental part of a work team and not just another element.

#### **2.5 Kaizen and the PDCA Cycle**

The PDCA - Deming Cycle - originated from a Seminar on Statistical Quality Control chaired by Dr. W.

Edwards Deming in Japan in 1950. According to Ismael (2015) the foundations of this cycle date back to the 1600s, when Galileo, based on philosophies of scientific evolution, created a method of scientific improvement. This method was adapted in 1939 by Walter Stewart for Specification Production Inspection, giving rise to the Stewart cycle with application in Mass Production processes.

The result of the Japanese interpretation of the Deming cycle gave rise to the PDCA continuous improvement cycle, Olani et al (2016, p. 65):

- P stands for Plan and aims to establish improvements by drawing up action plans to achieve the objectives;
- D comes from the verb DO, which means to do, that is, to put into practice the plans and their application;
- C stands for Verify. Its purpose is to analyze whether the implementation of the plans has been achieved.
- A means Act, which is the realization and standardization of new procedures, corrective actions.

The PDCA cycle means that the business situation must always improve. According to Imai (1990) the PDCA cycle goes on and on. Once an upgrade is made, it becomes the standard that will be challenged with further improvement plans. According to Ismael (2015) regarding the Kaizen methodology, the PDCA allows the information to be accessible to everyone and all employees to follow the implementation steps of the suggested improvements (Deming).

### **3. Methodology of Scientific Work**

In order to meet these objectives, this scientific article was elaborated from a bibliographical review in which support was sought in the analysis of the thinking of authors, such as Gil (2008); Lakatos; Marconi (2008-2009); Beard (2010); I live (2010).

The research had a bibliographic and explanatory nature, as described by Gil (2008), where previously published literature relevant to the subject was used. This type of research is developed from the so-called bibliographic sources, which are considered secondary data and comprise a diversity of materials that in its preparation have received analytical treatment, such as books, theses, dissertations, articles, among others.

The main advantage of bibliographic research is the possibility of elaboration of a state of the art of the studied subject, favoring its appreciation from innovative points of view and the formulation of original conclusions (GIL, 2008). Also, according to the author “the bibliographic framework used to work on the Kaizen philosophy theme is described below:”

#### **3.1 Step 1 - Fonts**

a) We used 11 books divided into subjects on scientific methodology and other work-related subjects, in Portuguese and English, published from 1989 to 2009.

b) Scientific articles on the subject were accessed in the Scielo databases and in specialized journals, published in the last eleven years (1996 to 2016). We used seven national and international articles, available online in full text.

- c) Articles available on the web with themes related to the study were used, from a total of four sources, between the period (2002 to 2010).
- d) Six master's dissertations available in the Google academic databases and online libraries published from 2010 to 2015 were used.

### **3.2 Step 2 - Reading the Material**

The previously selected works underwent fluctuating readings that allowed to exclude those without the potential to contribute to the objective of the study. Already selected works went through new readings, now more thorough and exhaustive, the relevance to the study. From these bibliographic sheets, the analysis and interpretation of the results was organized.

### **3.3 Step 3 - Taking Notes**

At this stage, an analytical reading was performed with the purpose of ordering and summarizing the information contained in the sources, in order to obtain answers to the research problem.

The final text was based on ideas and research by authors such as: Imai (1990, 1997, 1998), Pinto (2012); Pinto (2015); Ismael (2015); Oliani et al. (2016).

## **4. Kaizen Deployment Cases**

In this section we will present some case studies that illustrate the inherent benefits of applying Kaizen.

Ismael (2015) studied implementation actions of Kaizen tools at Iberol (biodiesel production company) as part of a Kaizen Manual prepared for the company. As a result of the implementation of Daily Kaizen, the creation and monitoring of

Team performance in each area has become a daily task. In order to incorporate all the information generated, an Excel format file (KaiDi) was created to facilitate the elaboration of the indicators of each area, requiring only the input of the data chosen by the head of each area.

Pinto (2012) described the application of Lean Production System (SPE) tools, whose main tool worked was Value Chain Mapping (VSM), in a process called Surface Mount Technology (SMT). Principles governing lean production, waste elimination and the creation of value flow in a real situation, through Kaizen events, were used to obtain results of this application, evidencing a lean transformation, with significant reductions in waste generated in the process. . Therefore, the author sought to combine Kaizen event techniques with integrated use of TPE tools and establishes a methodological innovation in change management in order to achieve the process maturity that were applied in a slab production line of the Manaus industrial hub. In the study, by mapping the value chain, we propose to draw the current state of the chain, proposing a future state, identifying and eliminating what does not add value

Guerra (2010) assessed the extent to which participation in Kaizen Sessions influences the attitude of the Human Resources involved and their knowledge and skills in Continuous Improvement. To this end, a study has been developed with a company that is adopting a Management Model based on Continuous Improvement, which has conducted a survey with participants in Kaizen Sessions. The study concluded that the Kaizen Sessions carried out in the company had a positive effect promoting a more proactive



attitude, more skills and better knowledge among workers involved in Continuous Improvement activities. This study reinforces the idea that Kaizen can be successful in other business sectors than industry.

Therefore, studies show and reinforce that successful Kaizen adoption depends on a company's organizational culture. This is why employee participation is very important to express their opinions about what should be improved in the company and also their ideas on how to do it.

Studies such as those by Pinto (2012) and Guerra (2010) show that, as far as today is concerned, Kaizen and its methods are being deepened among top managers and industry leaders who already contemplate the management systems of large world companies. In the incessant search for better answers and performances, new methods, tools and techniques are refined so that they can provide better conditions for achieving increasingly challenging goals.

## 5. Conclusions

This paper introduced the Kaizen tool as well as a continuous improvement process, demonstrating its importance for the pursuit of continuous quality evolution. The key idea guiding the development of this work is to show basics that support the applicability of Kaizen, as support for the preparation and cost reduction in production lines. It must be borne in mind that the acquisition of new technologies may not be the solution of problems in an organization but, for example, changes in process management.

Therefore, these notes can serve as a basis, guiding entrepreneurs for future restructuring within their respective companies, always aiming to obtain the best level of continuous improvement possible by the Kaizen tool in the Manaus industrial hub.

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# **CAD / CAM Application for the Development of Submerged Pump Maintenance Tools**

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## **Abstract**

*The design and implementation of maintenance tools is used in CAD / CAM tools, in order to make the necessary improvements in the whole process of disassembly of the equipment in question, and mainly to reduce the process time and eliminate the risk. breaking the most fragile parts of the equipment. The objective of the work is to elaborate the toolkit, to reduce the disassembly time and to eliminate damage to the equipment and its respective trajectories, with which the machine performs the machining of the designed drawing, were applied to the resources through a CNC language. (Computer Numeric Command) on a CNC lathe and a machining center. The elaboration of this project based on a CAD system, in this case Solid Works. The average time for disassembly of the equipment was around 2h, now with the proper use of tools, the same process had a time drop to 40 minutes, seen as a great time saving in the disassembly process.*

**Keywords:** CAD / CAM; Maintenance tools; Machining.

## 1. Introduction

With the increased use of these tools, coupled with technological innovations and market competition, has led to a significant drop in their price, making it increasingly possible to exchange 2D CAD software for 3D modelers.

Where you can access Computer Aided Engineering (CAE) and Product Data Management (PDM) CAD / CAM technologies in a single software. These tools (Software) have numerous features for modeling Solids, making projects run with high technology, speed and especially accuracy.

The use of software in the machining process, carried out by machines and tools, has its continuous development based on solutions to increase productivity and the quality of products and processes. Reducing the design cycle in a product's manufacturing and competitiveness requires the use of high technology equipment to obtain complex geometry.

Today, with the integration technology of machines, equipment and systems on the shop floor, greater flexibility and productivity is sought, utilizing technologies and resources that range from numerical commands to automated computer-integrated manufacturing environments. Notable in this approach are computer-aided design systems, CAD systems, as well as CAM-assisted manufacturing.

The objective of the work is to improve the sequence in the process disassembly handling, to conduct the routines to produce work results, to obtain the possibility of gains and better results, to have agility and care in the act of maintenance and disassembly, to design and to execute the kit. appropriate tools for the assembly and disassembly process, and ensure customer satisfaction of receiving the product within the estimated time.

## 2. Bibliographical Review

This research presents the main concepts that were explored in the work, from the literature about the studied problem, to make the studied process more efficient and effective, adding value to the organization inside and outside it.

### 2.1 Process Optimization

Process mapping can benefit companies by providing a set of techniques that can simplify the relationships between the various processes of an enterprise [1].

For [2] the advantages of agile methodology are to minimize the risk of the process and the system that it supports does not fit the business reality. However, in agile models there is a limited possibility of using formal methods for process optimization, which can be overcome using the traditional methodology.

The process refinement phase should take care of analysis and decision making based on the results found in the monitoring and control phase. This is the phase responsible for achieving and creating the continuous improvement of corporate business processes. The process refinement should be made in comparison between the results obtained from the processes and the established goals, being the optimization or process improvement a consequence of this work [3].

According to [1], although there are different models for the implementation of process management, they have in common the cyclic form, for this reason, we talk about "BPM cycles". A systemic model

composed of events, activities and tasks, with the purpose of organizing the flow and value exchange operations between suppliers and customers should guide the BPM [4].

## **2.2 Manufacturing Process**

For any organization to be managed through business processes, it is necessary to create a knowledge management culture, which means to win over people to practice cooperative behavior [5]. Process-managed organizations need to engage and motivate the people involved in the activities to achieve the expected results. Participants should be aware of and involved with the process, assuming that they are the ones who influence the performance of the process.

[6] They consider that teams must take into account the size of the organization and the complexity of business processes. For large companies the author proposes an initial step that includes a description of all organizational processes, so an agile approach is not advisable and the traditional one should be applied.

Second [7] the alignment between business processes and organizational strategy is found in the adoption of practices and methods aimed at continuous improvement in business processes. Thus, it is possible to see the relevance of the association and the necessary alignment between organizational strategy and business process compliance, characterizing the management of these processes as a means of reaching a strategic direction, which is established as a critical success factor. [7].

## **2.3 CAD / CAM System**

The introduction of CAD / CAM technology represented a great innovation for dentistry, as it made it possible to make dentures in a shorter time and in the office itself. In addition to time, one of the great differentials of the CAD / CAM process is the use of controlled industrially manufactured materials, free from imperfections and porosities. We can cite as advantage, a fully computerized manufacturing process, which allows to minimize failures and distortions that may be present in the manual process, as well as allowing the reproducibility of the process. These factors, associated with the accuracy of computer programs, allow the production of better quality restorations with better marginal adaptation. [8]

[9] They conducted this study to investigate the accuracy of marginal fit of zirconia infrastructure fabricated with different digitization (CAD) and milling (CAM) processes to obtain optimal tilt inclination (4 degree abutment, 4-5 axial height mm).

CAD / CAM restorations have better marginal fit or are compatible with conventional ones. [10] Restorations with jagged edges such as onlays and veneers appear to be more difficult to reproduce; Studies show that the marginal adaptation of these CAD / CAM system restorations is lower, although within clinically acceptable limits [11].

## **3. Tools and Methods**

This study was performed in an Electric Motor Rewinding company, where the flow was surveyed, through the process mapping, the identification of the problems, the need to have an adequate tool, as the interview with the company, was done. After identifying the difficulties faced by the problem, the

proposal was presented for the improvement of the dismantling process of submerged pumps, using a toolkit proposed to reduce the time, risks and final cost.

## 4. Application of Study

The previous process took an average of 2 hours to dismantle a submerged pump according to the flow chart below.

### 4.1 Process Flow (Old)

The initial process is delivered to the receiving department, along with the expert technician to identify the problem and generate the work order, after using the three tools, spare parts are required for service completion, until customer delivery. Final.

The figure below represents the sequence of tools used, such as: Tool 1, 2 and 3.



Figure 1 - Tools F1, F2 and F3.

Source: Author

### 4.2 Problem Identification

In the handling process of the tool step 1, 2 and 3 several stops in the disassembly sequence have been identified due to the use of the tools, the process is repeated in the closing of the service generating costs with generally damaged parts and delays due to the high hours. in the process of disassembly and assembly of the whole assembly.

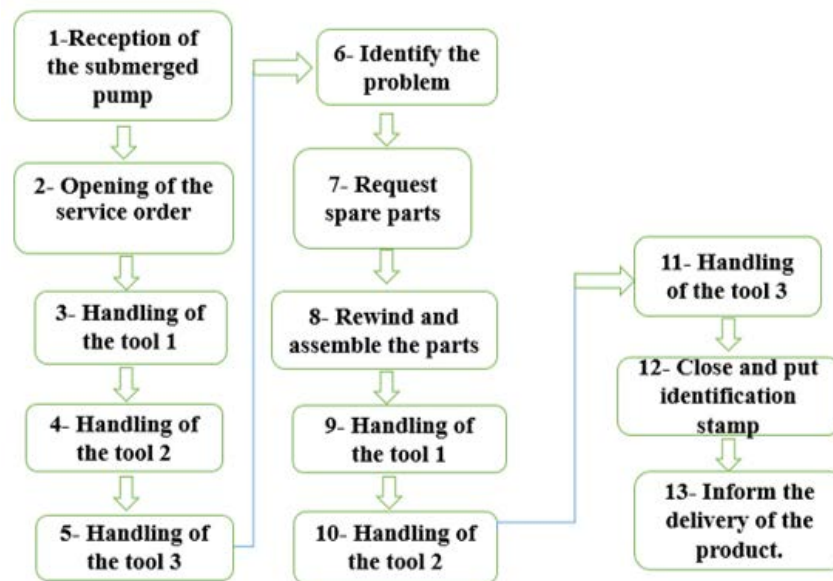


Figure 2 - Old Flow

Source: Author

As shown in figure 1 above, it is represented by the tools used in the previous process. Flow demonstrates each step during disassembly of submerged pump.

Figure 3 below represents tool F1, being used in the disassembly process of the pump motor cover.



Figure 3 - F1 Tool Coupled to Cap

Source: Author

To remove the motor cover of the pump, it is necessary to lock the tool F1 with the screws that are part of the cover.



Figure 4 - F1 Tool

Source: Author

Figure 4 represents the pump cover removed. To remove the pump motor cover that is mounted to the

equipment with moderate pressure, manual axial movements must be made on the movable part of the tool F1 about the tool axis.

The hammer shown in figure 1 as a tool F3 is used for cover assembly removed in the previous process. With improper use of the F3 tool, many cover failures occur during this process.



Figure 5 - Tool 2

Source: Author

Figure 5 represents an improper process, the pump is fixed directly in the vise, for the removal and subsequent assembly of the threadbare plastic part of the equipment, requiring the use of a screwdriver, causing possible damage to both the plastic part and the part. cylindrical section of the pump that is attached to the bench vise.

#### **4.3 Improvement Proposal**

Design and manufacture a toolkit that can be used for multiple tasks, reducing the amount of previously used tools, enabling faster and safer disassembly without damaging pump disassembly, and automatically reducing process setup. Figures 6,7 and 8 represent the Toolkit.



Figure 6 - Hexagonal Central Flange

Source: Author

The hexagonal central flange Figure 6, was manufactured following all quality standards, and heat treatment between 40 ~ 45 HRC, this guarantees resistance and durability to the equipment.





Figure 7 - Interchangeable withdrawal shaft

Source: Author

The interchangeable withdrawal shaft figure 7 is named because it can be used in conjunction with the tool of figure 6, the union of this set is made through the thread that is at the end of the shaft and inside the hexagonal central flange.



Figure 8 - Adjustable Wrench

Source: Author

The adjustable wrench figure 8 is used in conjunction with Figure 6 to assist in dismantling part of the pump, details that will be shown later.



Figure 9 - Pump Motor

Source: Author

Figure 9 represents the submerged pump in disassembly process. The submerged pump in question is divided into two main parts, motor according to figure 9 and Water pump figure 10.



Figure 10 - Water Pump

Source: Author



Figure 11 - Tool Kit Coupled to Pump Motor Cover

Source: Author

Figure 11 represents the tools of figures 6 and 7, being used simultaneously in the process of disassembling the central motor cover of the pump with axial manual movements.



Figure 12 - Motor cover removed

Source: Author

Figure 12 shows the pump motor center cover removed quickly and without damage.



Figure 13 - Hexagonal Center Flange Coupled to Pump

Source: Author

Figure 13 represents the hexagonal central flange coupled to the water pump for disassembly.



Figure 14 –Drive Fixed Pump for Unscrewing Plastic Part

Source: Author

Figure 14 shows the pump set correctly in the vise for removal of the screw cap. In this process the tool of figure 6 is fixed to the plastic part with the aid of screws and nuts, to unscrew it, with the proper use of the adjustable wrench of figure 8, it is possible to remove the lid without the risk of breakage and setup reduced.



Figure 15 - Disassembled Pump

Source: Author

Figure 15 represents the dismantled and breakable dismantled pump in the plastic parts, this shows the result in applying the improvement in the construction of a suitable toolkit for the entire pump disassembly process.

The current flow below, demonstrating the reduced process amount using only one toolkit, has been able to reduce tools 1, 2 and 3.

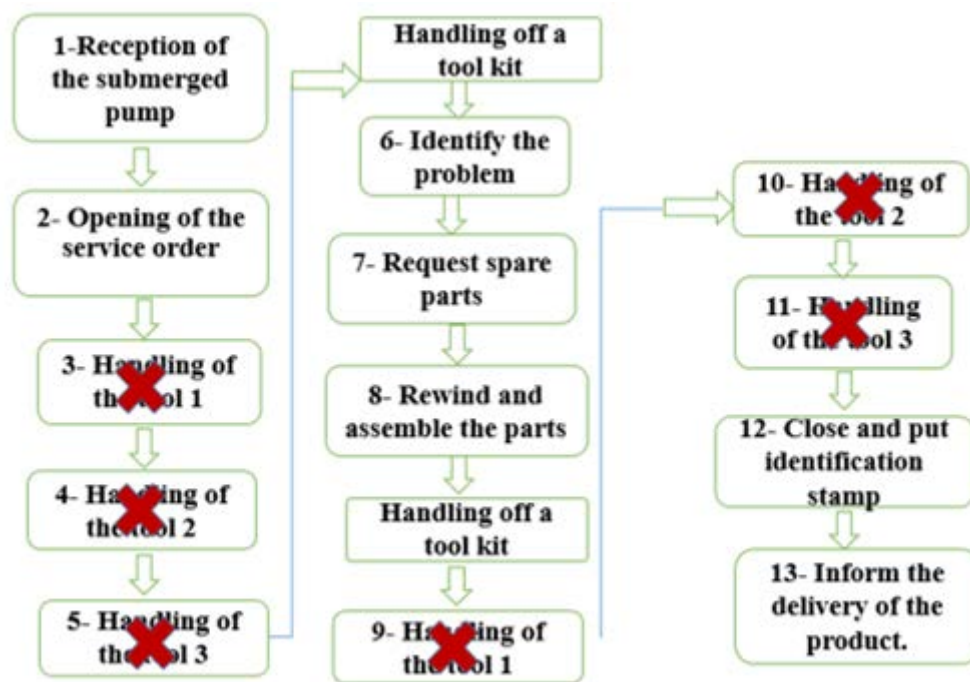


Figure 16 - Current Flow

Source: Author

With the application of the new method, the process flow reduced five steps, making the process more efficient, improving process time without compromising the correct maintenance.

## 5. Results and Discussions

With the conventional method the disassembly lasted around 2 hours, and with the new properly manufactured toolkit, it is possible to perform the same process around 40 minutes, considering the normal working conditions.

### 5.1 Tool construction

The elaboration of the Toolkit started with a project, which was specifically developed in SolidWorks, where all the 2D and 3D drawing was elaborated. The figure below represents the toolkit that was developed.

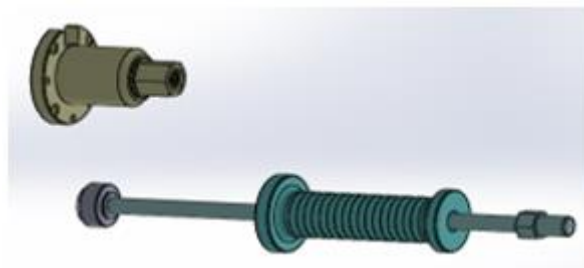


Figure 17 - Final Drawing

Source: Author

With the use of this software, it is possible to make these sizing checks also in 3D design, which greatly facilitates the detection of possible construction errors and can have a better visualization of the problem to be corrected, saving time in the development of the design. special tool, including simulating the procedures that the tool will perform when making use of disassembly, such processes as pre-drilling, hole finishing, roughing and finishing etc.

## 5.2 Comparison of Results

The result below informs the hours gained during the process, reducing the time per service.

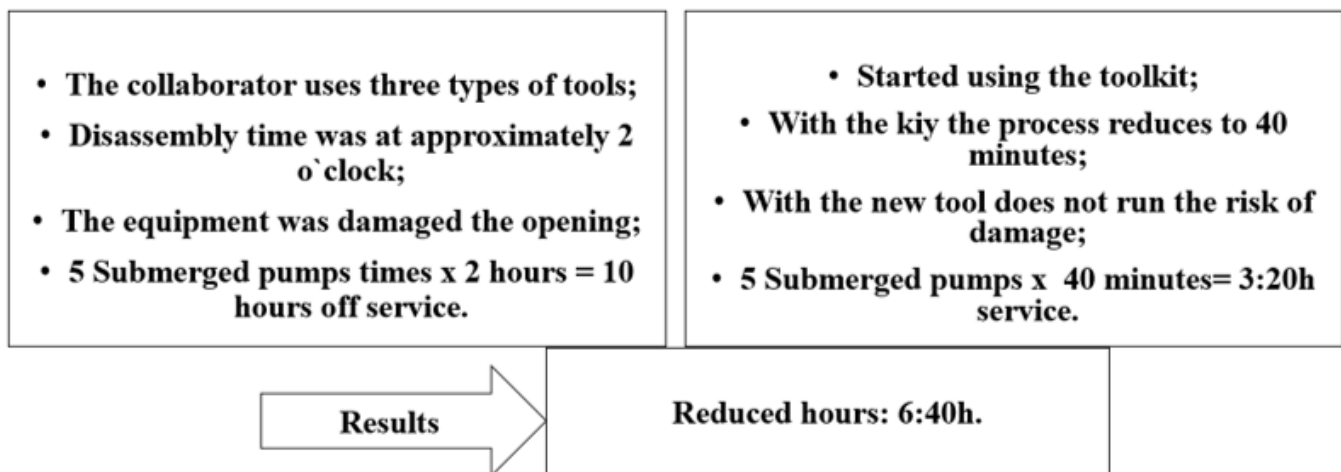


Figure 18 - Results

Source: Author

Using the toolkit of Figures 6,7 and 8, it is possible to observe the drastic reduction during the whole disassembly process of the equipment in question, without causing breakage or damage to the most fragile parts. The toolkit brought the process speed, quality and safety.

## 6. Final Considerations

This work was elaborated in order to present the evolution of the product design and its production, analyzing the current systems. We sought to show the theoretical basis of CAD / CAM systems and their applications in tool making, showing how the needs of these applications arose and how they can influence their production processes.

It is understood that the objective of this study was achieved, since it was possible to analyze the use of this technology and its applications in a manufacturing process of a toolkit and comparing with conventional manufacturing methods, obtaining a positive result. regarding the area of application of this tool.

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# **Proposed Preventive Maintenance in a Small Machinery Rental Company**

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## **Abstract**

*The purpose of this implementation proposal is to propose the company to reduce costs and prevent equipment breakdown, with the equipment stopped causing delays in services and unnecessary expenses. It has been observed that their maintenance is not scheduled and performed when the equipment is already defective / breakage. Inadequate services are performed that in the future an easily resolved problem will become difficult to solve as a result of greater damage and equipment stopped for a longer time. With the proposed implementation of the system we can make the company have reliability in the market (employees / partners) generating more profit and less waste, and we can gradually implement a tool that is used in large companies in small companies adding to it. more value in your development.*

**Keywords:** Implementation; Costs; Reliability; Profit.

## **1. introduction**

Currently there are several types of maintenance ranging from a simpler to a more complex, bringing major benefits to companies, such as improvements in production and especially with the reduction of costs.

In this paper we will address preventive maintenance by implementing it in a small company with segment in machinery leasing, where it was observed the lack of adequate structure to perform maintenance on their equipment that are performed randomly when the equipment already has defect / breakdown, the preventive maintenance has the purpose of preventing and avoiding the consequences of

the failures where we perform the change of the part before the problem occurs, preventing the machines stop, problems that end up hindering the development of the work. preventive maintenance implementation showing that we can apply this tool gradually without generating large costs but with the visibility of unnecessary cost and expense reduction and ensuring a uniform and safe work in a small business, with the main objective to prevent and prevent machine breakage eliminating unscheduled downtime due to lack of improper maintenance, impairing production and work development and the confidence given to the company, aimed at increasing equipment life, reducing costs and especially employee safety, adding value and reliability to the company. to the market.

## **2. Theoretical Review**

### **2.1 Maintenance History**

As it says Different authors identify different stages in the evolution of Maintenance's role over time. But overall, the perspectives converge. Moubray [1] brings together some consensus and distinguishes three generations in the evolution of Maintenance (Figure 1):

#### **2.1.1- 1st Generation**

Time period from the industrial age until World War II. At this time maintenance was in an embryonic state, as companies repaired or replaced equipment only in the event of a malfunction. Prevention was not an action taken by maintenance managers

#### **2.1.3 - 2nd Generation**

In the early 1950s, the increase in process automation made equipment more valuable. Any such breakdown would entail high costs for long stops, and there was a general feeling that such breakages could be prevented. This results in a progressive awareness of the preventive maintenance of equipment, which became increasingly complex.

#### **2.1.3 - 3rd Generation**

The emergence of bold and revolutionary philosophies, such as just time, required a substantial improvement in resource management. Low stock levels meant that an equipment malfunction resulted in high losses. Severe Maia became, because the increasing automation generated more and more malfunctions. Hence maintenance has progressively developed towards prevention and is in full development to this day. Thus, emerging new techniques, policies and ways to manage maintenance, which today is horizontal to the organization of a company.



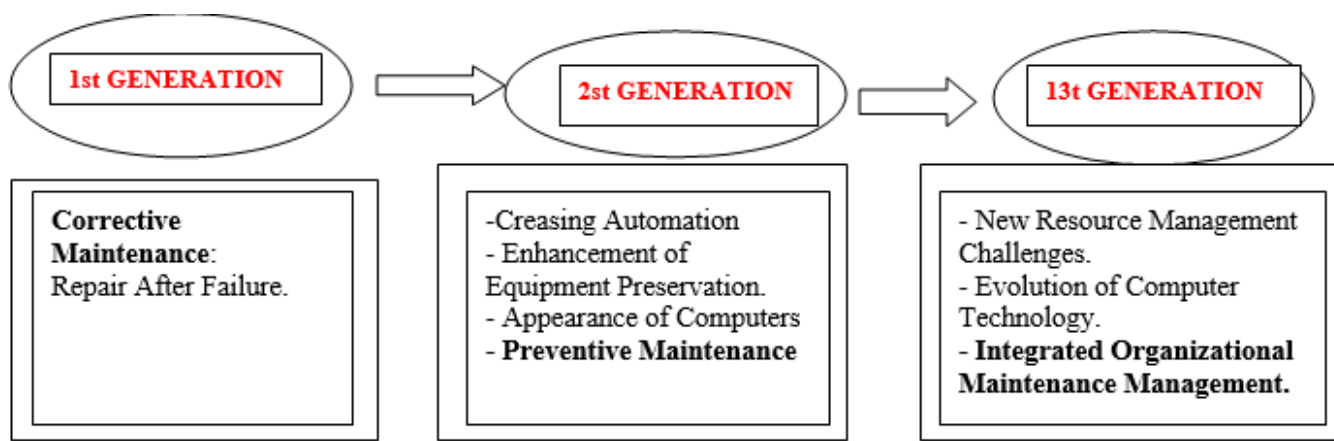


Figure 1- Maintenance Evolution

## 2.2 Maintenance Engineering

As Pinto & Xavier [2] assures an efficient Maintenance project is to continually abandon repair practices to look for root causes, modify permanent underperformance, stop living with chronic problems, improve standards and systematics, develop maintainability, give feedback to the Project, technically interfere with purchases. Engineering's attributions in the maintenance process are characterized by the use of elements for analysis, study and improvements in the intervention and maintenance models of the machines through modern methods, thus overcoming an impediment in the already solidified tradition of society. (PINTO & XAVIER, 2001). A Maintenance Engineering program has reflections on the maintenance system enrichment, and it is a more complex perception to be instituted because it establishes structural changes.

According to Siqueira [3] maintenance aims to “preserve the functional capabilities of operating equipment and systems”. Siqueira [3] says that the goal of maintenance is to “ensure that physical items continue to do what their users want them to do”, we can say that over time maintenance has undergone major changes making it more effective where we have different types of maintenance where each has application and right time to apply.

Almeida [4] tells us that maintenance generally encompasses all the procedures necessary to maintain the required facilities, machines, equipment and all infrastructure resources. According to the French Association for Standardization (AFNOR), in its NF 60-010, "maintenance is the set of actions that allows the restoration of a good to its specific state or measures to guarantee a specific service." NBR / 5462/1994, paragraph 2.81, states that maintenance is the combination of all administrative technical actions, including supervisory actions designed to maintain or relocate an item to a state in which it can perform a required function.

## 2.3 Corrective Maintenance

Almeida [4] Corrective maintenance happens in the event of unforeseen stops. The machine that is in production is responsible for ensuring the delivery deadline, so it is the accuracy that guarantees the quality and reliability of the product. Maintenance personnel immediately act to restore the operation of a damaged machine or equipment as soon as possible. According to NBR / 1994 “corrective maintenance is

maintenance performed after a breakdown has occurred to replace an item in a position to perform a required function”.

#### **2.4 Preventive Maintenance**

Almeida [4] Preventive maintenance is planned and controlled maintenance, performed at predetermined dates, with the objective of keeping the machine or equipment in proper working and conservation condition, in order to avoid unplanned shutdowns. Planning is possible when documenting corrective maintenance operations performed with part life information provided by the manufacturer. Another relevant factor is the conditions of the workplace where the machine or equipment is being used.

#### **2.5 Predictive Maintenance**

Almeida [4] Predictive maintenance is possible to indicate the actual operating conditions of a machine according to data obtained based on the phenomena presented by it when any part begins to wear or some adjustment is necessary; This is what mechanics popularly call “listening to the machine”. Based on periodic inspections during which phenomena such as temperature, vibration, excessive noise is observed through specific instruments, enabling short-term planning for a maintenance intervention with part replacement and defect elimination.

#### **2.5 Total Productive Maintenance (TPM)**

Total productive maintenance encompasses preventive and predictive maintenance programs, as well as a training program for operators that assists in machine monitoring with a predictive maintenance practice and performs maintenance-free operations such as changing oil, which is a preventive maintenance practice, highlighting the elimination of large losses, autonomous maintenance, planned maintenance and education and training. ALMEIDA [4]

#### **2.6 Reliability Centered Maintenance**

MCC can be defined as a program that brings together various engineering techniques to ensure that plant equipment will continue to perform the specified functions. They enable companies to achieve excellence in maintenance activities by increasing equipment availability and reducing costs associated with accidents, defects, repairs and replacements.

### **3. Methodology**

The methodology that was used to achieve the objectives for which this article proposes is described below:

Bibliographic review on the subject, in order to know the original thinking of several authors and the latest events in the area that was studied.

Observation of the methods and techniques used by companies that use the preventive maintenance model in their programming framework and in companies that are in the implementation phase.

Field research was carried out at ATHAYDE LOCASÇÕES E SERVICES - LTDA that the study is being

destined, where we made the survey of the problems found and possible solutions in order to be proposing the implementation of preventive maintenance in the company.

From the acquired knowledge and lived experiences, based on the initial objective outlined, it was possible to reach conclusions and results for the possible implementation of the system in a small company.

#### **4. Application of Study**

The study aims to study the best way to apply preventive maintenance in equipment (tractors, excavator and backhoe), where currently the entire process of maintenance of the company is corrective type, which generates a lot of occurrence and failure and downtime, become a big bottleneck in the company's production process. Thus, a preventive maintenance policy was elaborated, raising the main points to be inspected during a preventive maintenance stop, in order to find the right time to make the preventive maintenance stops, in order to maximize equipment availability at the lowest possible cost.

Application of preventive maintenance was performed in 5 steps:

1-Mapping of equipment, where a technical evaluation was performed, analyzing the current condition of the equipment, its lifetime and the time the equipment spends in operation. After this survey with the data everything is documented to go to the second part.

2- Classification as to the criticality, the classification was based on criteria of safety, cost, necessity and frequency of failure. It was analyzed what cost will be needed to maintain each equipment, if the machines are able to meet the demands.

3- Staff assessment is one of the most important steps for the preventive maintenance plan to become effective, assessing staff whether they have the ability and qualifications to perform routine and preventive maintenance on each equipment and have sufficient staff to meet the needs. ensuring all equipment receives the necessary attention.

4- Structuring the plan, with already defined information from the previous steps, had to take other factors into account for the plan to become effective. Considering this as a considerable factor, a schedule was prepared with the maintenance period of each equipment, analyzing if there is need to schedule scheduled shutdowns (routine / preventive) for each machine, estimated maintenance time of each machine, resources needed for maintenance. , being defined who will take care of each equipment, how the work orders will be issued.

5- Monitoring the preventive maintenance plan, already presented the maintenance plan to the team and explained the procedures and goals, the plan is implemented gradually, defining the responsible for each task. Accompanied by checklists to ensure that scheduled procedures have been performed, visit and inspection routines are also performed to avoid corrective maintenance where faults can be detected before they become major failures. The entire procedure is documented (work order, maintenance history, machine guide), and staff undergo training to ensure the efficiency and effectiveness of the implemented plan.

## 5. Results and Discussions

The process of performing preventive maintenance includes planning for machines to be overhauled without having a major impact on production and not disrupting the production cycle, planning maintenance times so that no service delay occurs. If preventive maintenance is not performed, the chance of an accident at work is very likely and the machinery is operating in a problematic way, putting the team at risk and causing major damage to the company.

After the implementation of preventive maintenance, the company had several benefits, preventive maintenance started to be performed regularly, the results of preventive inspections are recorded in the regular maintenance program, the equipment operator began to contribute reports about the conditions of the equipment where it performs inspection checklists daily and is analyzed by the maintenance team for abnormal problems, corrective maintenance occurrences are analyzed and follow up actions are taken so that it does not happen again.

The cost of preventive maintenance versus corrective maintenance has a big difference, making it the best choice and lowest cost preventative.

In order to assess the technical knowledge of the operators responsible for the tractors analyzed, a control form was prepared with the items evaluated on the machinery, as shown in Figure 2:

Operator Name: Operator	Code:
Level of education	
Procedures for Starting and Shutting Down the Tractor	
Checking Daily Maintenance Items	
Importance of fuel supply	
Engine acceleration	
How did you become an operator?	
Machine operation and maintenance course	
Most frequent operations you perform	
Correct use of tools	
Knowledge about air filter cleaning procedure	
How to proceed when starting on a tractor without battery	
Instrument reading	
Consult the manual	

Figure 2 - Control Sheet

Source: Adapter-Quality Control Sheet by Own Author (2019)

With the control sheet we have the quality control of the service and the responsible of the machine, analyzing its capacity. With this data the company can also be studying to be qualifying and training its employees, adding both beneficial to itself and the employee making it high capacity.

Table 1 - Service Order.

ATHAYDE RENTAL AND SERVICES-LTDA			
S.O. SERVICE ORDER No. 45			
OPENING DATE: 08/17		MAINTENANCE: preventive	
Type of maintenance activities: Service Request:		Application: Excavator	
01	Diesel oil filter		
02	Fuel filter		
03	Water separator filter		
04	Air conditioner filter		
05	Engine oil hydraulic return filter		
06	Swivel Command Oil		
07	Hydraulic system filter		
Pointing of manpower			
Date:	Description of the service performed	H start	H ending
17/08	Performed the exchange of all items above.	13:00	18:00
Closing Maintenance Order			
Closing date	Labor resp. Service	Workshop clerk	
08/17/2019	Nonato	Paulo	

Source: adapted by own author (2019)

In Table 1 we have the Service Order, through which we obtained a more precise control, where it contains all the data for the control of the plan in a practical and simple way facilitating the understanding of all.

By gradually implementing preventive maintenance on machinery, the company will be ensuring that they are and are properly repaired, adjusted and maintained to prevent abnormal wear and to detect defects before they can result in accidents.

## 6. Final Considerations

The main purpose of this work is to propose a preventive maintenance policy to be applied to equipment. Thus, corrective interventions related to preventable type failures are expected to be reduced to near zero. This guarantee is not only about the integrity of the machinery, which keeps it available for production and operation, but also for safety, as failure to perform the correct maintenance endangers the physical integrity of the people involved and society.

The main difficulties presented in the implementation of the plan was the adaptation of the employees to the new rules, as they already presented their own way of working having difficulties in adapting to the new techniques.

We concluded that failure to perform preventive maintenance increases the occurrence of corrective

maintenance, increasing the cost of maintenance, downtime of maintenance machinery, increasing service demand due to unscheduled downtime, and endangering employee safety. operating equipment with abnormal problems.

And finally, it was observed that it has the possibility to be inserting a high cost maintenance technique in a small company having time saving results, gaining credibility in the market of operation.

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# **Implementation of 5S Program in a Building Site of a Predial Reform in Manaus City**

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## **Abstract**

*The 5S Program is a quality tool that aims to restructure and improve the processes of teamwork production, system rationalization, desperation changes and especially the change of attitude of employees using a new work culture. In this situation, the article demonstrates the importance of implementing the 5S Quality Program in a monument to the city of Manaus - I am, with the purpose of improving the service provided to clients. The method used for the development of the work was a case study, based on the following steps: data collection, PDCA action plan, using Ishikawa, Flowchart and Gut Matrix tools. The results obtained consisted of the following occurrences in the environment were evident, such as: more organized environments, reduction of waste, availability of spaces in the monument to the work, easy access to equipment, as well as commitment of employees to the principles of 5S and research in relation to the execution of the program, to realize how much the changes provided by this instrument improve the area and way of working.*

**Keywords:** 5S Program; PDCA; Construction site;

## **1. Introduction**

The 5s program aims to provide knowledge by recommending to all participants to improve quality and productivity in the workplace in order to reduce costs and increase efficiency. Nowadays companies in the construction industry have been adopting the philosophy to improve the quality of the services rendered, and achieve the greatest reduction of financial impact.

For this reason, we need to invest in improving the quality systems in these industries to provide customers with improved and efficient service. For [1], even with the constant evolution of quality concepts, some tools created several years ago are still valid and widely used by companies that work with quality system.

From traditional management concepts to Total Quality Management, many management philosophies, techniques, tools, and forms have been created, refined, or redefined to create the right conditions in organizations for the best results [2].

Among the tools used in the total quality planning processes is the Japanese 5S Program, which seeks to clean and order the environments, as well as the elimination of losses through educational actions and training of people, resulting in better quality. working life and better productivity in organizations [3].

Thus, the present work aims to implement the 5s program in a building renovation site in the central region of Manaus, with the purpose of improving the service offered to clients, developing a sense of organization and cleanliness of the site. It also promotes respect and self-discipline on the part of employees.

## 2. Theoretical Foundation

For the effective realization of the research project and case study, it was sought to base the implementation of the 5S Program in the context of process and continuous quality improvement within the Construction and building reforms segment.

### 2.1 5 S Methodology

5S is a set of concepts and practices whose main objectives are the organization and rationalization of the work environment. Broadcasting in English as Housekeeping, 5S emerged in Japan in the 1950s as a Japanese Total Quality Control program. The program name refers to 5 Japanese words starting with letter S in western alphabet: Seiri; Seiton; Seiso; Seiketsu; and Shitsuke [4].

With the emergence of the 5S's, they made Brazilian companies in the productive sector of construction adhere to the ideology to reduce waste and improve the internal culture of employees, thus awakening a conscious mind and concerned about the quality of the tasks performed. The meanings of these words are presented in table 01.

Table 01 - Meaning of 5s words.

	Japanese	English	
1º S	Seiri Tidiness	Sense of	Use
			Storage
			Organization
			Selection
2º S	Seiton Orderliness	Sense of	Ordering
			Systematization
			Classification
3º S	Seiso	Sense of	Cleaning



	Cleanliness		Zeal
4º S	Seiketsu Standardization	Sense of	Cleanliness
			Hygiene
			Health
			Integrity
5º S	Shitsuke Discipline	Sense of	Discipline
			Education
			Commitment

Source: Adapted from CARPINETT (2012)

### 2.1.1 The Sense of Use (Seiri)

It means leaving only what is actually used on the desktop, unnecessary tasks should also be eliminated, the frequency at which equipment will be used should be analyzed, they should be kept in sight. Putting “in order what is messy,” when everyone should select items that are unnecessary to perform their tasks and give them a proper destination, is knowing how to use without wasting, [5].

### 2.1.2 The Sense of Ordination (Seiton)

This Sense can be summed up as the set of actions that allow the necessary objects, documents and data to be located quickly, correctly and securely. It is also responsible for improving visual communication through drawings, warnings and phrases. Generating benefits such as improving the physical environment of the company, saving time and energy by reducing unnecessary movement, speed, security and ease of searching for materials, documents and data, among others. It is knowing how to order to facilitate access and replacement, [6].

### 2.1.3 The Sense of Cleanliness (Seiso)

The sense of cleanliness comes to eliminate dirt, more important than clean and not dirty. This sense also comes preemptively seeking improvements and awareness, focusing that the clean environment is the least dirty. Cleaning should have its daily maintenance performed by each person living in the environment and using the machines or equipment. One must know how to use without fouling, attacking the sources of dirt, [7].

### 2.1.4 The Sense of Hygiene - Health (Seiketsu)

This Sense is also known as Health, Hygiene or Cleanliness. It is the result of the implementation of previous Senses, is directly linked to the physical and mental health of people and especially the physical and behavioral changes that occurred in the company. Several factors contribute to making people feel good inside the work environment and therefore can perform their tasks with joy and creativity, which is positive for quality and productivity. It is necessary to strive to standardize and maintain the first three S on a daily basis, as well as to take care of the health of body and mind, [8]

### 2.1.5 The Sense of Self-Discipline (Shitsuke)

The sense of self-discipline comes to systematize the new values and standards that the three senses Seiri, Seiton, Seiso. Seiketsu calls for everyone's awareness and commitment leading to standardization. It is to strictly comply with what is established.

Discipline comes when people start to do the things that have to be done and the way they should be done, even when no one sees and no one controls or demands, [9].

## 2.2 Quality Management

Quality is a fundamental factor for the growth and consolidation of companies or any other type of organization, as companies that have an efficient quality system become differentiated in the market. In order to ensure that quality is considered in daily management processes, various organizations choose to implement quality management systems (QMS) to demonstrate their full commitment and involvement in offering products or services that meet the needs of their customers. customers [10].

According to [11], QMS seek to contribute to the achievement of three main objectives: “to provide a systematic approach to all activities that may affect quality [...]; focus on prevention activities rather than relying solely on inspection; provide objective evidence that quality has been achieved. ”

Total Quality Control (TQC), which [12] says is "an improved administrative system in Japan developed from American ideas inserted after World War II, known as Total Quality Control - TQC." The author points out that total quality deals with the dimension's quality, cost, delivery, morale and safety, which affect the satisfaction of people's needs and, in particular, the survival of the company.

## 2.3 PDCA

The PDCA (Plan, Do, Check, Action) cycle is a methodology for problem solving based on continuous improvement, making it possible for the guidelines outlined by the strategic planning to be made feasible in the company. the method [13].

This cycle is uninterrupted and is intended for continuous improvement, because using what has been learned in one application of the PDCA cycle, another cycle can be started in a more complex attempt, and so on. With that, the last point on the PDCA cycle becomes the most important one, where the cycle will take on a new beginning [13].



Figure 1 - PDCA Cycle

Source: Adapted by own author (2019)

The PDCA Cycle (Plan, Do, Check and Act), known by some scholars also as MASP (Methodology of Analysis and Problem Solving), is a methodology of continuous improvement focused on the processes of the organizations. [14]

The PDCA involves four steps:

**2.3.1 PLAN**- Plan what is to be achieved by defining the objectives, the methodology and the schedule.

**2.3.2 DO** - Execute the planning. Includes training the professionals involved.

**2.3.3 CHECK** - Verify that results are being achieved as planned. It is at this stage that possible failures and errors are detected.

**2.3.4 ACT** - The remedial measures identified in the previous step apply. Action plans are defined to improve quality. The results are disseminated and the improvement is reflected.

According to [15] the PDCA cycle quality tool can be defined as an analysis and mediation of particular process (s) in an organization. It consists of four steps: Plan, Do, Verify, and Act. The initial letter of its steps gives rise to the term PDCA.

PDCA is used to guide the actions to be taken, which are broken down into the phases of problem identification, observation, root cause analysis, action plan, action to eliminate the root problem, verification of action effectiveness, standardization and conclusion.

## **2.4 Ishikawa**

The Ishikawa methodology or cause and effect diagram, or fishbone diagram, consists of exploring and indicating all possible causes of a specific condition or problem. This method was developed to delimit the relationship between effect x cause and cause x effect in the development of production processes and quality.

The problem specification is placed on the fishbone head. The causes are identified on some levels. When the possible causes at various levels are exhausted, the most repeated causes should be analyzed by summing up all the levels. Those that appear most frequently should be analyzed to identify which is the root cause of the effect [16].

Tool developed by Kaoru Ishikawa also known as cause and effect diagram or fishbone, provides a practical view of the variables that affect the outcome, [17].

This Diagram is a way of organizing what has happened inside the company and everything that can be reshaped and corrected based on the negative experiences that have happened [18].

## **2.5 Flow Chart**

The flowchart is an attempt to holistically visualize a given activity and, by definition, is the graphical representation of the various tasks. This tool should bring as much information as possible to its user, however, to be an accurate instrument and not overly overloaded, it is sometimes merged with other methods. The presentation facilitates the identification of critical points of operation and can clearly define the desired limits.

[19] presents the Standard Flowchart. The author describes it as a deepening of the Block Diagram, in which "each task of the process under study can be detailed to the extent that the standard flowchart can

be used as part of a new employee training manual." This form, however, is best used in situations where the process reaches an international standard quality level.

The flowchart begins with an issue / problem / mission / project that needs treatment or care within a team or organization [20].

In other definitions flowcharts are simple diagrams for documenting algorithms or processes in a formal, graphical manner.

Graphically, flowcharts are the heart of business process mapping [21]. A flowchart where roles are assigned indicates a process map consisting of shapes representing different elements of a workflow. For example, rectangles represent actions, diamonds represent decision points, and rectangles with wavy bases represent documents.

## 2.6 GUT Matrix

The GUT matrix is developed by analyzing the following criteria: Severity, Urgency and Trend of each of the existing problems, in order to identify which, one has the highest priority and which will therefore be analyzed and solved first [22].

This tool assumes that a large list of problems has been found and that the resources to solve these problems are limited. Therefore, it is necessary to focus on the most relevant problem at the moment [23].

In this view, [22] defines the three points of analysis:

Table 02 - Analysis Points

ANALYSIS POINTS	
GRAVITY	Refers to the impact of the problem on situations, outcomes, things people or organization
URGENCY	Is the relationship with the time available for the problem to be solved;
TREND	Is the proportion that the problem can reach in the future. In the GUT array, the problems are listed in rows in the same column and next to a column for each of the three parameters

Source: Adapted by own author (2019)

[24], clarifying how to use this method can serve to prioritize problems and address them. To do so, consider the Gravity, Urgency, and Trend factors, and each gives a score on a scale of 1 (one) to 5 (five), where Gravity is about not solving problems, and indicates the impact, especially on results, and processes that will emerge in the longer term.

Urgency is a specialized variable with time available to resolve the specific situation. Trend analyzes the trend or pattern of the evolution, reduction or change of the problem.

## 3. Tools and Methods

How tools applied to compose how cannon site improvement actions were planned for Excel control, Power point employee presentations, periodic meetings during deployment, 5S program finalization a team of auditors was chosen to be trained to perform compliance check and non-conformities using

Ishikawa. Through the use of the flowchart, it was remarkable the evaluation of all steps, especially in the places that need to be changed in appearance. The Gut tool showed that the collected data were essential for prioritizing the problem encountered, giving relevance to the emergency. In this case, it will be presented the methods of application of the PDCA tool, such as the process management system of the 5S program, in the case of a previous renovation work, which is located in the city of Manaus Amazonas. The PDCA cycle lasted 04 months. The system was applied from July to September 2019, thus meeting or planned schedule.

## 4. Application of Study

### 4.1.1 GUT Matrix

One tool was extremely useful during practice in project control, allowing you to prioritize the issues that must be solved. The earlier they are more affected by the impact, the faster the activity gets back in control and the lesser the dissatisfaction of the reduced parts.

Table 03- Gut matrix step

Priority items	G	U	T	G x U x T
Dirty bedding	3	3	5	45
Cardboard boxes on the floor	2	3	4	24
Disorganized stock	5	5	5	125
No identification	3	2	3	18
Shares and mortars on the floor	3	5	4	60

Source: Adapted by own author (2019)

### 4.1.2 Planning (PLAN)

In this step, I started with the designation of the 5S Team, this team was responsible for executing the program implementation planning, the user group experienced several problems in the area, such as equipment clutter, obsolete material with materials in use, lack of label. and stock control. The environment of mortar, cement and lime materials without local identification. Tools work completely off site, wasting time on a particular problem on the jobsite. With various Sector images, a presentation was presented to show employees or current status, and the weekly Action plan was set at a meeting with the entire 5S team.

Table 04- Planning Step (Action)

ITEMS	PDCA	TASK NAME	DAY
1	PLAN	Team Definition	1
2	PLAN	Industry Assessment	2
3	PLAN	Preparation of the Presentation	1
4	PLAN	Action Plan	2

Source: Adapted by own author (2019)

Through the mapping made by the flowchart it was possible to survey the problems and locations that would be applied the 5 senses, proposing the facilitation to reduce downtime, process failures and cost cutting.

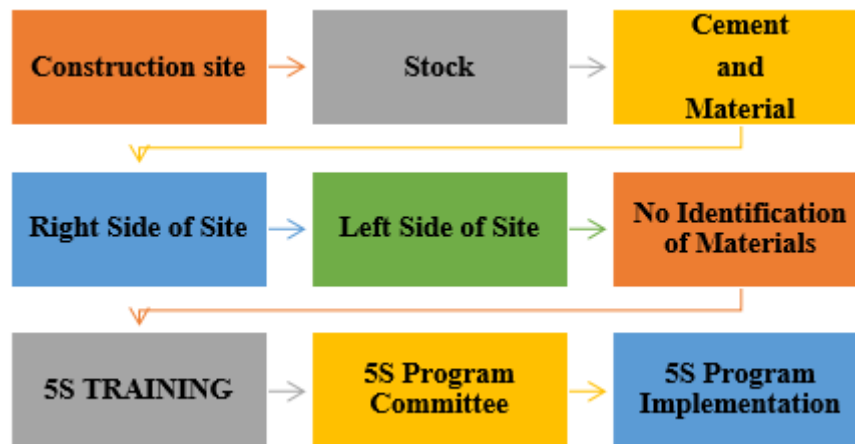


Figure 02- Flowchart Step

Source: Adapted by own author (2019)

#### 4.1.3 Implementation (DO)

Following the preparation of the Weekly Action Plan by the 5S Team, we sent the document to be approved by the Director. The first action after approval was to set the date of the presentation for the construction site employees. This presentation addressed the 5S Program, the Current situation that was the environment through images and the weekly action plan created by the commission, the employees saw the need for change, as the construction site had only business hours, the formation of teams among the employees became necessary, there was also a material request for the beginning of the activities, after the material was released we started the implementation with the Usage Sense, in table 07 the “Do” execution, and in table 08 the fishbone diagram was used for analysis. of the production process, aiming to identify the problems and the root cause.

Table 05- Execute (Do) Step

ITEMS	PDCA	TASK NAME	DAY
5	DO	Meeting for Implementation	1
6	DO	Team building	1
7	DO	Request Materials	1
8	DO	Implementation-Start of Activities	2
9	DO	Implementation-(Ordinance)	5
10	DO	Implementation-(Cleaning)	4
11	DO	Implementation-(Health)	5
12	DO	Implementation-(Discipline)	5
13	DO	Disclousure of Results	1

Source: Adapted by own author (2019)

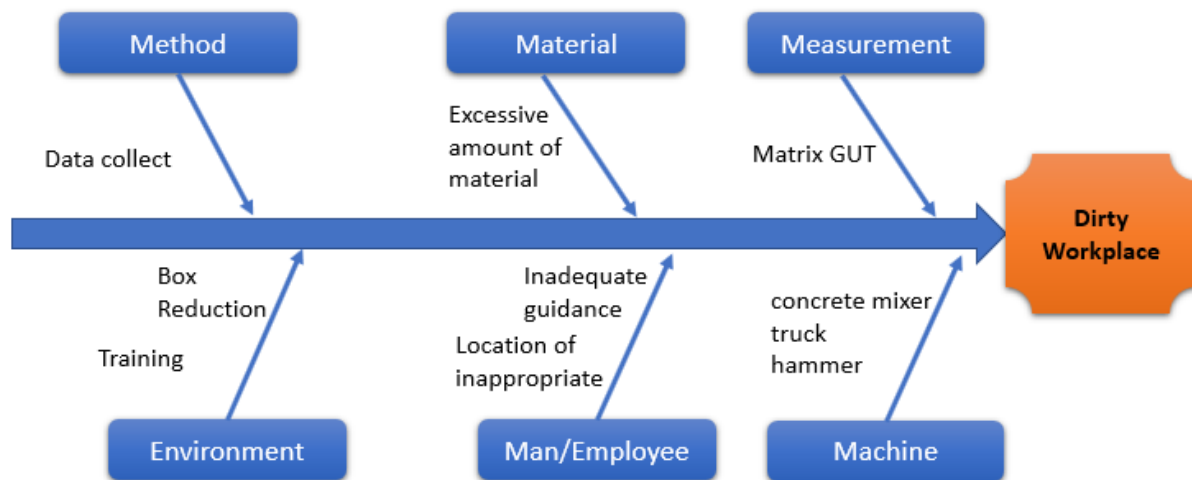


Figure 03- Herringbone Stage (Ishikawa)

Source: Adapted by own author (2019)

#### 4.1.4 Sense of Use Week

The first week of project execution was to separate what is useful from what is not, to improve the use of what is useful, to keep only what is needed on the construction site, to combat waste and idleness. Before week of use, it was possible to find several empty boxes in the sector, leftover shards, expired mortars, many useless equipment. In figures 4 and 5. An analysis of equipment and materials was made, and many of them were sent to the sector responsible for obsolete equipment.



Figure 4 and 5: Activity performed in the first week (Organization of the flowerbed)

Source: Adapted by own author (2019)

#### 4.1.5 Systematization Sense Week

In the second week was the turn of the Systematization Sense. The organization, in this sense, referred to the disposal of tools and equipment, mortars and cements, in an order that allowed the best flow of activity. The materials were being left where will be used later. The process is designed to eliminate unnecessary movement. Figures 6, 7, and 8.





Figure 6, 7, and 8: Activity Performed on Week Two (Inventory Organization)

Source: Adapted by own author (2019)

#### **4.1.6 Sense of Cleansing Week**

The third week, with the Sense of Cleanliness shown in figure 9 and 10, began to be streamlined, the whole sector was already visible along with the other senses there was already difference across the field. At this stage it was important not only to clean the environment but also to maintain it daily. The time has come to educate not to pollute, and always watch over all that is our responsibility.



Figure 9 and 10: Before the cables were all thrown to the floor, now they are fixed to the wall (Organization of the flowerbed)

Source: Adapted by own author (2019)

#### **4.1.7 Health Sense Week**

In the fourth week, the Health Sense was implemented, with it the challenge was to leave the most favorable environment that was already clean and organized, prioritizing physical, mental and emotional health, based on hygiene practices. A meeting was also held for suggestions and compliments, reinforcing the interpersonal relationship and respect for others while maintaining the Harmonize work environment.

#### **4.1.8 Health Sense Week**

By the fifth week, the Self-Discipline Sense was already well in force, since in the other senses these practices had already been stimulated, because the fact that every week, a group is scheduled for organization and monitoring of the work area, helped to keep everything that was already done. had been done.

Also, every Friday was collected the main changes to be made next week, on Monday is collected the results (photos), and sent to all staff.



#### 4.1.9 CHECK

In order to maintain the 5S Program, a group and work were defined to perform the audit training with the SGI (Person responsible for the Integrated Management System), so that there was control and monitoring of the development of the implementation.

The audit took place 10 days after the deployment results release meeting, through an ISHIKAWA, shown in table 08, produced by the SGI, where all 5S items that had been implemented were reviewed. The results achieved were very rewarding, meant the evolution of the improvement in the productive environment.

Table 6: Check step performed in Project - Flowerbed organization

ITEMS	PDCA	TASK NAME	DAY
14	CHECK	TRAINING FOR AUDITORS	2
15	CHECK	CREATION OF CHECK LIST FOR SGI	3
16	CHECK	APPLICATION FOR AUDIT IN AREA	2

Source: Adapted by own author (2019)

#### 4.2.1 ACTION

Subsequent to the Audit, there was a meeting with the 5S program committee, the Auditors and the SGI where the results were discussed and the timing of a new audit was decided, and it was defined at this meeting that the Audits would be held once a month for the audit. continuity of the program and adaptation of employees to the new reality of the work environment.

Verification items in which contributors scored higher would be added to the list of standardized items, verification items that scored lower would be treated as problem points, thus seeking through quality tools to eliminate the problem.

Table 7: Verification (Action) step performed in Project.

ITEMS	PDCA	TASK NAME	DAY
14	ACTION	ANALYSIS OF AUDIT RESULTS, MEETING TO DEFINE NEW ACTION PLAN	1

Source: Adapted by own author (2019)

## 5. Results and Discussions

The results show that the continuous improvement tools in particular PDCA Cycle, Gut Matrix, Flowchart and Ishikawa are extremely important for eliminating atypical events in the production process. Therefore, the objectives achieved by the 5S Program were essential to reach the metrics defined by Total Quality. Aiming to optimize spaces, and always keep it organized and clean, forging more agile processes, and easy access to searches of operational materials, where it was also possible to identify the main cause of the disorder of the area. Working with program deployment is very dynamic. There is pressure from all sides and it requires a large organizational capacity of those working in the sector. As the environment can change overnight, you need to be aware of changes and anything that can interfere

with the deployment progress.

Quality measurement and control comes as a strategic action to ensure project control and establish effective actions to put it on the expected performance baseline, whether in cost, time or project. As it was possible to realize during the search process, although there are a greater number of quality tools linked to the production and process areas, several tools can be used in a deployment, whether for indicator control, performance control, cause analysis. root or problem prioritization.

## 6. Final Considerations

Through the case study carried out in the field, it was possible to achieve the proposed objectives, that is, understanding how the presented quality tools can help the 5S program auditors and how they could use them proactively and analytically. enabling a better identification of the organization's problems and a more effective action in the possible solutions.

The main difficulties encountered were when the team was going to apply the shares, and using a lot of clay, leaving cardboard boxes on the production site and carrying many work tools, the return of these tools was almost always not organized. It was possible to see this, because the unions complained a lot about this failure, also when there were changes of rockers in the production area, almost always the equipment did not return to the places of origin, due to the small space of the sector, we always had to request an adjustment of the labels for identification of such equipment.

The space after 5S was organized, the sector began to breathe more clean air. Some difficulties were overcome, others really only with the analysis time, for possible adjustments. The Program demanded from each employee constant self-discipline, compliance with the rules and procedures was a great victory for Team 5S, and certainly a productivity gain and elimination of various waste that were occurring on the jobsite.

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## **Advantages and disadvantages of using the problem-based learning method - PBL for upper level students in business areas**

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### **ABSTRACT**

*Problem-based learning (PBL) is a teaching method that encourages the student's proactivity to reason, in order to seek solutions to the problem in question. This article aims to evaluate the advantages and disadvantages of using the PBL method for top level students in business areas. In order to meet the objective, a questionnaire was prepared from the literature studied and sent to 375 students, with a return rate of 19%. The main results show that 74% of the respondents consider that the practical classes contribute to the memorization of the content, 93% of the respondents consider it an opportunity for personal and social formation, besides promoting the sharing of knowledge and improvement in decision-making. It also found that 83% feel more protagonists in the PBL method and more than 81% feel more engaged in their own learning. As a result, it was possible to identify a favorable perception of the learning method that leads and engages the student. This research also allows us to conclude that the PBL is, in fact, perceived as a more current and innovative method by students.*

**Keywords:** Methods. Undergraduate. Problem-based learning. Evaluation. University.

### **1 INTRODUCTION**

One of the main objectives of education is the training of critical and fully participating citizens, motivating the constant improvement of teaching-learning techniques to accompany the changes observed in society. The evolution of the labor market also generates pressure on the forms of teaching and learning, and contemporary methodologies are directed primarily towards the training of independent professionals capable of solving diffuse problems (DE MASI, 1999). Undergraduate programs are currently presented as the main testing arena for the formation of a new generation - known as Y - that matured amidst the new information technologies and the global network; a generation characterized by entrepreneurship, independence, restlessness, agitation, anxiety and impatience (LEMOS, 2011; MUNRO, 2009; SOARES, 2008).

The profile of this new generation points to the need for teaching techniques that value autonomy and practical experiences, addressing real-world issues to establish relationships between objects and concepts in the search for solutions, simultaneously stimulating the conceptual, procedural and attitudinal development of students (BOROCHOVICIUS; CRISTINA; TORTELLA, 2014). Considering this context, Problem-Based Learning (PBL) - is presented as a pedagogical resource to meet the learning demands found in these students. Starting from practical problems, the PBL stimulates the search for solutions in small groups, using systematic processes of analysis, search and exchange of information and

critical self-evaluation in the cycle of resolution of the issues presented (FREITAS, 2012; KAROLINE, 2010).

In order to verify the efficiency of this pedagogical method, this article presents a preliminary evaluation of the application of the PBL in the training of bachelors in Administration, Foreign Trade, Economics and Accounting of a private educational institution in Paraná. Using a questionnaire, the students' perception of Problem-Based Learning was evaluated, highlighting the advantages and disadvantages that the PBL presents in relation to traditional teaching methods, highlighting among them the expository method.

## 2 CONCEPTUAL/THEORETICAL FRAMEWORKS

The emergence and application of the problem-based teaching method in universities, according to Gomes, Brito and Varela (2016), began in medical courses in Canada, more precisely in the 1960s. The method was structured in four axes, which go through the integrated curriculum, with the fusion of scientific disciplines in thematic axes; the study based on problems based on reality, involving research and discussion in small groups for the resolution, understanding and acquisition of knowledge; insertion of students in public health and education services and evaluation in differentiated methodology, leading to the appropriation of metacognitive knowledge (GOMES; BRITO; VARELA, 2016; MENEZES-RODRIGUES et al., 2019).

During the subsequent years of its implementation, the PBL began to be disseminated to the Netherlands, Australia and the United States (BRANDA, 2009; COELHO, 2016). In Brazil, it began at the School of Public Health of Ceará in 1993; at the Faculty of Medicine of Marília in 1997; and at the Medical Sciences course of the State University of Londrina in 1998 (BRANDA, 2009). The idea began at the medical schools and it was later recommended for other areas besides medicine such as economics, law and engineering in several places around the world (RIBEIRO, 2005).

Barrows (1986) described the basic cycle that make up this path of problem-based learning, as the organization of working groups where students receive the problem in order to examine it, discuss it and define a search for solutions. Then, the aspects of the problem are identified; the questions that were not understood are ordered and, from there, information and new knowledge are shared, closing cycles with self-evaluation as individuals and collective (BARROWS, 1986).

Innovative teaching practices are necessary for learning - considering that, according to Velloso (2014), the rapid transformations that society has experienced with the information technologies developed from the network connections and accessibility through mobile devices, such as smartphones, has influenced the formation of a new student profile: more dynamic, more technological and less patient to sit paying attention to content merely passed by the teacher. These students seek information through the Internet and are involved in this context, therefore, there is a need for a methodology that follows this reality, since the traditional methods of teaching learning, whether in basic education or undergraduate education are not sufficient to achieve a higher cognitive learning (GIL, 2015), in short, the most recent projections for the future of education indicate that the school, as it is today, has little chance of survival in the coming decades (BARBOSA; MOURA, 2013).

The PBL connects classroom activities with problems in the student's daily life, gives them more responsibility and ability to solve issues that will arise in their daily lives and thus have systematic arguments to make the resolution effective. In this way, innovation in education is promoted, with a new curriculum suited to this method and where learning is not only the acquisition of much information, but also transform this information into knowledge that will be useful to manage the life of the student in school, in primary education, in high school, in undergraduate and postgraduate education (BARBOSA; MOURA, 2013; GOMES; BRITO; VARELA, 2016).

In this way, a collaborative and solidary space between the various entities of the group is spontaneously created. This climate favors the construction of an enriching environment that only collaborative work can provide, and in this sense the teacher who traditionally transmitted knowledge as a protagonist, becomes mentor and tutor in this transformation of the learning teaching process (LAMBROS, 2004; SOARES, 2008).

The process of teaching learning is a challenge for teachers, principals and all those who make up the school, in an attempt to make the student have a high intellectual and cognitive capacity. Building conceptual learning, lacks current and a well developed methodologies (BEERS, 2005; CEZAR et al., 2010; MENEZES-RODRIGUES et al., 2019).

However, in the PBL, student commitment is fundamental to the success of the teaching and learning process; cooperative learning requires individuals to be in line with the group's objectives. It happens that the teacher in the classroom needs to have skills to develop interpersonal relationships in students through a change of posture, since education is a dynamic process of learning, in this sense the teacher also has the responsibility to be in permanent update of interdisciplinary knowledge, considering that the PBL requires a close relationship between teacher, student and content for the objectives of learning are achieved effectively (BOROCHOVICIUS; CRISTINA; TORTELLA, 2014; GOMES; BRITO; VARELA, 2016; MENEZES-RODRIGUES et al., 2019a).

The tutor-teacher has several specific functions in the PBL, such as encouraging students to make their own decisions; contributing to students seeking reliable references through research; identifying students with difficulties in this process, so that it is possible to lead them to learning; promoting the integration of working groups; and stimulating the exploration of knowledge already existing in the student to be added to the new (DELISLE; OLIVEIRA, 2000; LAMBROS, 2004)..

That said, it is necessary to reflect on how this teaching strategy takes place in practice, what the PBL cycle is and how the teacher behaves who intends to work in a more innovative way in his methodology. Thus, Freitas (2012) points out that, in the PBL, the curriculum has a difference in the organization of traditional education being organized by modules or axes and this implies a more robust and complex structure for the operationalization.

By observing the teaching practice in universities, through the regulations and criteria adopted by the regulatory body (MEC, 2019) still resembles the traditional one, in which the teacher transmits the content; discusses with students; performs the activities; and, the student answers the questions; and moves on to the next content after the memorizations. That is, a methodological strategy that is still perceived in most schools. However, different strategies have been developed by teachers who believe that they can teach in a different way and, thus, will be more effective in the content and learning of

students. These are innovative practices, with the aim of making the student stop being just a listener and begin to actively participate in learning, that is, as a protagonist of their own knowledge (SOUZA; GOLDEN, 2015).

In this educational context, all those who make up the school should be encouraged to seek new forms of teaching that would be more appropriate to the student and the needs of society, with methodologies that innovate the way of teaching, in which learning is more effective (BOROCHOVICIUS; CRISTINA; TORTELLA, 2014; GIL, 2015).

The PBL in educational practice is a curricular challenge, since it needs systematic structural changes, as well as an integrated teaching staff and trained to work the content in an interdisciplinary way. However, it offers a development of new skills, such as: autonomous learning; teamwork; and adaptability to change (KAROLINE, 2010; RIBEIRO, 2005).

The PBL methodology is usually applied through working groups, in which students receive the problem; discuss; diagnose; elaborate the questions that have answers; for the unanswered questions, research the solutions and finish with collective evaluation and self-assessment. It seems a simple strategy, however, the responsibility and qualification of the teacher increases considerably (GIL, 2015; MENEZES-RODRIGUES et al., 2019b).

The construction of knowledge by the PBL is a method of interdisciplinary and transdisciplinary learning, i.e., all school entities may be involved in this process, unlike the traditional alternatives where the teacher of the subject is the only protagonist of teaching. Moreover, when the teacher ceases to be the protagonist so that the apprentice can manage his own knowledge relying on the guidance of the teacher, who at this time becomes a mentor, a new reality of reconnection of knowledge is created where it seeks to develop new knowledge and skills of students (BARROWS, 1986; DELISLE; OLIVEIRA, 2000; GIL, 2015).

The development of guided and non-impulsive thinking makes it possible to face complex problems and situations. The use of the PBL in undergraduate education allows students to develop conceptual and procedural skills (KAROLINE, 2010). In other words, they are built in an active and not passive way, leading to autonomous learning; the application of memorized knowledge in other contexts; the use of knowledge acquired in the analysis of new problems; and situates the student since the beginning of the course in his professional area (GOMES; BRITO; VARELA, 2016).

As mentioned by Mamede and Penaforte (2001), the construction of knowledge in an active way reinforces the idea that the PBL cannot be applied in isolation, although the student has the capacity to seek their own solutions, the discussion and sharing of information is fundamental for the strategy to work effectively. Understanding the content in a complete way requires an effort not only from the student, but also from the teacher when accompanying the groups as a guide and motivator, in this sense the presence of the teacher is essential for the objectives to be achieved.

For Vygotski (2015), the child's development takes place first at the social level and only then at the individual level. In other words, between people and after by himself, this application also takes place in the memory and formation of concept and also emphasizes that the superior functions originate from the real relationships between people. From this approach of the thinker, it is observed that the group study provided by the PBL method has numerous advantages, since it promotes and still encourages

social interactions not only of the child, but also of the adult already at the level of undergraduate education. When communication is established, there is an active participation in the production of knowledge and also provides the individual with the interaction that makes him/her feel a sense of belonging. Thus, the individual is an element in this construction and cultural and social development.

Morin (2015) points out that group work is an opportunity for personal and social formation and offers learning that provides a planetary citizenship. As one of the main characteristics of the PBL, the student has the opportunity to share knowledge and learning through collaboration in solving problem situations.

At PBL, group work stands out as a form of activity in which there is an appreciation of the student's coexistence in the learning process, in which all are protagonists and collaborate with mutual learning and in an integral manner (BARRETT; MOORE, 2011). In this approach of the authors, collaborative learning is essential to the formation of independent subjects. In this process of seeking the solution of the problems presented, the student faces different ideas, divergent points of view, has to make analysis and interpretation of the facts and will necessarily have to learn to respect divergences in order to find solutions to proposed issues.

Finally, in the PBL, the teacher ceases to be the protagonist and starts to stimulate the student to be independent and reason with autonomy. According to Borochovcicius et. al (2014), this methodology does not only meet the needs of students, but also of teachers. In other words, the method has the function of allowing students to solve problems related to the future profession and thus will be able to learn, be critical and make the decisions they will need in life as professionals. With regard to teachers, the method encourages them to research more and seek interdisciplinarity, in order to make connections in teaching with the needs of professionals who will be their students in the future.

The professor who uses the PBL, besides being prepared with interdisciplinary knowledge, certainly needs to have other important qualities for this new learning reality, such as respect for the opinion of students, leadership and constant feedback (MARTINS; NETO; SILVA, 2018).

Thus, the PBL offers paths for pedagogical problems related to teaching activities, such as deficiencies in the integration between theory and professional practice and difficulty in promoting knowledge beyond the technical-scientific curriculum (COELHO, 2016). As indicated by the author it is pertinent to evaluate and consider that the professor is fundamental in this process, the opportunity to make the student more active by making him have transformative actions in a multidisciplinary context is necessary for the development and quality in learning. Ribeiro, (2005) also emphasizes that working with real life problems is fundamental for the development of concepts and thinking skills.

The educational context of the PBL is rich in possibilities, however, the experiences need to be accessible to students and teachers, who need structures and training in order to glimpse an effective teaching methodology (MAMEDE; PENAFORTE, 2001). Realities below the imagination or the solutions proposed by the teacher can have negative results for learning, so many teachers seek methodological alternatives that are compatible with their realities, exploring the possibilities and mobilizing the interdisciplinary processes so that they effectively have positive results (SOARES, 2008).

However, there are questions about the PBL that should be the object of reflection, such as the practice being more forceful than the theory. The PBL has a much greater relationship with practical



studies than with the theory commonly used in the classroom, since the student is in a real situation of experience with a real problem to be solved and obviously being encouraged to think to solve it. In this sense, one can imagine that, without theoretical knowledge, the mentee will not have subsidies to develop strategy and seek the solution to the problem in question, enriching the concepts and making learning complete (FREITAS, 2012).

The implementation of the PBL, may encounter resistance in schools that are accustomed to traditional methods, since allied to the lack of updates and improvements of teachers, there are misunderstandings and apprehensions on the part of the teaching staff that resist the new reality. That is, they feel threatened in their conservative and traditional posts by the new model, in which they no longer have the domain of learning so that the student is more independent (BEERS, 2005; GIL, 2015).

### **3 METHODOLOGY**

The research conducted is characterized as descriptive as to its objectives and quantitative as to its approach, with results based on the application of a questionnaire type survey. It was chosen the descriptive research with the objective of clarifying the phenomena and consistent facts of a reality or context of interest to the researchers, in this case, the reception of students to the PBL as didactic method. The quantitative orientation was selected by the need for a rapid range of responses, with a lower focus on the interpretation of the object, objectively measuring the perceptions of students about the classes held (BOGDAN; BIKLEN, 1994; GERHARDT; SILVEIRA, 2009).

The research population consisted of 375 second and third year students from the Administration, Foreign Trade, Accounting and Economics courses of a private university in Paraná. In this universe, the sample was established in a non-probabilistic way, with intentional training or by judgment, according to the concepts presented by Oliveira (2001). According to the author, in the intentional sample the researcher uses his or her own judgment in the definition and choice of the research participants, who were selected according to their availability and conformation as good sources of information for the objectives defined in the investigation.

It was decided to use the questionnaire in data collection because it presents the following advantages for the research: obtaining a large number of data; saving time; obtaining faster and more accurate answers; maintaining anonymity; focusing on a specific group simultaneously, in addition to obtaining the opinion and experiences of respondents in relation to a particular phenomenon, theory or experience (LAKATOS and MARKONI, 2011).

The questionnaire was constructed based on a critical review of the literature. Between July and August of 2019, texts, books and scientific journals from the SciELO, Scopus and Web of Science databases were consulted, which discuss constructivism in education, with a focus on Problem-Based Learning. The Scopus and Web of Science databases were chosen because they are considered the main international databases, both with millions of peer-reviewed articles (CHICKSAND et al., 2012; FAHIMNIA et al., 2015; MISCHIATTI; MOLETA; CATAPAN, 2017). The SciELO database was chosen because it is one of the main Brazilian scientific databases (MISCHIATTI; MOLETA CATAPAN, 2017).

Based on the critical review of the articles consulted it was possible to arrive at the basic structure of the questionnaire that would be applied, for which questions were prepared focusing on two specific topics: 1) differences between traditional classes and classes with the PBL method and 2) survey of the main characteristics of the PBL and how they were perceived by students. Most of the questions had the objective of contrasting the theoretical and practical classes, showing whether or not there were perceived differences between the two methods.

A pre-test was performed, and after the adjustments and corrections, the instrument had ten questions. For the topic of differences between methods, questions such as "Have you ever participated in a class in which, after theory, students meet in groups to solve a problem?", and for the topic of perception of the characteristics of the PBL were asked questions such as, "which class do you consider more 'traditional': theoretical or practical?". Among the ten questions, eight presented closed answers with two alternatives from which the respondent should select only one. The two remaining questions also used closed answers, but with three alternatives that represented the level of agreement or disagreement of the respondent in relation to an assertive with the theme "group work".

The basic (free) version of the surveymonkey software was used for the application (SURVEYMONKEY, 2019). This tool was chosen due to the fact that it presents simple completion and automatic tabulation of responses, maximizing the number of respondents and generating accurate and reliable data at the end of the survey. The questionnaire was transferred in its final version to the digital platform, generating a link that was sent to the 375 students who made up the survey population. The participants accessed the platform between 22 and 26 August 2019, a period in which 72 responses were obtained, corresponding to a participation rate of 19.2%.

Even considering that the sample is not probabilistic, the number of participants reached within the population configures the survey as statistically valid for a 90% confidence level (COMENTTO, 2019). The population was considered as more homogeneous (80/20), due to the fact that all participants were students of a specific level from a private institution, sharing demographic characteristics, such as age, and of a similar sociocultural level, which was also considered in the intentional selection of the sample by the researchers.

## 4 ANALYSIS AND DISCUSSION

The results of the survey were grouped in relation to the contractive character between theoretical classes (expository/traditional) and practical classes (in working groups/PBL). In the first place, it was observed that 75% of the respondents declared to have already participated in classes similar to the PBL method, with initial theoretical exposure followed by group meeting for practical approach of a problem or question (in contrast to the classes only expository and without practice or consequent group work). The expository theoretical classes are also perceived as the most "traditional" type of class by 91.67% of respondents, which allows us to conclude that the PBL is, in fact, perceived as a more current or different method by students.

When asked about the deepening of the content, more than half of the respondents (54.17%) indicated that the traditional expository classes retain advantage over the practical classes. However, for

all the other questions, the practical classes were indicated as superior to the expository classes, in the perception of the participants. Chart 1 summarizes the answers to the respondents' perception of the practical classes.

Chart 1 – Synthesis of the opinions in relation to the practical classes (in groups)

There is more learning	72,22%
They are more innovative	91,67%
Feels like a protagonist	83,33%
Feels more engaged	81,94%
Memorize the content better	73,61%

Fonte: the authors (2019)

As Chart 01 shows, the results also indicate that 72.22% of respondents consider that this type of classroom conduction provides greater learning than the use of the lecture alone. 83.3% also feel more protagonists of the class and 81.94% more engaged in their own learning when they participate in practical group activities, with better memorization of the content for 73.61%. Finally, 91.67% consider that this type of class is more innovative, corroborating the contrast perceived in relation to the expository class as the most "traditional" method.

With the data it is possible to assume that there is a perception of benefit and advantages when the method used involves practice, student groups and problem solving. The answers show that protagonist and engagement are characteristics which more than 80% of respondents agree. These answers corroborate the ideas of Barret and Moore (2011), who consider both teachers and students protagonists of learning in the classroom.

The collected results emphasize that the activities carried out in groups, favor an independent learning, in which the apprentice becomes a protagonist of his or her own knowledge (BEERS, 2005; RIBEIRO, 2005; BARRETT; MOORE, 2011; GIL, 2015; COELHO, 2016). According to Barrows (1986), this happens because this method goes through the following stages: the identification of the problem, the exploration of different approach strategies, the assessment of the solution and the consolidation of the learned contents. It should be noted that, in addition to the benefits perceived by students in this research, Borochovcicius et al. (2014) report that this method also brings advantages for teachers, although it requires greater dedication and effort for the assembly and supervision, when compared to other methods, on the other hand, it allows dividing the time for research and laboratory activities, often prevented by routine disciplinary activities.

When asked which of the methods is more traditional, 91.67% agree that they are the theoretical expository classes, pointing out that it is an almost integral perception of the respondent students. This teaching technique arrived in Brazil recently, in the 1990s, and is increasingly being used in several courses in Brazilian universities for its benefits and for being considered innovative (BRANDA, 2009).

In relation to the deepening of the subject, there was a proximity of the answers, 54% stated that the theoretical classes (expository) bring greater depth of content, against 46%, who stated that there is greater deepness in practical classes (groups).

It is observed that, in the sense of "greater volume of content", the students considered that it is the expository classes that meet this requirement. This perception is contrary to the thought of the authors

Ribeiro, 2005; Soares, 2008; Freitas, 2012; BorochoVICIUS et al., 2014; Gil, 2015; Coelho, 2016, who consider that there is greater depth of concepts and learning in the PBL, which would result in a higher cognitive learning for students. This perception of students can be explained, according to Mamede and Penaforte, (2001), for the reason that schools often do not provide adequate structures and training for teachers to use the methodology effectively.

The two statements were tested and, for the first, 38% fully agree that "group work is an opportunity for personal and social training and offers learning that promotes citizenship", and, they did not have "totally disagree". For the second, 47% fully agree that "group activity, based on a problem, gives the student the opportunity to share knowledge and make decisions. The answers are in line with the authors Ribeiro, 2005; Soares, 2008; Freitas, 2012; BorochoVICIUS et al., 2014; Gil, 2015; Coelho, 2016; Martins; Neto; Silva, 2018, who argue that this approach brings more involvement of students with the problems of society and helps in decision-making.

Finally, it was observed, by the perception of the students surveyed, that there is a tendency that the classes in participatory groups tend to be better used than the expositive ones. This is in line with the concepts researched and exposed in the theoretical framework.

## 5 CONCLUSIONS

This article aimed to analyze Problem-Based Learning through a survey questionnaire for business students from a private university in Paraná who are in their second and third years of education.

It was verified that the PBL is a form of learning with a high potential of reasoning for a society that needs to learn autonomously, generating a transformational learning, engaging the student and leading him to the search for own and contextualized solutions to different problems and issues.

As presented in the discussion of the results, the most evidenced positive characteristics were related to learning, innovation, protagonist, engagement and memorization. Thus, this methodology is considered an innovative and effective proposal, but in its application, must be present concomitantly with a theoretical framework that enables the student to seek solutions to the issues in an integral manner with quality methodological theoretical subsidies.

It is also noteworthy the practical application of this research, which proposed to analyze the advantages and disadvantages of the PBL by the vision of business school students. This analysis compared the answers to the questionnaires with the main authors of the area verifying a compatibility of ideas and positive perceptions in this teaching model.

It is still necessary to reflect that there are really positive points of wide coverage in the strategy of teaching by problems. However, if not applied in a responsible and integrative manner, there is a serious risk of not effectively achieving the improvement in the quality of teaching that is sought with new methodologies.

With the application of this research it was verified that the relevance and positive perception in relation to the use of this teaching methodology. However, it is important to note that this article was restricted to a quantitative research, focusing on the application of a structured questionnaire to a limited sample in a single private university in the State of Paraná.

As a suggestion for future research, it is recommended that a qualitative research be carried out with different universities in Brazil, to validate the main results obtained, with different data collection techniques, such as an application of individual interviews and focus group.

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## **The Impact of Mobile Phone Use on Adolescent Health**

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### **Abstract**

*With the increasing rise of smartphones among adolescents, the question arose about the impact of the use of mobile phones among this audience, seeking to assess the harms caused by their excessive use. The present work was elaborated through bibliographical research in articles, books and websites, in a non-systematic way through qualitative and quantitative research, analyzing printed questionnaire. Regarding the results related to the problems caused by the use of smartphones, such as lack of attention, indisposition, poor school performance, little interaction in the classes kept an average of 22.5% difference for those who felt affected, about the posture we have a relatively few. high, however, is still less than half of respondents, but only 33.75% of people who do not worry about posture when*

*using the phone showing, therefore, that young people, focus of our research, has a good ergonomic behavior, both when using the smartphone and watching classes, picking up objects on the floor, and sitting in the chair.*

**Keywords:** Smartphone; Postural Changes; Cell Phone Overuse;

## 1. Introduction

According to (IBGE, 1990), the adolescent becomes the subject aged between twelve and eighteen, according to the Child and Adolescent Statute [1].

With the increasing number of handsets, and hence the price drop, Brazil has advanced to the fifth largest smartphone-using country in the world [2]. As a cheaper form of entertainment and applications that can connect people from different places, it is even more beneficial to use them, as phone lines have become an outdated medium and have higher costs.

Thus, according to a survey by Hootsuite and We Are Social, Brazil ranks third among the countries that spend the most time using mobile phones, a survey of people aged 16-64 [3]. Taking into account the time spent on mobile phones, social networking sites, current news search, search / search engine, downloading music and videos and sending / receiving emails and text messages / SMS are the main purposes that Teenagers tend to do it when they are using cell phones, according to a survey by the National Youth Secretariat (SNJ) in 2013 [4].

As a form of entertainment, the use of cell phones brings with its health risks to the adolescent that, added to school factors such as poor posture when sitting, turns out to be the beginning of several degenerative spinal problems in adulthood [5]. For that, the meanings for a good posture are diverse. According to Hullemann (1978), posture can be considered as the balance imposed through the muscles, ligaments and intervertebral discs [6]. However, lucid or not, the posture is also associated with the internal feeling or its absence, which will reflect to the observer through the posture itself or when we move [7].

Therefore, the negative aspects brought by mobile devices should be explained, both regarding problems in everyday school life (disinterest, tiredness and problems in learning), as well as problems regarding poor posture when using mobile devices daily.

## 2. Methodology

Through non-systematic reviews: based on obtaining non-critical data from renowned authors and bibliographic reviews, through the topics: School Impact and Postural Problems in the Use of Cellular Devices, a qualitative and quantitative research was conducted to obtain data through schools and universities through printed questionnaires. The research will be done with high school and college students, in which ages vary between 14 and 27 years. The answers obtained were 48 male and 30 female and 2 females did not report gender, however, the amount of response of each gender was not balanced and the data collected are shown in tables 1 and 2 below. .

Thus, an exploratory research will be assembled with questions about the postures adopted in daily life based on the article by Juliana Benini and Ana Paula Barcellos [8], in addition to the problems that the



use of the mobile device causes during the day and before bed, due to its irrational use. From the questionnaire and the empirical objects, the level of disinterest, the level of tiredness both in class and in other places they attend, will be investigated from the social / school impact, as well as school performance (grades, participation, learning).

Table 1 - Question about mobile phone use

Do you use your mobile device before bed?	Yes	Not
Do you feel tired, unwell the other day due to mobile phone use at night?	Yes	Not
Do you feel the learning is impaired due to the constant use of the cell phone?	Yes	Not
Does it resemble the lack of class participation due to cell phone use?	Yes	Not
Resembles low grades due to cell phone use?	Yes	Not
When performing any activity (school, home, work, reading), is mobile mode switched off, or mobile data, Wi-Fi off, or airplane mode switched off?	Yes	Not
Do you have a tool that favors the more rational use of mobile?	Yes	Not
At dusk, does it dim the phone screen, or put the glow in night mode?	Yes	Not
Turn off Wi-Fi or put your phone in airplane mode before bed?	Yes	Not
Do you sleep with your phone under the pillow or near the bed?	Yes	Not
How many hours a day do you use your phone?		

Source : Own Author

Table 2 - Questionnaire about the positions adopted on the column.

Spine position in sitting posture when using cellphone.	Straight, leaning against the chair	Bent over against the chair	Bent away from the chair	Do not know
Foot position in sitting posture when using mobile phone.	Reach the ground, feet flat	Hanging feet	Reach the floor, sitting on the edge of the chair	Only the tiptoes reach the floor
Position when attending class.	Sitting back to back	Sitting, back sliding over chair	Other	
Pick up objects on the floor	Bending the back Bending the knees		Bending the back Bending the knees	

Source : Own Author

Following the context of Van den Bulik's [9] survey of 1,656 adolescents over a 12-month period, it proved that those who used their cell phone during their sleeping period showed fatigue, malaise the other day. Through this research, a questionnaire about the use of the mobile device was prepared.

However, beginning basically at school age, we have the pathophysiology of the spine, Kendal et al (1999) [10]. According to the same, around the age of seven, occurs the first episode of acceleration and bone growth, named as growth spurt. However, in both females and males, the second growth spurt occurs approximately between the ages of eleven and fourteen. Thus, the bad posture adopted by this age group, ends up generating proportions in several muscle groups, according to César (2004), which, consequently, start factors for spinal dysfunction, which stimulate the appearance of diseases such as : hyper lordosis, scoliosis, hyper kyphosis, among others, according to Schmidt (1999) [11]. Based on this knowledge, the above questionnaire was assembled to obtain information about the ergonomic postures of the school population.

### **3. Theoretical References**

#### ***3.1. Harmful health effects due to use of the handset***

People who have televisions, video games, cell phones in their rooms feel the most tired the other day from handling these devices instead of sleeping [16], but in addition to tiredness, diseases such as obesity and depression they are related, according to a survey by King's College in London of 125 198 people between 6 and 19 years of age from various countries. Just having a cell phone in your room without using it can already affect the rest period, due to the expectation of notifications arriving (receiving messages, calls, etc.). Sleeping poorly or poorly can cause damage to both mental and physical health, including impaired immune system, stunted growth and mental problems (depression and suicidal tendencies), and lead to more serious illnesses such as cancer or heart attacks. [17] .

In a school or learning environment, cell phone use reduces or even takes away student concentration, as taking turns between moving the phone and paying attention in class can result in stress and even Attention Deficit Disorders (ADHD), consequently, a drop in school performance tends to be greater [18]. One of the factors that is directly related to good grades is having a good night's sleep, since cognitive or behavioral problems in the classroom are related to a bad night's sleep [19].

#### ***3.1.2. Link between cell phone use and lack of postural quality***

Because cell phones become indispensable in our daily lives, they show that their use is of fundamental importance, both to talk to someone on the other side of the planet and to get around the city where they live, but people end up adopting bad postures in its use [12]. For their convenience, adopting a stance in which the head is fixed downward looking straight at the phone answering text messages, watching videos and even playing ends up having an effect in what is described by the term "Text Neck". "Text Neck" [13], and over time the body's natural physiology ends up changing, leaving the user with the head forward [14], in addition to leading to musculoskeletal injuries [15].

As much as students strive to maintain a good posture, the continuity of the same tends to end, and thus, among the various postural changes that can be found in students, scoliosis is highlighted [20].

#### 4. Result

Table 3: Data collected from school and university regarding cell phone use.

	Yes	Not
They use their cell phone before bed.	78	2
They feel tired, unwell the other day due to their mobile phone use at night.	29	51
They feel learning is impaired due to the constant use of their cell phones.	35	45
They resemble the lack of participation in classes due to the use of mobile phones.	31	49
They resemble poor grades due to cell phone use.	29	51
While performing some activity (school, home, work, reading), the mobile data, Wi-Fi or airplane mode is switched off or the mobile phone is switched off.	33	47
They have some tool that favors the more rational use of mobile.	30	50
At dusk, they darken the screen of the phone, or put the brightness in night mode.	38	42
Turn off Wi-Fi or put your phone to airplane mode before bed.	24	56
They sleep with their cell phone under the pillow or near the bed.	63	17
Average hours per day that usually use the phone.	8.93	

Source : Own Author

Table 3 shows that most people use their cell phones before bed, however, the similarity between tiredness, indisposition, lack of participation in classes and low grades does not have a direct link with cell phone use, as shown in Table 3 shows that more than half of the participants do not resemble the survey topics.

Figure 1 shows the results of Yes - Data collected from school and university conditions regarding cell phone use.

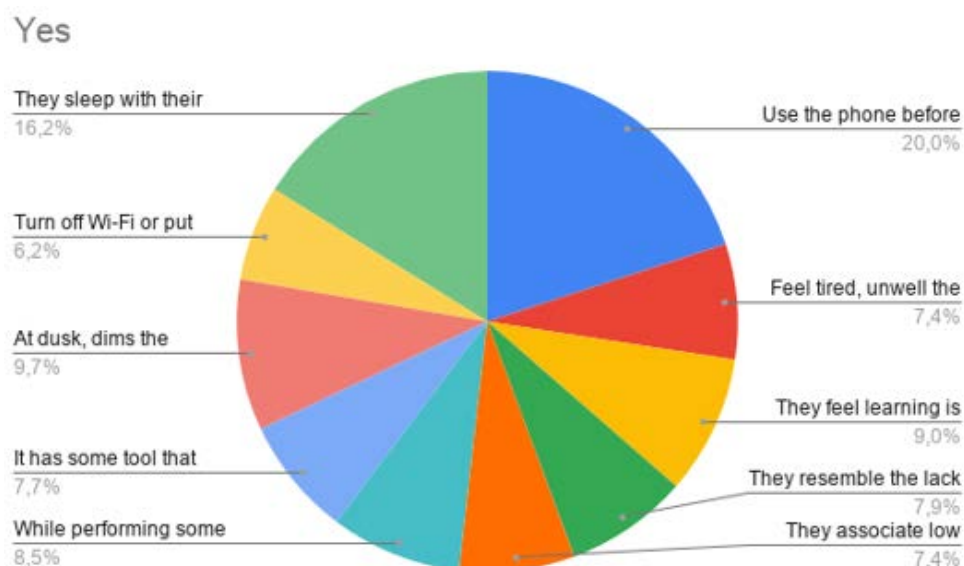


Figure 1 – YES: Data collected from school and university regarding cell phone use.

Source : Own Author

However, the difference in the number of people who do not feel tired, unwell the other day due to the

use of mobile phones during the night; do not feel the learning impaired due to the constant use of the cell phone; do not resemble the lack of participation in the classes due to the use of the cell phone; and do not resemble poor grades due to cell phone use are relatively small, with differences of 22 (27.5%), 10 (12.5%), 18 (22.5%), 22 (27.5%) respectively, for people who resemble. This shows that people do have a lack of sensitivity when it comes to mobile phone use, since the causes felt the other day are linked to smartphone use at night, according to Brunborg [16], as well as notes. which, by a difference of only 22 (27.5% of the candidates) people, resemble the use of the cell phone with the obtained low grades. Even though most of the candidates do not resemble the topics in table 1 with their mobile phone use, it is still worrying that the number of people they resemble is relatively high, for example having poor learning or having little participation in them. classroom due to mobile phone use being almost half of the participants, 35 (43.75%) and 31 (38.75%) respectively.

Figure 2 shows the results of No - Data collected from school and university conditions regarding cell phone use.

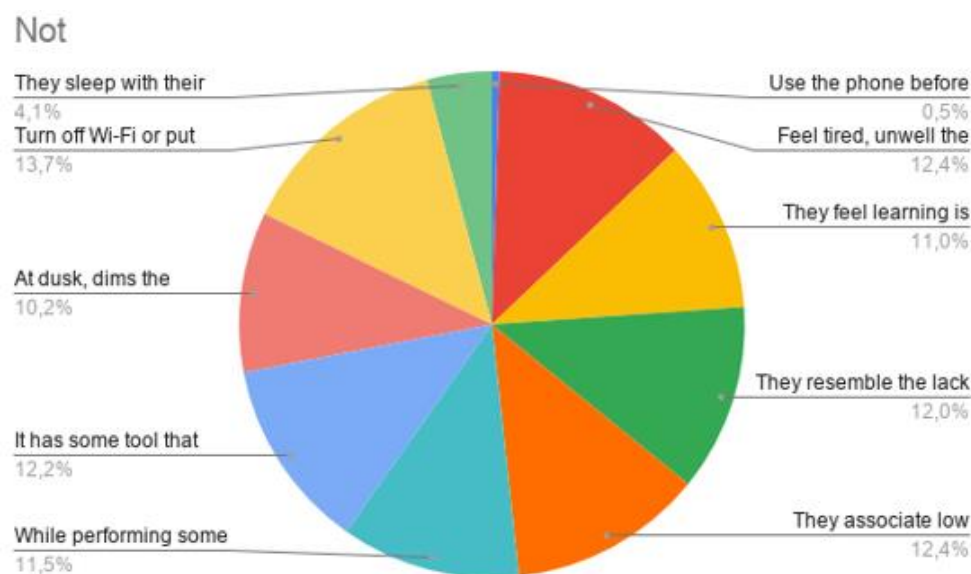


Figure 2 – NO: Data collected from school and university regarding cell phone use.

Source : Own Author

Despite the various tools that exist to control smartphone use, people do not possess, with 50 (62.5% of candidates) people, as shown in table 3, so it becomes even more complicated to have a good daily performance once that the unreasonable and rampant use of cell phones disrupts study, reading, routine tasks, and, as shown in table 3, on average 8 hours and 9 minutes per day is spent per day just for using the smartphone.

Table 4: Data collected from school and university regarding daily posture.

<b>Spine position in sitting posture when using cellphone.</b>	
Straight against chair	34
Bent over against the chair	27
Bent away from chair	5
Do not know	14
<b>Foot position in sitting posture when using mobile phone.</b>	
Reach the floor, feet flat	51
Hanging Feet	21
Reach the floor, sitting on the edge of the chair	3
Only the toes reach the floor	5
<b>Position when attending class.</b>	
Sitting back to back	56
Sitting, back sliding over chair	23
Another	1
<b>Pick up objects on the floor.</b>	
Bending the back	33
Bending the knees	47

Source : Own Author

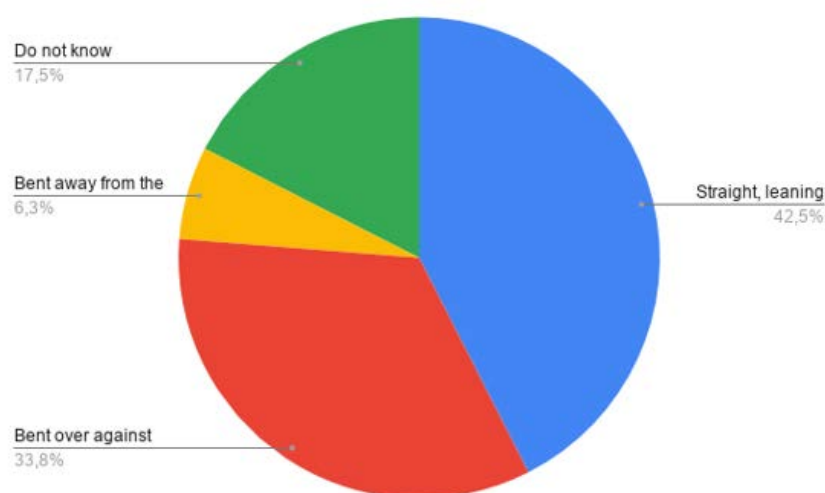


Figure 3 - Spine position in sitting posture when using cellphone.

Source : Own Author

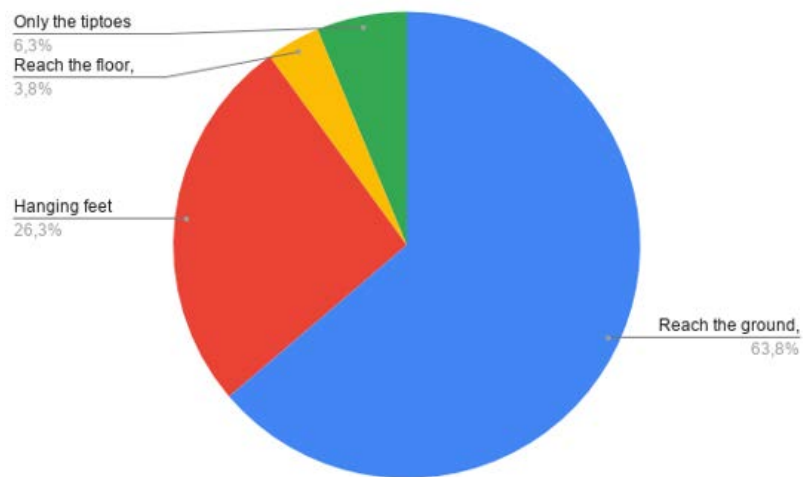


Figure 4 - Foot position in sitting posture when using mobile phone.

Source : Own Author

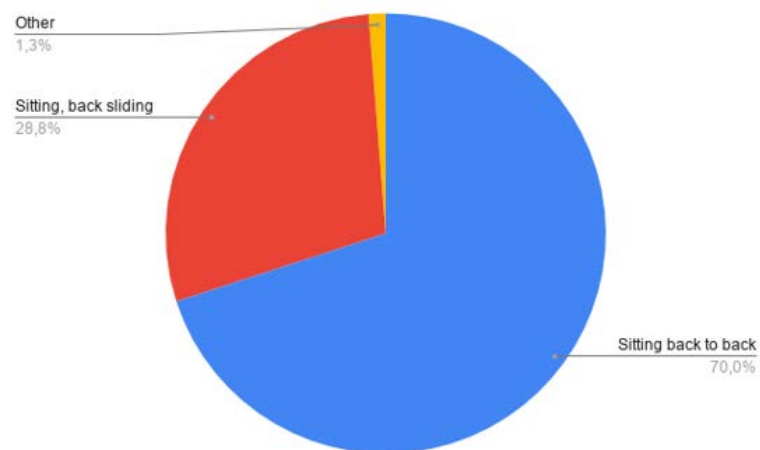


Figure 5 - Position when attending class

Source : Own Author

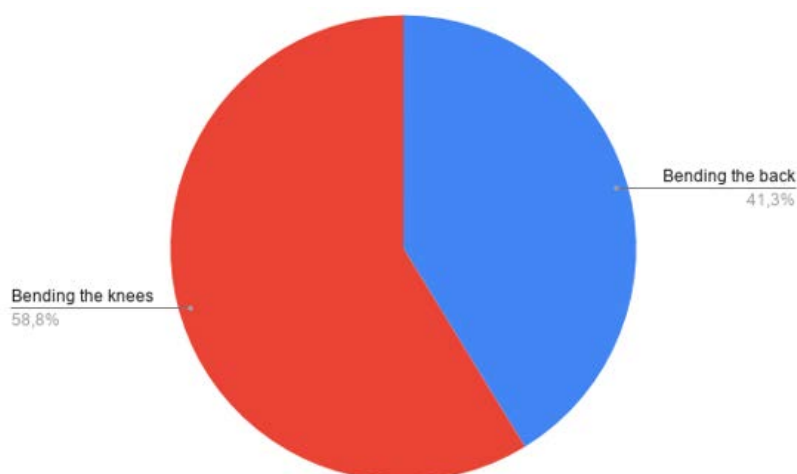


Figure 6 - Pick up objects on the floor.

Source : Own Author

Even with this rapid connectivity between mobile phone users, obtaining agile information, urban and

personal ease, but its use can bring ergonomic problems. However, as shown in table 2, students end up adopting positive attitudes regarding their daily lives. Almost half of the participants, 34 (42.5%), use a correct posture when using the mobile device, being this - straight, leaning on the chair - however, is still worrying the number of people who do not have a correct posture when using the mobile phone, 27 (33.75%) participants.

The same applies to the sitting position of the feet, in which 51 (63.75%) participants use the correct position of the feet when sitting, as well as, when attending class, most participants adopt a healthy posture in the sitting position. which refers to sitting with the back supported, being 56 (70%) of the participants. With regard to picking up objects from the floor, the participants also observed good conduct, 47 (58.75%), bending the knees instead of the back, thus showing a good knowledge about healthy postures.

## 5. Discussion

The results found in the present study suggest that a portion of the people interviewed in this research have a tendency to have difficulty in reconciling studies with the healthy use of mobile phones, aiming that about 35 (43.75%) respondents feel harmed due to constant use. followed by 31 (38.75%) who tend not to pay attention in class due to the use of mobile, as shown in table 1, raising a discussion about what should be done to minimize these numbers. One of the first measures would be the re-education on the use of mobile phones for those with attention deficit, on the other hand these data could be used by teachers looking for a methodology that involves students' cell phones, making the classes dynamic or even a change in the current approach. aiming to hold students' attention. In Table 2, we observed that 51 (63.75%) are concerned with the correct posture, although more than half, the percentage of people with a bad posture is large which causes health problems, the most common is scoliosis [ 20].

## 6. Conclusion

Thus, knowing that Brazil is one of the countries that most use smartphones in the world. It has become an almost indispensable tool these days. On the other hand, there is harm brought on by the constant use of the cell phone, attention deficit, loss of productivity, ergonomic problems among other diseases. When thinking about the problems, we can note that the debate on the topic is extremely important, so also looking for ways to get around and get better use of technology in our daily lives. Therefore, reeducation is the best way for those who are harmed by the excessive use of the cell phone, aiming at rest of sight, self-monitoring of sitting posture, getting up to get something and thus seeking a high knowledge of the limits of our body, to a harmony in academic, personal life, not forgetting physical exercises. Given this, seek to reduce the number of people harmed by the use of mobile.

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# **Economic Feasibility Study Generated on Replacing Tubular Fluorescent Lamps with Led Lamps in a Commercial Building**

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## **Abstract**

*The present study has as main objective to verify the reduction of electric energy consumption, allied to the possible economic-financial and environmental benefits that are associated with the use of LED lamps in a commercial building, where it develops office activities covering only part of the building. , which served as the experimental basis for the application of the case study, initiated after a survey of the electrical and constructive characteristics of the luminaires installed on site. In research conducted in the local market specialized in the subject, we selected lamps that are more easily found, analogous to those already installed, manufactured by traditional companies in the field. The monitoring of lighting loads was made by measuring by specific equipment and simulation of energy billing according to the rules of calculations established in rules governed by government agencies and tariff framework in which the building is in both scenarios, before and after lamp replacement. Providing financial technical evaluation through the use of indicators that show the viability of this substitution.*

**Keywords:** energy consumption, benefits, lighting.

## **1. Introduction**

In 1973, the first major oil crisis began, and it was then that there was worldwide mobilization in function of energy saving and the search for other forms of generation through alternative sources[1].

In Brazil, the National Program for the Conservation of Electric Energy - PROCEL was created on December 30, 1985, to promote the efficient use of electricity and to combat its waste [2]. Following the policy of reducing dependence on oil and its derivatives. "CONPET is a Federal Government program, created in 1991, by presidential decree, to promote the development of an anti-waste culture in the use of non-renewable natural resources in Brazil" [3].

On the other hand, the lack of diversification of energy matrices accompanied by the neglect of the rulers and climate change culminated in the first major energy crisis in Brazil in the early 2000s[4]. After a period of electricity rationing, the contribution of "alternative" energy sources has been increasing significantly year after year. This is due to the creation of public policies aimed at the sector. Data show [5] that the origin of the corresponding Brazilian energy matrix today is 61% Hydro, 14.8% Fossil, 8.8% Wind, 8.4% Biomass, 4.6% Imports (Paraguay, Argentina, Venezuela and Uruguay ), 1.3% Solar and 1.1% Nuclear.

Brazil experienced an increase of 94.28% in electric power, from 1995 to 2018. Considering the following categories: residential, industrial, commercial and others. A prominent class showed a significant increase in this period, the commercial, surpassing the level of 175% of electricity consumption [6].

A practice adopted by consumers today is the replacement of conventional lamps with lamps that use LED (Light Emitter Diode) technology. At the end of 2014, LED lamps were included in the Procel Seal award program. With them, the program reached the milestone of 39 categories of equipment with the seal, which, in 2014 alone, provided energy savings of over 10.3 TWh, corresponding to about 2% of national consumption [7].

Based on the above, this study seeks to highlight the economic viability of replacing low-pressure discharge fluorescent tube lamps with LED tube lamps in a commercial building.

## **2. Theoretical Referential**

### **2.1 Low Pressure Discharge Tubular Fluorescent Lamp and Control Devices**

They consist of a cylindrical bulb of glass, having at its ends metal tungsten electrodes (cathodes), through which electric current circulates. Inside is mercury vapor (Hg) or argon at low pressure, and the inner walls of the tube are painted with fluorescent materials, known as phosphor crystals [8].

For their full operation are used devices that assist in startup, are known as reactors. It is a device used to limit and / or control the electric current in the discharge lamps by supplying the necessary voltage for its operation. It is also responsible for providing an adequate luminous flux. Reactors can be conventional (electromagnetic) or electronic [9].

### **2.2 Power Factor**

Power factor and the ratio of active electrical energy (kWh) to the square root of the sum of squares of active (kWh) and reactive (kvarh) electrical energy consumed over the same specified period. "The reference power factor " $f_R$ ", inductive or capacitive, has the minimum limit allowed for the consumer units of group A, the value of 0.92" [10].

### **2.3 LED**

LEDs are optoelectronic mechanisms that convert electrical energy into light. “When a direct voltage is applied through the p-n junction, unbalanced junction, electrons and holes are injected through the depletion region. These excess minority carriers may radically recombine with the majority carriers, giving rise to light emission”[11].

### **2.4 Led lamp**

LED lamps depending on the model can last four times longer than fluorescent lamps, they pose less risk to consumers and the environment because they do not contain mercury in their manufacture, they do not emit ultraviolet and infrared radiation. However, some external factors may affect product durability, such as power line surges, poor contact at the point of installation, unsuitable locations, contrary to manufacturers' recommendations [12].

### **2.5 Quantities and Lighting Concepts**

For the different types of lamps in the market, shapes, colors and shades, numerous applications can be performed, taking into consideration the environment (residential, commercial or industrial), whether they are indoor or outdoor, whether the lighting is decorative or necessary for performing visual activities [13]. So, some luminotechnical concepts we need to know:

Luminous flux ( $\phi$ ): is the total amount of visible light that a light source radiates in various directions, measured in lumens (lm);

Color Reproduction Index (IRC): A measure that corresponds between the actual color of an object and its appearance against a particular light source. Ranges from 0 to 100. The lower the (IRC), the lower the quality of the lamp;

Luminance (L): is the luminous intensity emanating from a surface in a given direction, captured by the retina of the eyes;

Luminous efficiency ( $\eta_w$ ): indicates the rate at which the consumed electrical energy is converted to light, the ratio of the luminous flux emitted by a lamp to its electrical power (lm / W);

Color temperature (K): is the classification given to a lamp compared to the color tone of the emitted light given in (Kelvin). It can range from 800 K (red light) known as warm colors to 6500 K (blue light) cold.

### **2.6 Definitions of the National Electric Energy Agency (Aneel) through Normative Resolution No. 414 of 2010**

Contracted demand (kW): demand for active power to be compulsorily and continuously provided by the distributor at the point of delivery, according to the amount and effective period established in the contract;

Measured demand (kW): higher demand for active power, paid at 15 (fifteen) minute intervals during the billing period;

Rush Hour: period consisting of 3 (three) consecutive daily hours defined by the distributor considering the load curve of its electricity system, approved by ANEEL for the entire concession area, except for weekends and national holidays;

Off-peak hours: period composed of the set of consecutive daily hours complementary to those defined in rush hour;

Green hourly rate: applied to group A consumer units characterized by differentiated rates of electricity consumption, a single end-to-end demand tariff; and

Blue hourly rate: applied to group A consumer units characterized by differentiated rates of electricity consumption and power demand, according to the hours of use of the day;

Tariff: monetary amount established by ANEEL, set at R \$ (Reais) per unit of active electricity or active power demand, based on the definition of the price to be paid by the consumer and stated in the electricity bill, as follows:

a) energy tariff - TE: unit monetary value determined by ANEEL, in R \$ / MWh, used to make monthly invoicing related to energy consumption; and

b) distribution system usage fee - TUSD: unit monetary value determined by ANEEL, in R \$ / MWh or R \$ / kW, used to bill monthly users of the electricity distribution system by using the system;

Primary Voltage: consumer units supplied with supply voltage equal to or greater than 2.3 kilovolts (kV) that are part of group A;

Binomial tariff: consists of the active electricity consumption (kWh) and the power demand (kW) applied to the group A consumer units.

## **2.7 Tariff Structure**

The amounts charged (tariff) for electricity consumed in Brazil, vary in various regions of the country. In this study, we will emphasize the consumer unit belonging to group A and we will use as model (energy bill) Amazonas Energia (AME). “The tariff represents the sum of all components of the industrial process of generation, transportation (transmission and distribution) and commercialization of electricity. In addition, the charges for the cost of applying public policies are added ”[14].

## **2.8 Tariff Modality - Group A**

In tariff modalities, differentiated energy tariffs are applied for electricity consumption (kWh) and power demand (kW), according to the hours of use of the day, in order to rationalize the consumption of electricity. For hours of use of the day, two different tariff stations are established (peak and off-peak hours), and may opt for the blue or green tariff [15]. Amazon rush hour: 8:00 pm to 10:00 pm [16].

## **2.9 Electrical Power Invoice Calculation Components - Group A**

ANEEL publishes, by resolution, the value of the electricity tariff, without taxes by consumption class (residential, commercial and industrial). Based on these amounts, the energy distributors include taxes (PIS, COFINS, ICMS and COSIP) and issue the energy bill that consumers pay [17]. There is an adjustment of the electricity tariffs (TE) and the distribution system usage tariffs (TUSD) annually. The

AME in 2019 follows the tariff values (table 1) determined by means of Homologation Resolution No. 2,478 of October 30, 2018.

Table 1 - Application rates without taxes, Group A (subgroup A4), AME

SUBGROUP	MODE	POST	APPLICATION RATE		
			TUSD	TE	
			R\$/kW	R\$/kWh	R\$/kWh
A4(2,3 a 25kV)	Blue	Tip	34,43	0,13584	0,45538
		Out Tip	16,6	0,13584	0,27643
	Green	Tip	16,6	0,96534	0,45538
		Out Tip	16,6	0,13584	0,27643

Source: Adapted from Homologation Resolution 2,478, ANEEL, 2018.

### 2.10 Consumption Value

The consumption value to be paid by the group A consumer, among the charges embedded in the energy bill value, are the peak and off peak energy consumption (kWh), demand (kW), surplus reactive energy consumption ("fine" charged for low power factor) if any, street lighting (COSIP). For each tariff mode (blue or green), differentiated tariffs for consumption and demand are applied, as well as for the tariff station (rush hour and off peak). [18] the consumption and demand (R \$) installments are calculated as follows:

$$\text{Total Consumption (R\$)} = \{[\text{Consumption Portion (R\$ / kWh)} + \text{Demand Portion (R\$ / kW)} + \text{Excessive Reactive Energy (R\$ / kWh)} + \text{Overload Demand (R\$ / kW)}] / 1 - (\text{Taxes})\} + \text{COSIP}\}$$

Rate mode - BLUE:

- Consumption Portion (R\$ / kWh) = (TE (Tip Consumption) x Consumption (Measured at Tip)) + (TE (Off Tip Consumption) x kWh (Measured Off Tip));
- Demand Installment (R\$ / kW) = (TE (Tip Demand) x kW (Measured Tip)) + (TE (Demand Off Tip) x kW (Measured Off Tip)).

Rate mode - GREEN:

- Consumption Plot = (TE (Tip Consumption) x kWh (Measured at Tip)) + (TE (Off Tip Consumption) x kWh (Measured at Tip));
- Demand Installment = (TE Demand x kW contracted).

Overpass Demand:

- Overrun Demand Value (R\$) = (kW\_Measurement – kW\_Contracted) x 2 x TE (Overrun Demand).

### 2.11 Economic Feasibility Analysis

The investment and actions employed in an energy efficiency project demand proof of viability, that is, the financial return over a certain period of time, when the designer and / or client deem it satisfactory. For this, it is necessary to calculate some financial indicators through investment analysis techniques (simple payback, discounted payback, net present value, internal rate of return) to prove the benefits of the proposed Project [19].

Simple payback is the recovery period of the invested financial resources, the time required for the return on the initial investment from the revenues resulting from the implementation of the project, the ratio between the initial investment and cash flow. Similar to the simple payback, the discount takes into account the interest rate (currency devaluation) during project implementation, focusing on cash flow values (difference between the reduction of energy consumption and the additional maintenance costs) [19].

Every activity that involves the use of money requires observance of the level to be discounted or applied over time, called interest which may be simple and or compound. [20] Interest is the return on capital applied over a given period of time, and interest rate is the degree arising from the ratio of interest to capital employed. Special Settlement and Custody System (Selic), "It is the main monetary policy instrument used by the Central Bank (BC) to control inflation and influences all interest rates in the country, such as interest rates on loans, financing and financial investments" [21].

### 3. Methodology

The research approach is comparative because it consists of replacing low pressure fluorescent tube lamps with Led tube lamps. Combining all costs generated to perform the process and the resulting electricity savings.

It is a building, for commercial purposes, where the main activity developed is administrative. Met in primary voltage (13.800 V), three phases, its form of electricity billing is binomial and the tariff mode green. The building has 07 (seven) floors, underground to the 5th floor. The object of study, is located on the first floor, comprising an area of approximately 226.45 m<sup>2</sup>.

The model of the predominant luminaires in the administrative / office areas is built-in. Each luminaire has 04 (four) low pressure discharge fluorescent tubes, each lamp has a nominal power of 16 W, for each pair of lamps an electronic ballast (2x16 W) with power factor 0.98, as indicated by the manufacturer.

The number of luminaires distributed in this sector is 61 (sixty-one), totaling 244 (two hundred and forty-four) fluorescent tubes and 122 (one hundred and twenty-two) reactors, the lighting load is distributed in 04 (four) circuits. three of them belong to the southern light distribution panel (QDL-SOUTH) and one to the general emergency panel (QGE), the mains voltage is 220 V.

The building lighting system is automated, the opening hours for administrative areas during the day are from 6:45 am to 11:30 am in the morning and from 1:00 pm to 7:00 pm in the afternoon. Therefore, the daily working time is 10h45min, 22 (twenty-two) days per month, totaling 236.5 hours / month and in 1 (one) year approximately 2,838 hours. Currently installed lamps have a color temperature of 5000 K (cool white), luminous flux of 1150 lumens, IRC of 85, with efficiency of 72 lm / W.

The LED tube lamp model chosen for retrofitting was the one that had the characteristics similar to those of fluorescent lamps, in terms of size and color temperature, so that the existing luminaire rails could be reused. Therefore, the LED tube lamps chosen have a rated electrical power of 10 W, color temperature 6500 K, luminous flux of 900 lumens, IRC greater than 80 and luminous efficiency of 90 lm / W.

Measurements of lighting loads occurred in two steps, only on business days for 10 (ten) days, in the first step, with the "old" system, using fluorescent lamps and in the second, after replacement by LED tube

lamps, resulting in five days for each, one hour in the morning and one hour in the afternoon for each circuit, in order to verify the occurrence of requested power variations (W) of the electric network. The meter used was a wattmeter, model AK353 - True RMS, AKSO manufacturer, calibration certificate no. 130700377. The electrical values noted were: Voltage (V), Current (A), Active Power (kW), Apparent Power (kVA) and power factor.

With the data collection, tables were elaborated, inserted in them, quantity of existing luminaires in the environment (office), hours of operation of the system and estimated consumption in 22 days (kWh / month). Then the consumption in the energy bill was calculated, taking into account, operating hours (top and off), tariffs applied according to tariff mode (green tariff). With the consumption results, the financial technical viability of the energy efficiency project was analyzed through the payback calculation. This includes the initial costs with materials (lamps and cables) and labor in relation to the energy savings generated, allowing to verify the return time of the invested capital.

#### 4. Results and Discussion

In the measurement for the first lighting system (fluorescent lamps), the samples collected showed homogeneity between the readings taken in the morning compared to those taken in the afternoon. Through the arithmetic mean, the data exposed (table 2) represent the estimated system consumption monthly, considering, utilization time, demand (kW), peak and off-peak consumption.

The simulation of the amount (R \$) of the energy bill was made using the monthly consumption, without taxes and charges on energy tariffs, to better evaluate the possible benefits generated with the implementation of the project.

Table 2 - Electricity consumed by the lighting system - Tubular Fluorescent Lamp - 16W

Switchboard	Circuits	No. Light Fixtures 4x16 W	Measured Voltage (V)	Measured Current (A)	Power Factor (cos $\theta$ )	Measured Demand (kW)	Utilization / month (Hours)	Consumption Outside Tip (kWh)	Consumption (kWh / month)
QDL-SOUTH	S.1	12	212,8	3,56	0,99	0,75	236,5	178,32	178,32
	S.2	18	212,6	5,31	0,99	1,12	236,5	265,83	265,83
	S.3	18	214,0	5,24	0,99	1,12	236,5	262,99	262,99
QGE	SE.1	13	211,7	3,57	0,99	0,75	236,5	177,61	177,61
<b>TOTAL</b>	<b>-</b>	<b>61</b>				<b>3,74</b>		<b>884,75</b>	<b>884,75</b>

The “monthly consumption” of electricity using fluorescent lamps was 884.75 kWh, the average demand was 3.74 kW. Due to administrative office hours in the building, the lighting system shuts down daily at 7 pm. For this reason, consumption at peak hours is zero.

The green billing energy bill (R \$ / month) will be: (R \$ 1,42072 / kWh x 0 kWh peak) + (0,41227 R \$ / kWh x 884.75 kWh off peak) + (16.6 R \$ / kW x 3.74 kW) = **426.86**.

For measurements, after replacement by LED lamps, the data were collected and organized similarly to those presented above, as shown in table 3.



Table 3 - Electricity consumed by the lighting system - LED Tube Light - 10W

Switchboard	Circuits	No. Light Fixtures 4x16 W	Measured Voltage (V)	Measured Current (A)	Power Factor (cos $\theta$ )	Measured Demand (kW)	Utilization / month (Hours)	Consumption Outside Tip (kWh)	Consumption (kWh / month)
QDL-SOUTH	S.1	12	211,9	2,30	0,97	0,48	236,5	112,34	112,34
	S.2	18	210,7	3,60	0,97	0,73	236,5	171,94	171,94
	S.3	18	212,1	3,50	0,97	0,72	236,5	170,28	170,28
QGE	SE.1	13	212,0	2,50	0,97	0,51	236,5	120,62	120,62
<b>TOTAL</b>	<b>-</b>	<b>61</b>				<b>2,43</b>		<b>575,18</b>	<b>575,18</b>

The amount of electricity consumption (R \$ / month) will be: (R \$ 1,42072 / kWh x 0 kWh peak) + (0,41227 R \$ / kWh x 575.18 kWh off peak) + (16, 6 R \$ / kW x 2.43 kW) = **277.50**

Average savings per month is R \$ 149.36 (one hundred and forty nine reais and thirty six cents) and annually it will be R \$ 1,792.32 (one thousand seven hundred and ninety two reais and thirty two cents) representing approximately 35% reduction in electricity bill.

The initial costs and revenues generated with the implementation of the new project, materials and labor, this second, performed by two qualified professionals (electrician and assistant) for 4 (four) days, 8 (eight) hours daily. Follows (table 4) statement below:

Table 4 - Costs of Goods and Services

<b>Material</b>	LED tube light	<b>R\$ 3.513,60</b>
	Cable 1.0 mm <sup>2</sup>	<b>R\$ 73,57</b>
<b>Services</b>	Labor	<b>R\$ 823,10</b>
<b>INITIAL EXPENDITURE</b>		<b>R\$ 4.410,27</b>

The time required for the return on invested capital will be counted from the first year after project completion. It has been set by means of discounted payback at a basic interest rate of 6.5% (selic) per year, with a fixed cash flow of R \$ 1,500.22 which the difference between the annual savings on the energy bill (R \$ 1,792.32) and the maintenance expenses (twice a year) of the system (R \$ 292.10) in the lamp life will be 3 years and 4 months, values shown (table 5) below:

Table 5 - Discounted Payback

YEAR	CAPITAL	DISCOUNT CAPITAL	BALANCE
<b>0</b>	-R\$ 4.410,27	-	-R\$ 4.410,27
<b>1</b>	R\$ 1.500,22	R\$ 1.408,66	-R\$ 3.001,61
<b>2</b>	R\$ 1.500,22	R\$ 1.322,68	-R\$ 1.678,93
<b>3</b>	R\$ 1.500,22	R\$ 1.241,96	-R\$ 436,97
<b>4</b>	R\$ 1.500,22	R\$ 1.166,16	R\$ 729,18
<b>5</b>	R\$ 1.500,22	R\$ 1.094,98	R\$ 1.824,16

The balance will be positive before the middle of the fourth year. The profit after the installation of the “new” lighting system at the end of five years will be R \$ 1,824.16 (one thousand eight hundred and twenty four reais and sixteen cents).

In order to compare, valuing the results obtained, we used the results achieved in another study of the same nature, [22] which achieved savings of 55% (figure 1) in reducing energy consumption when replacing fluorescent lamps of 40W by 18 W Led lamps. However, the method used to calculate the monthly consumption was performed through online software simulation, which considers the number of

lamps, nominal wattage (W), usage time (hours) and the average fare charged per kWh. Since, losses in the system were not considered as a function of power quality.

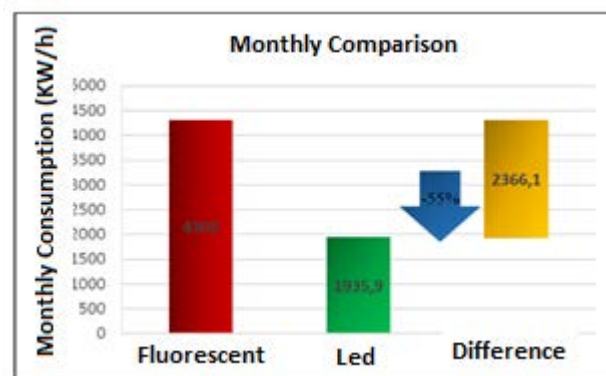


Figure 1 - Results of Sousa, Ramos and Campos. (2017) for comparison purposes.

*Source: Comparative study between fluorescent and LED lamps, applied in the environment of a public university in the state of Amazonas, 2017.*

Given the fact that, in the current study, the economy is around 35% (kWh) (figure 2). This is due to the nominal power difference of the LED lamps used in the retrofit that does not exceed 37.5% of the lamp power replaced.

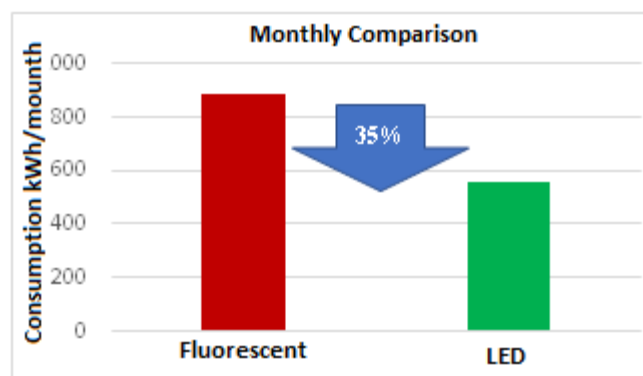


Figure 2 - Reduction of monthly consumption

*Source: Adapted, Sousa, Ramos and Campos, 2017.*

Another study used in comparison to the results, is in relation to the return on the capital investment initially used in the execution of the project. [23] The amount invested of eighteen thousand and eight hundred and sixty-nine reais and sixty cents (R \$ 18,879.60) in the replacement of 32 W tubular and 26 W compact fluorescent lamps with 18 and 16 W LED lamps respectively, resulted 50% reduction in electricity consumption and provided a cash flow of five thousand nine hundred and seventy-six reais and fifty-six cents (R \$ 5,976.56), this capital was recovered in 3 years and 1 month . As in the first comparative study, lamps with higher energy efficiency were used, above 40% on average compared to fluorescent lamps, lower consumption, ensuring greater energy savings annually.

The calculation method used in this study [23] does not consider the devaluation of money over time (simple payback), this substantially reduces the estimated return time. On the other hand, in the study in question, the indicator used to measure the return on investment was through discounted payback, where

a compound interest rate (basic interest rate 6.5%) is inserted, causing the adjustment in the estimated cash flow, thus extending payback time (3 years and 4 months).

Finally, the study and execution of the project brought satisfactory results, and even greater savings in electricity are possible, since there are in the local market more efficient lamps of the same model that can also be used in future projects.

## 5. Conclusion

The implementation of this energy efficiency project met expectations, proved to be economically viable, with a positive profit margin in the middle of the third year after implementation. It contributed to the reduction of electricity consumption with lighting, consequently with the reduction of the electric current, the heating of cables and protection devices, the reduction of joule effect losses, the lower heat dissipation to the environment, also contributing to the reduction of thermal load relieving the cooling system.

Another relevant factor is the minimization of the risk of contamination of soil, air and water by heavy metals contained in discharge fluorescent lamps and their reactors after disposal.

The quality of the energy supplied by the Eletrobras Amazonas Energia concessionaire is one of the main problems encountered, in addition to the quality of the products (LED lamps) offered in the local market. The voltage level provided by the dealership can be up to 4% more during the day. Constant power outages and oscillations from the opening and closing of disconnecting devices and shields can lead to anomalies in the sinusoidal signal of the voltage, thus dramatically reducing the life of LED lamps and even premature burnout of equipment.

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## **Economic analysis of an automated lighting system with presence sensor at a state school in the city of Manacapuru-AM**

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### **Abstract**

*This work addresses the consumption of electricity in a state school in the interior of Amazonas, highlighting the importance of the search for available technologies to reduce energy consumption. In this context, the main objective of this study is to demonstrate the energy costs in the lighting system of a state school in the city of Manacapuru, and also to analyze economically the feasibility of an automated lighting system with presence sensor in classrooms. Since, the lighting of the classrooms is manual and depends exclusively on the need for a public servant to turn on and off the switches, thus, the energy consumption of the luminaires and the time in which the exacerbated consumption occurs directly affects the energy bills of the place. In the development of research, it was found that the use of presence sensors would result in both financial savings and an environmental issue. The results showed that it is possible to have a saving of 31.43% in the value of energy compared to the value currently paid. Therefore, the amount of the investment that costs R\$ 1.998,00 would be paid in two and a half months. This way, it would contribute to the useful life of the lamps and thus avoid their early disposal, thus avoiding an environmental impact because the replacement and disposal of these materials are usually very harmful to the environment.*

**Keywords:** automation; energy saving; electric energy

## **1. Introduction**

Consumption of electricity grows along with the evolution of society. Thus, man has become highly dependent on this energy, which can be converted to generate light, move machinery and equipment, make various electrical and electronic products work, streamline communications, etc. Electric energy is an indispensable asset that plays a fundamental role in our homes, industries and businesses [1].

This energy can be used in many ways, but it is not available directly, it is usually obtained through the transformation of natural resources. The diversification of energy sources and the rational use of electrical energy are increasingly in the spotlight worldwide. This is partly due to the depletion of some energy sources and the high cost of producing others [1].

The Brazilian electricity sector has been suffering from difficulties in planning and guaranteeing the supply of electricity to meet the current increases in domestic demand. These difficulties are characterized both by the strong water crisis, more severe as of 2014, and by the increase in the consumption of electricity by Brazilians, which follows a global trend [2].

In Brazil, hydroelectricity is the main energy source in the country, however, since at the present time the environment still suffers a lot from conventional methods of energy production, which in their great majority are very aggressive to the environment [3].

Observing the relationship between generation and demand, it is noted that there is a great waste and inefficient use of electric energy. According to ABESCO (Brazilian Association of Energy Conservation Service Companies), between 2013 and 2016 alone, there was a waste of electricity in Brazil that cost R\$ 61.71 billion, equivalent to 143,6 million GWh (gigawatt/hour) [4].

Therefore, there are several measures that can be taken to reduce energy consumption, such as the use of automation systems, enabling greater productivity, an optimization of processes, communication between equipment, greater accuracy in date and controls, increase in quality [5].

The use of measures of this nature, in addition to bringing direct advantages to the user, such as cost reduction, as well as ensuring indirect benefits, for example, reduction of maintenance costs, increased useful life of replaced systems. And in the same way it brings benefits to society, because it contributes to sustainable development, use of fewer natural resources and reduction of greenhouse gases [5].

Therefore, it is important that society seeks information and available technologies to reduce energy consumption. It is up to the government to create conditions for regulations and standards to encourage the development and use of more efficient equipment. Because wise use and concrete changes bring savings without diminishing comfort.

Energy saving imposes itself on any action within a company or institution and an automation system must provide the elements of decision making, through information based on date and history of operations performed.

Thus, large companies and institutions seek to control spending on electricity are concerned with emphasizing investments in the area of automation. For them, energy efficiency is a decisive factor when obtaining solutions aimed at maintaining the business [6].

This study aims to demonstrate the energy costs in the lighting system of a state school in the city of Manacapuru, analyze the economic of an automated lighting system with presence sensor in the classrooms, and also determine the benefits of inserting presence sensors to control unnecessary spending of energy.

## **2. Theoretical Reference**

### ***2.1 Importance of Energy in Contemporary Society***

Energy is an indispensable input for society and in people's lives, since it is necessary to enjoy its benefits rationally and avoid waste.

It is coherent to affirm that technological advances are exactly associated with humanity's own growth, one of these perspectives can be shown when evaluating the function performed by electricity in people's daily lives. Electricity is now everywhere on the planet, in the homes of millions of people, it can be pointed out as one of the great revolutions of humanity since it has become one of the most relevant tools for the social and economic development of the modern world, consequently the contemporary society [7].

The consumption of electricity in the grid, for the years 2015 and 2016, by class of consumption and by subsystem. It is expected that the consumption of the industrial and commercial classes in the network will close the year with strong decreases of 3,0% and 2,5%, respectively. With this, consumption in the network for Brazil is down 1,1% [8].

The most diverse methods are used to obtain electrical energy, through hydroelectric plants, wind farms, photovoltaic panels, nuclear reaction, among many others, are many different ways to produce electricity. This variety of procedures for generating this energy is the result of a society that increasingly requires advantages provided by this innovation, and electricity is so important to the community in general, because it has also become an object of study in the academic field, in several lines of scientific research increasingly promising, thus motivating scientists and researchers in the development or design of new technologies for the capture of electricity and for its optimization [8].

Thus, even though energy resources may seem infinite or inexhaustible, in reality everything is exhaustible if not controlled, because they are very valuable resources for humanity, and it is necessary to seek a control, both for the individual economy and for society.

### ***2.2 Efficiency in the Use of Electric Energy***

It is always important to emphasize the need to question two fundamental points when the subject is efficiency of electric energy use. The first point is the environmental issue, whether the use of energy is sustainable or not. The second point is the financial issue, it is presumable that an electric energy optimization system will provide a possibly considerable saving, if it is well applied. Thus, it is not always easy to reconcile these points and have a system that satisfies everything, however, the search for effective and efficient systems should be permanent [9].



Involving the efficiency and effectiveness of the applicability of electric power "the fact that the consumer is particularly concerned with the initial costs related to the investment, without considering the operating costs that are significant and that act throughout the life cycle of the system deployed" [9].

Therefore, it is necessary to have a watchful eye so that it can eliminate waste and increase productivity. Therefore, energy efficiency consists in improving the use of energy sources, using them rationally. That is, a lower energy expenditure is studied to provide the same work or perform the same task [10].

The use of energy in societies generally goes through a series of stages of transformation from the stage when it is found in nature (primary energy) to the energy services that matter, such as light, movement or heat.

Energy efficiency is not rationing or "forced rationalization", which aims at reducing energy service or reducing the use of this service for energy saving. The term energy efficiency has been more widespread due to the need to reduce energy expenses as much as possible. This can be seen in industries, in commerce, in condominiums and even in residential installations, where the energy bill corresponds significantly in expenses [10].

Therefore, the use of initiatives that seek to achieve this improvement brings some benefits, such as positive impact on the economy, decreased emissions and impacts on the environment, improvement in processes and equipment and contribute to awareness against waste.

The use of a special purpose resource, designed to perform an action with greater efficiency is one of the first strategies of automation. Therefore, the automation and the truck productivity in parallel, in order to achieve the objectives previously defined, helping the organization to evolve with efficiency and effectiveness.

### ***2.3 Lighting Automation***

Artificial lighting is a tool where it has helped man in the adaptation of the new context, industrialization, man as a visual being above all. With this, the lighting that used to be rustic and archaic when passing through time was being transformed and gained other functionalities as an object of decoration. However, the artificial lighting remained with a continuous growth and its use each day more intense, emerging resources for its use [9].

The automation of lighting is the result of the development of artificial lighting, being a recent and innovative concept. However, today, we consider this resource as a limiter of energy expenditure, in order to optimize the use of electrical energy. Since electric power is not only a financial issue, but also an environmental issue, because its consumption causes environmental impacts, which may lead to the extinction of future energy production, being this a fundamental resource the basic needs of contemporary society. And, search for sustainable solutions aiming at minimal impact on the environment, has become a global priority. Thus, one of the best ways to save energy is by managing your own lighting system through the use of presence and movement sensors. Since the use of sensors enables a better environmental gain in terms of energy savings [9].

Presence sensors are proximity sensors that operate in order to detect the proximity, presence or passage of solid, liquid or gaseous bodies. Being characterized as passive infrared sensors, because they use infrared radiation or thermal radiation to detect proximity, where it is thanks to the heating due to agitation of atoms and molecules of the material that it can identify hot mass. And they are called passive, because they do not emit infrared light only to detect the movement of infrared light [11].

Thus, the procedure for managing the status of lighting by presence sensor this process occurs as follows: the lighting user approached the environment and is soon perceived by the sensors that immediately send the information so that the lamps can turn on, as shown in figure 1:



Figure 1 - Detection area of the presence sensors.

Source: Electrician Brazil, 2014.

The presence of the human body can produce enough infrared radiation to excite a sensor with pyroelectric material. In other words, the light signal emitted by the human body diverts the light beams emitted by the beams activating the sensor and this beam is converted into an electric signal, activating the lamp through an electric circuit between the lamps and the presence sensors [12]. Therefore, there is the capitation of the hot mass.

Consequently, after leaving the environment used, the sensors do not recognize the presence of the user, i.e., the movement of hot bodies, instantly sending the information to the lighting shutdown after the set time and not being detected any more movement in this interval. It can have the adjustment of the expected time between 10 seconds to 10 minutes, depending on the preference of the user [12]. Thus, turning off the lamp. Figure 2, shows the installation of the Intelbras ESP 360+ presence sensor:

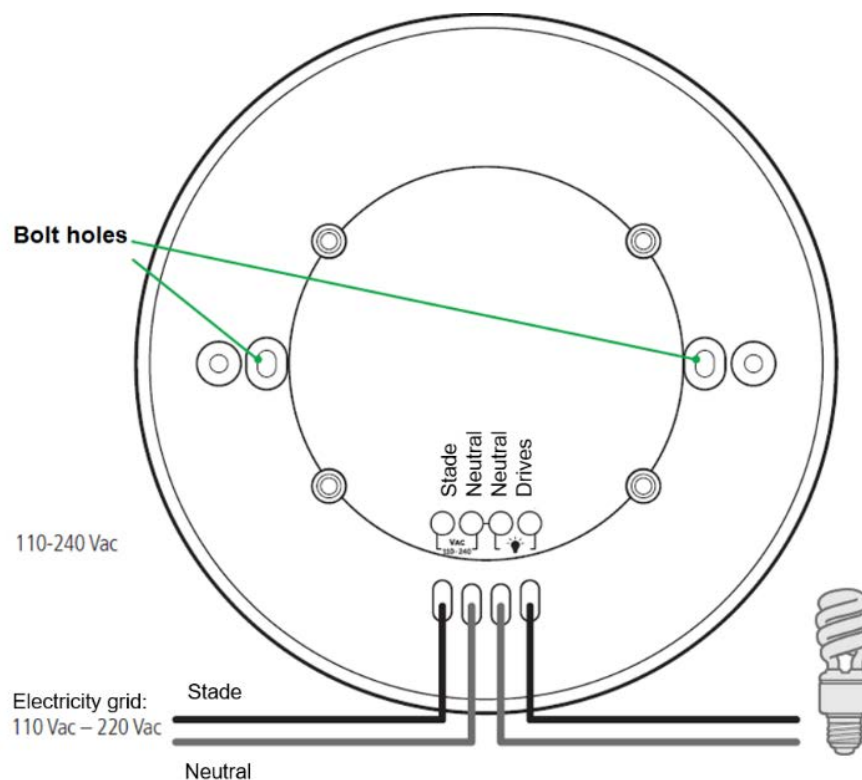


Figure 2 – Installation of the presence sensor.

Source: Intelbras, 2018.

Different from the complexity of some other mechanisms for optimizing the consumption of electrical energy, when viewing figure 2, we notice the simple connection of the sensor in the lighting circuit. In addition, depending on the type chosen for the location of the sensor in the wall vertically or in the ceiling, will determine the model of 360 degrees or 180 degrees [12].

In close proximity to places that have a very large variation in temperature, such as, for example, place where we have a lot of sun exposure or strong wind, such as windows, doors, fireplace, heater, air conditioning [12].

In short, they have the advantage of being easy to apply, making them low cost and high return, considerably avoiding energy waste, generating sustainability and financial gain. Although, it can cause a visual discomfort, even if it is minimal, and in its installation and presents a cost of installation and purchase of equipment, however it is only at the time of investment for a future economy.

### 3. Methodology

#### 3.1 Study Area

The study area is a state school, located in the Terra Preta neighborhood of the city of Manacapuru/AM, on Carolina Fernandes street. The public institution works in the morning, afternoon and night shifts, serving students of regular high school and education of young people and adults (EJA).



Figure 3 – Study Area.

Source: Google Earth Pro, 2019.

The field of study was limited to classrooms only. Allowing the specificity of the theme and thus it was possible to obtain the date for the formulation of the problem of each item pointed out by the analysis of the field research, proposing viable solutions for the competences of the people involved.

### 3.2 Date Collection

The study was characterized as an exploratory and descriptive research, in which it seeks to make the subject explicit or build hypotheses, involving bibliographic survey, while in the descriptive the researcher needs to raise various information about what he wants to research, seeking to describe facts and phenomena of a reality [13].

As for the approach, the qualitative/quantitative method was chosen. This method explains the reason for things, specifying what needs to be done to solve a problem without worrying about the proof (qualitative) [14].

The date collection took place through visits to the educational institution, and by observing the students and school collaborators, in order to seek information on how the lighting system is used and how to avoid wasting energy, using the exploratory research method.

It was observed the consumption by school shifts, the times are: morning time (from 07h to 11h and 30min); afternoon time (from 13h to 17h and 30min); and night time: (from 18h and 30min to 22h and 15min), according to the functioning of the school.



Another method used was the comparative analysis between the use or not of sensors for the activation of fluorescent lamps. The comparison was made based on a financial simulation of the price spent for each of these two systems and on the economic feasibility of implementing the sensors and the time of return on your investment.

#### 4. Analysis and Discussion of Results

For the analysis of the data are presented in table 1 the quantities of lamps in each environment and their powers, there is only 1 type of lamp in operation at the study site, which is 40W fluorescent and the model of the luminaire is gutter type, which then receives 2 lamps. Although some lamps are burned out, in this calculation we will consider the full operation of all devices. Below table 1:

Table 1 - Survey of wattage consumption per room.

Shift	Classrooms	How many luminaires	How many lamps	Lamp wattage	Power per room	Power per room (total)
Morning	18	6	12	40 W	480 W	8.640 W
Afternoon	18	6	12	40 W	480 W	8.640 W
Night	18	6	12	40 W	480 W	8.640 W
TOTAL POWER CONSUMPTION IN WATTS						25.920W

##### 4.1 Consumption Calculations

The monetary value charged for energy consumption is generally based on consumption in kWh (kilowatt-hour), for each kWh is multiplied by the service charge, as shown in equation 1:

$$\text{Value (R\$)} = \text{quantity (KWh)} \times \text{tariff} \left( \frac{\text{R\$}}{\text{kWh}} \right) \quad (1)$$

The rate adopted here is: R\$ 0,70 /kWh. It was based on the average of the 2018 tariffs charged by Eletrobrás Amazonas Energia, which is the company responsible for energy distribution in the state of Amazonas.

The consumption time includes the period that the lights are turned on, which starts at 6 hours and ends at 23h and 15min. It has an operating period of 17 hours and 15 minutes. Taking into consideration a month with 30 days, being 22 working days, we have the amount of hours of use per month. According to table 2 below:

Table 2 - Hours of use of classroom lighting - monthly

MONTHLY HOURS OF USE					
CONSUMPTION	START	END	DAILY HOURS	WORKING DAYS	HOUR/MONTH
	06:00	23:15	17:15	22	377,3

Monthly monetary consumption kWh = (216 lamps x 40W x 377,3 hours/month)/1000 x tariff (0,70) kWh = R\$2.281,91 monthly, considering manual lighting.

However, with the use of presence sensors there will be a lower consumption of hours, and thus achieve a noticeable saving in energy consumption, as shown in table 3:

Table 3 - Hours of use of lighting with presence sensors.

MONTHLY HOURS OF USE WITH PRESENCE SENSORS					
SHIFT	START	END	TOTAL HOURS	WORKING DAYS	HOUR/MONTH
Morning	07:00	11:30	04:30	22	91,3
Afternoon	13:00	17:30	04:30	22	91,3
Night	18:30	22:15	03:45	22	75,9
Total hours of luminaire consumption					258,5

#### 4.2 Comparison of Consumption

Figure 4 can bring a better visualization of the comparison of the two processes manual (with switch) and automatic (with sensor):

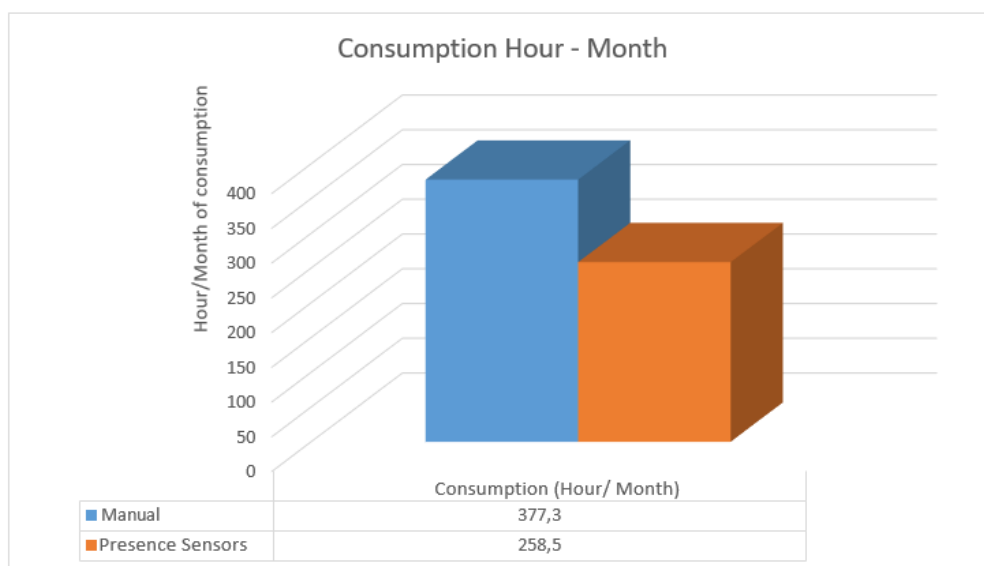


Figure 4 - Comparison of hour-month energy Consumption.

From figure 4, it is noted the reduction of 31,43% of consumption in the energy of the luminaires, which results in the economy of the cost of energy expenses, calculated above the tariff of R\$ 0,70, as shown in figure 5.

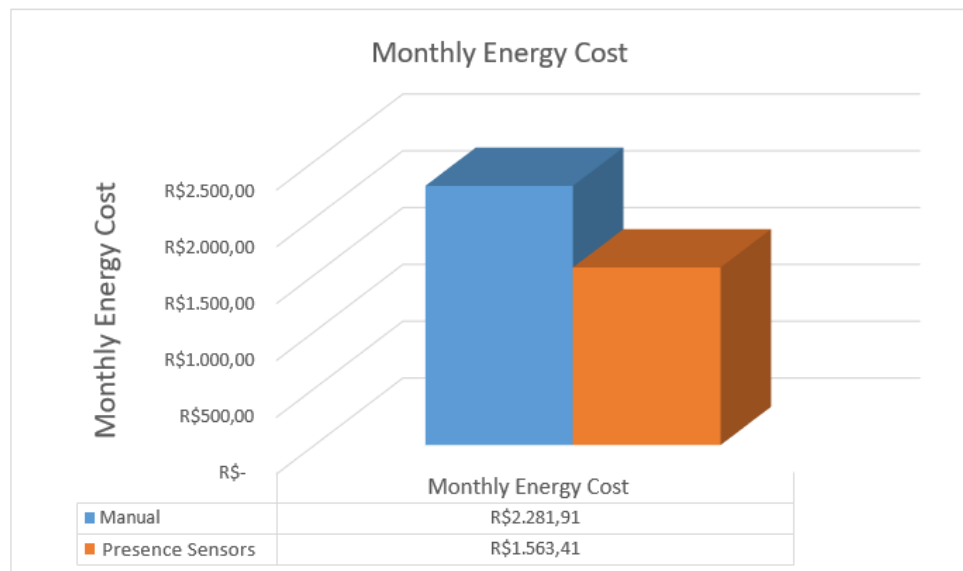


Figure 5 - Comparison of hour-month energy consumption.

The comparison of figure 5, in which brought a monthly result of R\$ 2.281,91 for the use of switches, and R\$ 1.563,41 for the automatic process with sensor. That is, a saving of R\$ 718,50 per month, then a saving of R\$ 8.622,00 per year.

#### 4.3 Calculations for Decision Analysis and Investment Evaluation

It was performed the measurement of the present value of the cash flows generated by the project throughout its useful life according to the Intelbras manual of the ESP 360+ sensor has a maximum detection distance of 18 meters and 360 angle of detection, so it will be necessary 1 sensor for each environment, 18 sensors leaving everything in a range of R\$1.008,00. As shown in Table 4.

Table 4 - Sensors for each environment.

Environments	Quantity of sensors	Unit Value R\$	Total Value R\$
18 ROOMS	18	R\$ 56,00	R\$ 1.008,00

Adding the total value of table 4 to the value of the installation service that costs R\$ 55,00 [15], that is, R\$ 990,00, so the value of the investment is R\$ 1.998,00 with a minimum required rate of 10% a year and a useful life of five years, we have table 5.

Table 5 - Implementation cost.

Environments	Quantity of sensors	Sensor value	Installation value	Total value
18 ROOMS	18	R\$ 56,00	R\$ 55,00	R\$ 1.998,00

With the value of the investment we can apply the Net Present Value (NPV) method and perform the analysis of the economic feasibility [16]. The following equation refers to the NPV formula:

$$NPV = -I + \sum_t^n = 1 \frac{FCt}{(1+k)^t} \quad (2)$$

Replacing the data, we have in the equation 2, read the equation 3:

$$NPV = -1.998,00 + \frac{8.622,00}{(1,1)^1} + \frac{8.622,00}{(1,1)^2} + \frac{8.622,00}{(1,1)^3} + \frac{8.622,00}{(1,1)^4} + \frac{8.622,00}{(1,1)^5} = R\$ 30.682,12 > 0 \quad (3)$$

The NPV is positive, which indicates the economic viability of the alternative. Thus, the implicit protection of R\$ 30.682,12 is actually a profit of economic value, which exceeds the required minimum earnings standard – 10% per year.

Another method to be implemented is payback, which consists of knowing the recovery time of an investment. Let's consider then that the Minimum Rate of Attractiveness (MAT) is established as 10% per year for this investment. This way, it is enough to make the following calculation to find the value of the discounted payback:

$$I = \sum_n^T = 1 \frac{FCt}{(1+k)^t} \quad (4)$$

Replacing the values in equation 3, we get equation 5:

$$T = \frac{1998}{\frac{8622}{1,1}} = 0,21 \text{ years} \quad (5)$$

Therefore, the investment of R\$ 1.998,00 shall be recovered on at least 0, 21 year, calculation obtained by the above equation, enabling a very promising economic viability. This indicator is used together with the NPV in which they indicated that the investment is viable and the payback that the value of the investment will be recovered. That is, in 2 months and 15 days, the investment in sensors is paid, which results in a viable cost-benefit.

## 5. Conclusion

One of the purposes of automation is to achieve energy savings by making the process efficient through presence sensors, without the real need for manual handling either to turn on or off the lights.

In this context, the construction of an innovation in which the optimization of energy resources competes and the possibility of a new way to reduce costs for public institutions are potentially efficient perspectives. They aim not only at improving the current economic situation, but also at



stimulating people to change their attitudes and behaviors in relation to the exacerbated consumerism of natural resources.

The presence sensor control system, if applied at school, enables a possible innovation in the lighting structure. The results showed that it is possible to have a saving of 31,43% in the value of energy compared to the value currently paid. Therefore, the investment amount that costs R\$ 1.998,00 would be paid in 2 and a half months.

In this way, it would generate a constant economy, with a guarantee of up to 5 years, avoiding waste and contributing to a more sustainable environment, because in addition to minimizing unnecessary consumption would contribute to the useful life of lamps and thus avoid their early disposal, thus avoiding an environmental impact because the replacement and disposal of these materials are usually very harmful to the environment.

As future works, it is proposed to expand the forms of energy control, not only with lighting, but also with air conditioners, since they are turned on in the same period as the luminaires and consume an even greater amount of energy. Thus, to propose the insertion of automatic trigger controls based on the shift times. And also, to verify the use of natural lighting and the feasibility of changing fluorescent lamps for LED lamps.

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# **Predictive Maintenance Through Thermographic Analysis: Case Study in a Manaus Industrial Pole Company**

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## **Abstract**

*Due to the high demand for electricity in the manufacturing industry, companies to obtain greater profitability on their produced goods, seek and adopt ways to reduce energy consumption, and use predictive maintenance as a tool by applying thermography. Thus, the purpose of the research is to show the importance of thermographic analysis for assessing losses and preserving the safety of the company's physical facilities. The research is descriptive, qualitative and case study. The instrument used for data collection were direct observation and document analysis. In this context, the results obtained were the mapping in the manufacturing facilities and the identification of some failures in the company's electrical system. After this data collection process, it was possible to analyze and plan the corrective actions. In conclusion, it is possible to reduce manufacturing costs through predictive maintenance through the thermographic analysis tool, positively impacting the company's financial results.*

**Keywords:** electrical installation; thermography; predictive maintenance.

## **1. Introduction**

Predictive maintenance has applications in various areas, with the most diverse purposes, however in the area of electrical, the method used is thermography, a procedure that the equipment used is the thermographic camera. Predictive, thermographic maintenance is intended to perform routine inspections

to correct overloaded cables, and eliminate heated connections, these two main factors dissipate heat energy, causing power losses, increasing power consumption and energy bills.

Thermographic monitoring should be planned and executed with the utmost importance so that the cost of electricity does not get out of control, and companies do not end up having low profitability due to monitoring reports made sporadically it is possible to map major causes and greater propensity, with up-to-date maintenance on electricity will be reduced, as well as fire hazards.

It is well known that industries today have a high demand for electricity so that they can produce their products, and get their revenue, however, it is not enough to have a high profit if you have to pay a high price on the electricity bill, Measures can be taken to avoid unnecessary energy consumption. Thus, the research problem seeks to answer the following question: What is the importance of predictive maintenance through thermographic analysis for an industrial center industry in Manaus?

In this context, the present research aims to discuss the importance of thermographic analysis for the evaluation of losses and preservation of building security. To achieve this objective, some specific objectives were stipulated which are: to analyze an electrical system of a company of the industrial pole and Manaus; point out the advantages of thermographic analysis for company results; compare the results with other thermographic analyzes of the Manaus industrial branch.

The choice for the theme arose from the need to solve the problem of the studied company in relation to the energy consumption that is very high, identifying these failures through thermographic analysis, to present possible solutions.

In this context, the relevance of the theme is to show that building maintenance through thermographic analysis has several benefits not only in the area of maintenance, but a thermographic analysis can point out possible flaws that can cause damage to the company's financial performance and safety. Of their collaborators, being able to avoid accidents and risk of death.

For the company, thermographic inspection in its greatest contribution is to avoid the waste of electricity, also ensure the safety of employees, and the integrity of the company building, because through inspections routinely made in the electrical circuit of a company, it is possible to detect points hot wastes that are wasting energy, and over time can even damage material parts of the company, thus contributing to the financial savings in terms of energy consumption as well as the safety of everyone in the environment.

## **2. Theoretical Referential**

### **2.1 Predictive Maintenance**

Maintenance has several applications. With the evolution of production processes, machines and technology in general, it has become increasingly important to maintain commercial, industrial and residential facilities, which has made the concept of “repair” very comprehensive and assumed. Greater importance than that linked to immediate problem solving [1].

Maintenance is the process that is intended for the conservation of goods (facilities or equipment), maintaining their technical, functional and safety characteristics. This is a set of technical care indispensable for the regular and permanent operation of machinery, equipment, tools and installations

[2].

It is seen as the need to ensure that systems and equipment present availability and performance when required to operate and make maintenance teams come to work to positively transform work situations in a process of continuous improvement [3].

The mission of maintenance is to ensure the availability of the function of equipment and facilities to meet a production or service process, with reliability, safety, environmental preservation and appropriate costs, leading to maintenance as a strategic function in obtaining results and leveraging the company and competitive levels of quality and productivity [4]. As for strategy and how maintenance is performed, there are at least three basic types, as illustrated in the following figure.

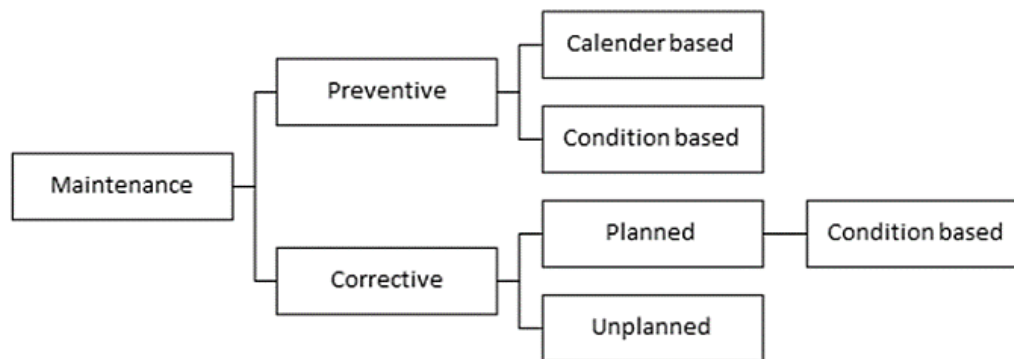


Figure 1. Types of maintenance

Source: SENAI, 2014.

For the company to achieve excellence, improvement in all areas is required and this will only be achieved by the engagement and collaboration of the entire team ensuring the availability and reliability of the facilities at an optimal cost point. To achieve this goal, it is responsible for keeping the production system equipment and facilities in perfect working order. For each machine or equipment there must be a maintenance plan that must be followed.

In this research, only preventive and predictive maintenance will be addressed. The type of predictive maintenance consists of evaluating the actual operating conditions of machines or equipment, as well as their parts, for efficient use of the useful of and planning of maintenance interventions [1].

Predictive maintenance has a wide field of application, both mechanical and electrical tracking, the differential of this maintenance is to show the actual state and performance of the equipment in its operation, thus providing data that ensures the interval between repairs, in addition, decreases occurrences of unscheduled machine shutdowns created by faults or improper operation [4].

Preventive maintenance is the maintenance modality that works based on hours worked of machines, accessories or equipment, for that is used the mean time curve for failure (CTMF) tool that generates data and graphs of problem histories presented, with Based on these data preventive maintenance is planned, it is the maintenance mode that acts before the problem becomes bigger, thus avoiding corrective maintenance action, the most important difference of this mode is the ability to program the machine shutdown, accessory or equipment, so that it has less impact on production [5].

In the case of industrial electrical installations which is the main object of study, electrical networks require inspection and cleaning routines of electrical panels to ensure the safe operation. Large

installations incorporate transformer stations, which are subject to legally binding inspection and management conducted under the responsibility of a recognized professional, the so-called TRIESP (Technician responsible for private service electrical installations) [6].

In this context, thermography is the most common technique and is prominent in predictive maintenance. With a wide range of applications, it is possible to discover various production failures, preventing electrical breakdowns, mechanical and material and equipment fatigue, yet can be applied to investigate component temperatures to detect future premature machine and equipment failures, avoiding downtime. of production [7].

## 2.2 Thermographic Analysis

The use of tools that anticipate the verification of electrical problems in the industrial sector has been growing over the years, such as infrared radiation analysis or thermographic analysis. The use of thermography has been expanding rapidly in various sectors of civil society. The most common applications are in studies of thermal comfort, preventive and predictive maintenance, medical, mechanical and electrical component evaluation, artwork evaluations and material properties [8]. The use of tools that anticipate the verification of electrical problems in the industrial sector has been growing over the years, such as infrared radiation analysis or thermographic analysis. The use of thermography has been expanding rapidly in various sectors of civil society. The most common applications are in studies of thermal comfort, preventive and predictive maintenance, medical, mechanical and electrical component evaluation, at work evaluations and material properties [8].

Thermography is considered a tool of the quality of rising predictive maintenance, as its advantages are of great importance, such as nonintervention in the operation of equipment and production processes, in addition to the relative ease of analysis and imaging and ease of operation of the thermal imagers. In the industrial sector, it is possible, through a thermographic report, to pinpoint the exact location of the problem (hot spot), in time to avoid losses of relevant magnitude [7].

Figure 2 shows the evolution of display term technology: Liquid nitrogen-cooled detector, optical/mechanical scanning system, total weight of 37 kg used in the 1970s. Electrically cooled detector, optical/mechanical scanning system, weight 6, 1 kg used in the 80's. Uncooled, FPA (Focal Plane Array) detector, weight 2.0 kg widespread in the mid-2000 year. Flir E30 detector, weight 825g used since 2012.



Figure 2. Evolution of display term technology

a) Liquid nitrogen cooled detector; b) Electrically cooled detector; C) Uncooled detector, FPA (Focal

Plane Array); d) Flir E30 detector.

Source: Cardoso; Fernandes; Valentine, 2015.

In this context, thermographic analysis is a noninvasive inspection technique, i.e., it does not interfere with machine production or equipment operation based on the detection of infrared radiation emitted by bodies having an intensity proportional to their temperature [9].

Today the instruments used to perform thermographic analysis are: infrared camera, data collector, radiometer, analysis program and conveyor belt. As illustrated in the following figure.



Figure 3. Thermographic analysis equipment

Source: Schekiera, 2011.

Regarding non-contact thermography, the infrared technique is the capture of thermal radiation emitted naturally by the bodies, allows the formation of thermal images and the temperature measurement in real time. It is made with mobile thermal imagers to detect and convert infrared radiation into visible images facilitating temperature measurement [10].

The thermographic technique can be classified as qualitative and quantitative. Qualitative using thermal standards to assess anomaly identified during inspection and quantitative in priority and seriousness analyzes for maintenance scheduling and planning [11].

The qualitative information is related to what is captured by the infrared inspection device and the quantitative is related to the graphics that will point out possible equipment and machinery failures, as illustrated in the following figure.



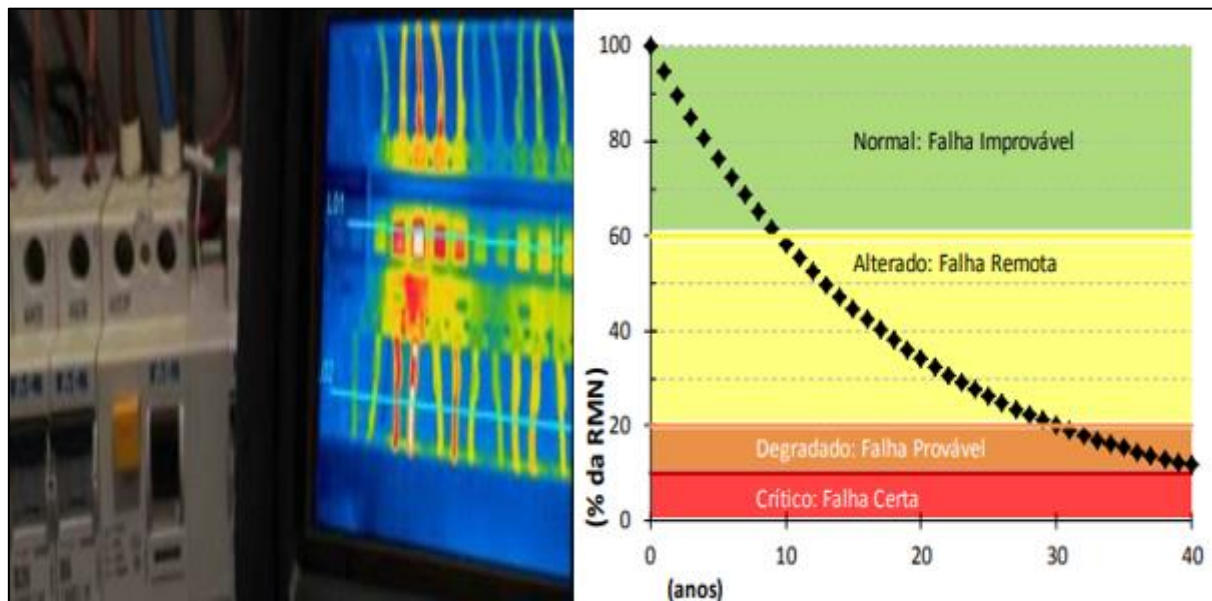


Figure 4. Qualitative and quantitative information of an inspection

Source: Amarante, Bridges, Michaloski, 2016.

Because temperature is the main detectable variable in the failure process of an electrical installation, this is where the largest application of thermography in the industrial area is concentrated. A thermographic inspection of electrical installations will identify problems caused by current / resistance ratios, usually caused by loose, corroded, oxidized connections, or component failure itself. In addition, design errors, assembly failures and even excessive and / or lack of preventative maintenance can cause overheating in electrical systems.

## 2.2 Standard Temperature of an Electrical System

One of the most important variables in predictive maintenance of electrical panels is the Maximum Allowable Temperature (MTA) of its components, i.e. the maximum temperature under which the component is allowed to operate. This standard is based on ABNT (Brazilian Association of Technical Standards) standards, NBR 5410, manufacturer tables, International Electrical Commission (IEC) references [12].

The main components of a power grid and their respective temperatures are detailed in tables 1 and 2.

Table 1. Maximum Allowable Temperature (MTA)

COMPONENTES ELÉTRICOS	MTA
Contactors Coil	100 à 140 °C
Fuses (Body)	90 à 110 °C
NH Fuses (Claw)	90 °C
NH Fuses (Claw)	70 à 110 °C
Metal Connections - BT Cable	70 à 90 °C
Metal Connections - Metal and BT Buses	90 °C
AT Disconnect Switches	50 °C
AT connections	60 °C

Source: Adapted Brito, Filho, Alves, 2010.

Table 2. Temperature classification of electrical components

ELECTRICAL COMPONENTS	Normal Temperature (°C)	Light Temperature (°C)	Moderate Temperature (°C)	Severe Temperature (°C)	Temperature Extreme (°C)
Contact coil	T<35	35≤T< 40	40≤T<60	60≤T<100	T≥100
Fuse (Body)				60≤T<90	T≥90
NH fuse (claw)					
Metal connections			40≤T<55	55≤T<70	T≥70
Metal and Buses					
Hooded wires					
Metal Connections - BT Cable				45≤T<50	T≥50
AT Disconnect Switches					
AT connections				50≤T<60	T≥60
High voltage			10≤T≤20	20≤T<30	T≥30

Source: Adapted Brito, Filho, Alves, 2010.

### 3. Methodology

The study area is located east of the city of Manaus - AM, in an industrial center company that receives incentives from Suframa. This is an industry of plastic injection industry, possui duas fábricas na cidade de Manaus, uma na Bahia e outra em João Pessoa. The case study will be carried out at the headquarters of the city of Manaus, which has a manufacturing area of 7500 m<sup>2</sup> of built area, 83 injection molding machines and about 850 employees who during 3 work shifts industrialize more than 650 production items, It currently has about 43 customers in the most diverse segments including: electronics, mechanical, two wheels, entertainment, personal hygiene, watchmaker, computer and disposable products.

The company adheres to strict quality standards including ISO 9001 which specifies requirements for the quality management system, with a focus on sustainability, risk prevention and continuous improvement of the organization's QMS performance, also ISO 14001. which deals with specifying requirements for the environmental management system, with a focus on improving environmental performance, meeting legal and other requirements and achieving environmental objectives.

IATF 16949 specifies requirements for the automotive quality management system, with a focus on sustainability, risk prevention and continuous improvement of the organization's QMS performance.

### 4. Analysis and Discussion of Results

Based on the standard equipment temperature table (Tables 1 and 2), a third table was used to scale the priority level of each equipment according to colors ranging from lowest priority (good) to highest priority (black), which shows that the correction on that circuit, machine / equipment must be done immediately, as shown in the following table.

Quadro 1. Priority level escalation

Severity	Temperature Condition	Corrective action
<b>Good</b>	Normal temperature	Do thermography conf. programming
<b>Light</b>	Temperatures lightly above normal	Do thermography conf. programming
<b>Moderate</b>	Above normal temperature	Make intervention schedule
<b>Moderate</b>	Temperature far above normal	Make intervention schedule
<b>Extreme</b>	Extreme temperature above normal	Make urgent / immediate intervention

Source: Adapted Brito, Filho, Alves, 2010.

After performing the thermographic mapping on the facilities and machines and equipment, and based on the tables detailing the working temperature and maximum allowable temperature, it was possible to generate a table and graph with number of cases detailing, the number of mild cases, moderate, normal, severe, extreme, and the maintenance field where the equipment was undergoing preventive maintenance, and the stopped field where the equipment that was stopped due to lack of production demand as shown in figure 5.

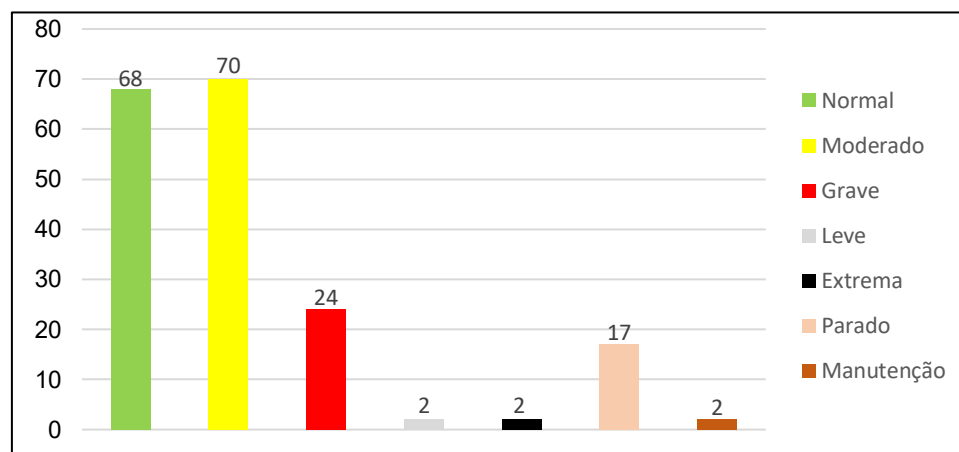


Figure 5. Number of cases detailed by level

Source: Own author, 2019.

According to the above data, 70 inspected equipment operating moderately; 68 equipment work at normal temperature; 24 devices work critically; 17 devices are stationary and the other 6 are under maintenance or are running lightly.

Further stratifying the results it is possible to list the equipment with the highest rate of problems presented, in this case the highest rate of overheating was detected in the cables, which were not badly sized, but cables that over time suffered a higher current demand causing thus overloading the circuit in general, ranging from cables to protective equipment (circuit breakers and fuses), busbars and connections integrated to the same circuits also suffer from heating, as shown in figure 6.

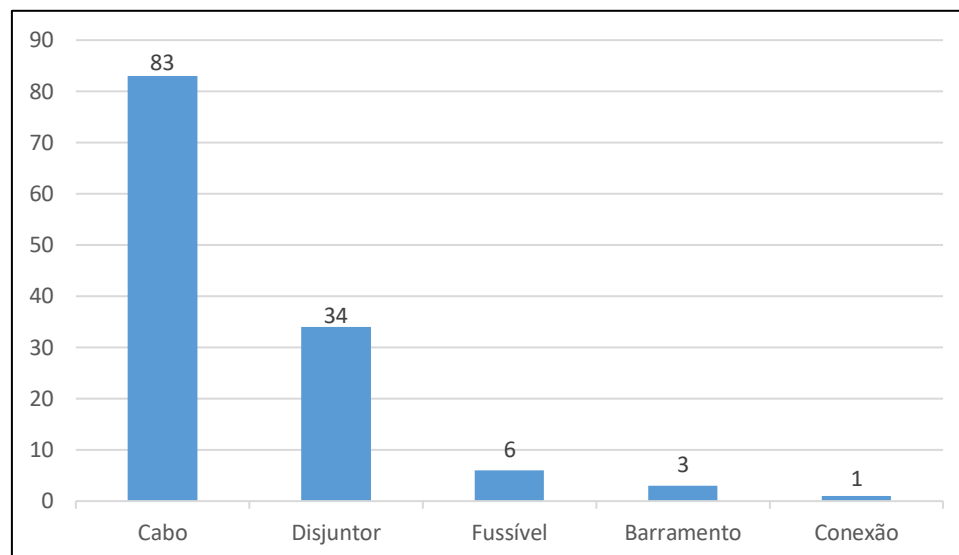


Figure 6. Equipment Issues

Source: Own author, 2019.

The data in the graph above show that 83 cases come from the mains cables; 34 cases in relation to circuit breakers; 6 fuse cases; 3 busbar cases and only 1 connection case.

Heating of the inspected mains cables and wires works at a high temperature due to the Joule Effect. Which is directly proportional to the size of the electrical current conducted by the conductors of the electrical installation, i.e. the greater the electrical current in the wiring, the greater the amount of heat generated in the conductors. When a current flow through it, a conductor heats up, releasing thermal energy due to the dissipated electrical power in its ohmic resistance. In other words, heat is released into the environment due to the meeting of moving electrons with the conductor atoms.

Other research related to the industrial thermographic analysis had similar results, in the analysis made in an electronics industry of Manaus city, in its analysis were evaluated 260 panels of low and medium voltages, with the result of the analysis were detected a higher index of heating in cables, safety devices (circuit breakers), terminals and connections [8].

In a thermographic inspection made in a company of the plastic injection branch of the Manaus industrial pole, it was concluded that the cables operate at a moderate temperature and that it requires more attention at the time of the periodic thermographic inspection [13].

Comparing these three thermographic inspections using a table we have results shown in table 3:

Table 3. Comparison of thermographic inspections

Main inspection	Equipments	Amount
	Cables	83
	Circuit breaker	34
	Fuse	6
	Bus	3
	Connections	1
	<b>Total</b>	<b>127</b>
va In sp ec	Equipments	Amount

	Termination	15
	Cables	7
	Connections	6
	Circuit breaker	5
	Counter	1
	<b>Total</b>	<b>34</b>
<b>Medeiros Inspection (2019)</b>	<b>Equipments</b>	<b>Amount</b>
	Cables	83
	Circuit breaker	34
	Fuse	6
	Bus	3
	Connections	1
	<b>Total</b>	<b>127</b>

Source: Own author, 2019.

According to table 3, comparing the three thermographic inspections we have as main equipment that operate in moderate or severe temperature the cables, circuit breakers and fuses.

## 5. Conclusion

Maintenance types are indispensable within the industry, each operating in a different scope and with different goals, but for one goal to be achieved.

Putting a predictive maintenance system in a company requires analysis and preparation of it. Which means that once installed, the company will no longer be subjected to unnecessary downtime due to equipment and machinery breakdown. Since preventive maintenance keeps track of what is happening on each piece of equipment in real time, thus preventing it from stopping indefinitely.

According to what has been presented, predictive maintenance using the thermography technique has a greater benefit and profitability compared to other maintenance.

Therefore, the thermographic analysis, is within the predictive maintenance, is the type of maintenance in which the equipment is analyzed in its operating state, basically is the maintenance made through image analysis with the use of thermal imagers, where a standard is adopted. of temperature variation for a given equipment, in that when the temperature varies outside the working standards, that equipment becomes obsolete, thus losing yield, and generating heat due to these losses, and for this reason the thermographic analysis should be done routinely. In order to monitor the equipment, to avoid the highest energy consumption for a given activity, the analysis is done over a period of six months, thus generating reports and history of higher incidence rate.

Finally, the thermographic analysis is not only linked to the performance of the equipment, it also covers the safety field, because through constant monitoring, it is possible to avoid circuits overloading the short circuit point, electrical panels, fuses, disconnect switches, cables between others, avoiding fire principles.

Finally, the thermographic analysis is not only linked to the performance of the equipment, it also covers the safety field, because through constant monitoring, it is possible to avoid circuits overloading the short circuit point, electrical panels, fuses, disconnect switches, cables between others, avoiding fire principles.

## 6. Acknowledgment

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# **Prototype Development Open Source Platform-Based Electricity Meter with Minimum Rate of Change According to Module Five of the Electricity Distribution Procedure in the Brazilian National Electrical System (PRODIST)**

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## **Abstract**

*The article proposes the development of a low-cost, well-performing open source residential energy consumption demand meter compared to commercial meters in order to achieve accurate results and remain within the limits determined by technical standards, with the objective of measuring real and instant energy consumption through microcontroller and current sensor. The prototype has the ability to provide energy consumption data for a low voltage residential load or wiring to obtain the final amount of energy consumption Data is collected in stages by collecting current and voltage, the microcontroller receives analog stimuli from sensors, as voltage and current samples are processed to calculate power, current and voltage. The use of the device leads the consumer to clarify the instantaneous energy consumption per installed component and it is possible to compare the cost benefit in relation to the energy consumption, providing consumers the follow up and a detailed view of its consumption, leading*



*to efficient and sustainable use, enabling the improvement of the quality of energy supply to equipment connected to the distribution system.*

**Keywords:** micro controller; sensors; electricity meter;

## 1. Introduction

With the crisis of fossil fuel power sources, several countries have gone in search of other power sources with the intention of maintaining security and stability in global energy supply and mitigating man-made impacts to the environment. One of the main objectives with obtaining new sources of energy is to achieve energy autonomy and weaken the link with sources of generation from fossil sources. During the twentieth century there was a major economic advance in the country, requiring a greater supply of energy to meet demand and keep up with technological developments. A determining factor that drove Brazil to seek the generation increase was the growing expansion of industries and the emergence of new technologies with their constant evolution. In the 1970s, large industries expanded to occupy larger demographic spaces, and along with economic developments there was also a large urban sprawl aggravating the need for more energy sources to keep up with the accelerated growth that intensified over a 30-year period, tripling in 2000 [1]. Then it was noted that population development was growing beyond existing available demand, the demand deficit became evident in the first crisis in 2001, where there was a mismatch between demand and supply of energy resources. [2]. In humid periods, with excessive rainfall, the participation of hydroelectric plants remains in constant generation to meet the demand of energy consumption that reaches 90%, however in periods of rain shortage this supply capacity may decrease, being necessary the supply of energy from other sources, since consumption demand remains the same. According to (EPE, 2019.) about 30% of the country's power generation comes from thermoelectric power plants and other adjacent sources, especially fuel burning plants. [3]. In need of diversifying the energy matrix and improving energy conscious consumption many measures have been agreed at major sustainability events around the world. The present work proposes the development of a low cost electric energy consumption meter for homes with the purpose of generating consumer information and comparing the data obtained with the results of commercial meters, in order to achieve accuracy of results and keep within the limits determined by national which allow uncertainties to vary by up to 2%.

## 2. Theoretical Referential

Energy is anything that can produce heat, mechanical work, light, radiation, etc. In a general sense, it could be defined as the basic substrate of all things, responsible for all the processes of transformation, propagation, and interaction that take place in the universe. Electric energy is a special type of energy through which we can achieve the above effects; It is used to transmit and transform the primary energy from the power source that drives the generators into other types of energy we use in our homes.[4].

### 2.1 Electric Power Meters

Energy meters were accepted as science in the early nineteenth century in the year 1872, because at that

time the quantification of energy was done inaccurately, by estimation with constant loads and no variation of currents and its variation only in periods of consumption having by creator Samuel Gardiner [5]-[6]. Over the years and the constant effort to quantify energy consumption, in 1878, a meter was developed by JB Fuller, an alternating current-hour meter, consisting of a pair of coils that vibrated with the frequency of in this way there was an advance of the counting in the clock-recorder, and with this the recording of the energy [6]. Evolution called for even more advancements and continued to go through the ideas of engineer Thomas Edison, who from 1878 to 1880 developed the first meter of the amount of energy consumed based on chemical reactions.[6].Five years after the invention of Thomas Edson, Italian professor Galileo Ferraris with the discovery of the induction principle developed a more accurate meter, this meter is based on the magnetic flux produced by two coils acting on a metal rotor that produces a force and the makes it spin. This is the working principle of alternating current electromechanical meters manufactured to this day [5]. Electromechanical meters use the principle of electromagnetic induction for their operation and the electronic meters through integrated circuits, both of which are designed to operate at purely sinusoidal [7]. Currently, most installed energy meters are induction type and consist of the following components:

- Motor element;
- Movable element (disk):
- Permanent magnet;
- Recorder;
- Adjusting devices;
- Structure for mounting the components.

However, with the evolution of electronics in the 1970s, began the introduction of electronic meters of electricity that in addition to informing energy consumption, have information on quality and availability of electricity. Electronic energy meters will grow in use due to the expansion in smart grid connection projects and the customer's need for real-time consumption information [8].

## **2.2 Electric Power Measurement**

The importance of measuring the demand for electricity consumption is directly linked to the coherent survey of the energy consumption of each customer in order to apply the prevailing energy tariffs. Therefore, this measurement is the responsibility of the electricity utility, being at the discretion of the customer. The same is the use of the electromechanical or electronic meters, but the most adopted today are the electromechanical because they have simple handling, measurement accuracy, robustness, long service life and good performance over the years [8].Electricity is a valuable commodity with the power to change the direction of a country's development, which is currently traded by energy utilities.

## **2.3 Operation principle**

The voltage coil is connected in parallel with the load and the current coil is connected in series with the load and the aluminum disc forming the movable assembly. From the power supply of the coils the

electric energy passes through the coils generating a magnetic field that interact with each other, giving rise to the phenomenon of electromagnetic interaction. This phenomenon generates a force that forces the disk to rotate, each revolution that the disk makes equals energy consumption, informed by the manufacturer on the disk, the shaft is coupled to gears that rotate registers providing the reading (figure 1) [9].

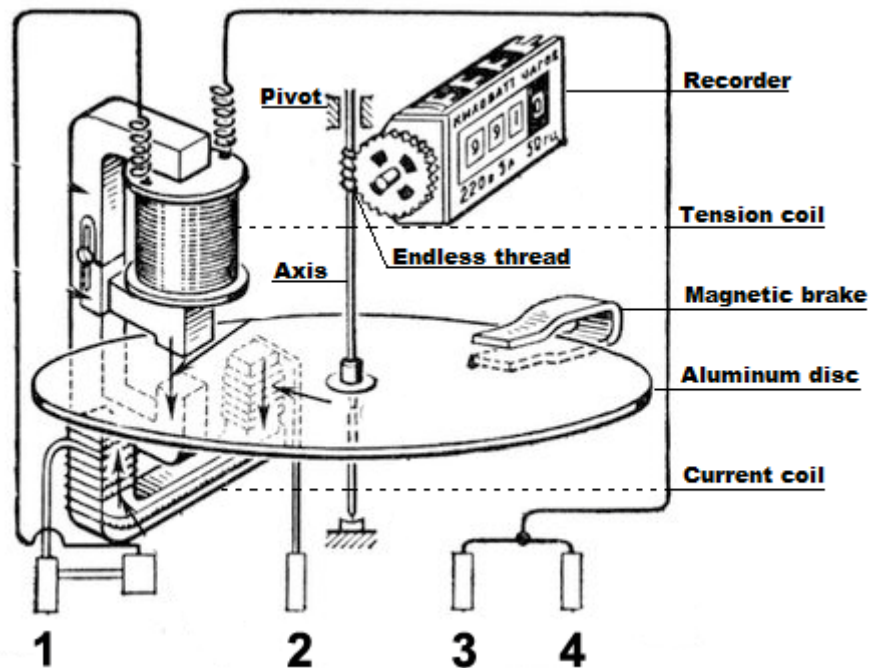


Figure 1. Internal Operation of an Electromechanical Meter (Nova Eletrônica, 2019. [10].)

### 3. Methodology

The prototype was developed from the Arduino platform, using a set of electronic components widely used in projects and prototyping that require satisfactory performance hardware with low cost[7]. The prototype has its hardware divided into three parts: sensors for reading energy variables: current and voltage, control and processing of variables and the user interface. The prototype operates in two stages by monitoring and conditioning the current and voltage signals to act within the working range of the microcontroller ranging from 0 V to 5 V. The module responsible for conditioning the input signals is represented by the diagram in figure 2.

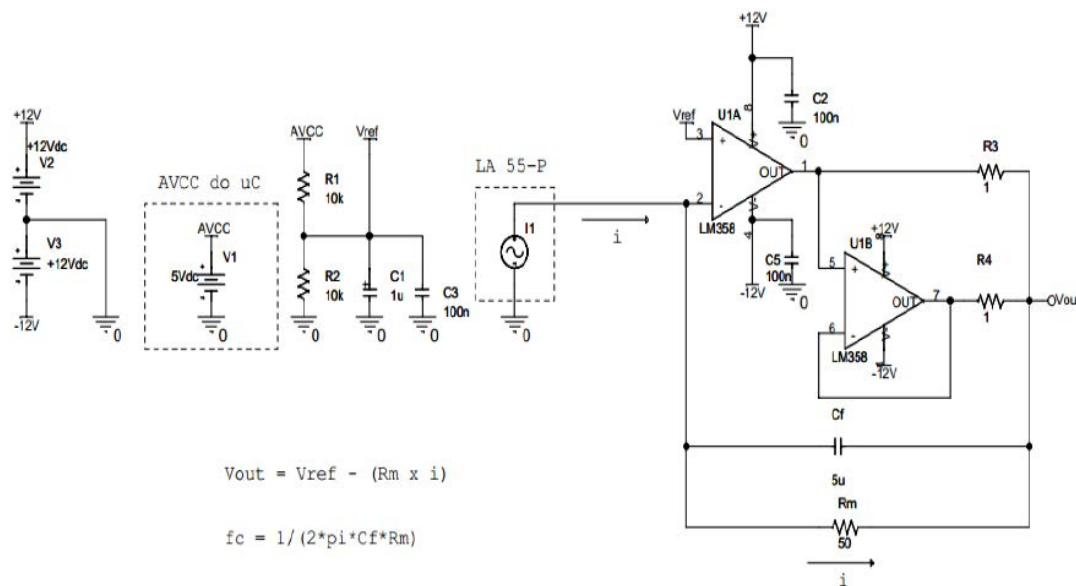


Figure 2. Diagram of the processing circuit and conditioning of current signals.

The circuit features a Hall Effect sensor with passive electromagnetic transduction behavior capable of transforming current amplitude into voltage amplitude, which in turn will be applied to the analog input of the microcontroller. In this way, the output voltage will be in a range of - 2.5 V to 2.5 V, so that you have a real sampling of the electrical signal in a smaller scale [11]. The sensors for reading current and voltage used were selected to meet the reading ranges of low demand residential loads.

The LA 55-P sensor operates in the 0 A to 50 A range of current. Receiving an external 12 V supply, a  $V_H$  voltage perpendicular to the 'I' current direction arises across the semiconductor when placed in the presence of a B magnetic field. The current sensor obtains real sine stimuli collected directly from the mains, so it was necessary to conditioning of the current signal converted to voltage. The voltage sensor circuit uses a 220 VAC: 12 VAC transformer, generating an output signal proportional to the input voltage, like the current signal, the output voltage signal will be in the range of -2.5 V to 2.5 V, also requiring polarization for voltage levels to operate within the maximum control range of the micro controller ranging from 0 V to 5 V. To monitor monitored signals from voltage and current output to analog inputs Arduino, you need to shift the signal so that there is no more negative component. The developed circuit has the Summer function, adding the continuous signal to the monitored signals and shifting the alternating signal, making it possible to apply it to the A / D converter input of the micro controller. The program was developed in C language and compiled by the Arduino IDE. The created prototype aims to acquire signal samples through sensors, to calculate the consumption, active power, apparent power, power factor and present the results of these calculations on Arduino own IDE serial output.

#### 4. Analysis and Discussion of Results

According to NBR 14519, electronic meters must pass several tests until their acceptance. Therefore, four tests were performed to evaluate the prototype behavior in order to compare and validate the results. For

the first test performed in the laboratory, a load with known power of 750 W was used, with the aid of a standard multimeter of electrical quantities MMW02- WEG 50/60 Hz, calibrated and calibrated and sharing the same circuit both the multimeter and the prototype were installed to verify the total power. Using the 750 W power load, the results obtained in table 1 can be observed.

Table 1. Comparison of energy totalization on standard meter and prototype.

Readings	Power active (W)	Power within1 hour (kWh)
Multimeter	742,33	0,740
Prototype	741,81	0,734
Error (W)	0,52	0,006
%error (W)	0,07%	0,81%

As in the energy totalization test it was verified the result of the current flow readings with the multimeter and prototype sensors arranged in series, and in parallel the voltage amplitudes, the results obtained from the flow and amplitude readings can be observed. Table 2, as well as the percentage of error between the prototype and the multimeter MMW02-50 / 60 Hz.

Table 2. Comparison of readings of electrical variables in standard and prototype meter.

Rated voltage	Standard meter MMW02-50/60 Hz		Prototype		Error		% error	
	Tension	Current	Tension	Current	Tension	Current	Tension	Current
127 V	125,51 V	5,94 A	124,17 V	5,98 A	1,34 V	-0,04 A	1,07%	-0,67%
220 V	217,60 V	3,45 A	215,28 V	3,49 A	2,32	-0,04 A	1,07%	-1,16%

As observed in the data obtained from the first test it can be considered that the percentage of loss of the prototype is practically negligible having very low errors compared to the standard meter.

The next test performed on the meter is to compare the measured quantities within a given time period and compare with the calculated uncertainty. To obtain 1 kWh it is necessary to apply a voltage of 100 V and a current of 10 A within one hour, and this is the expected result of the prototype at the end of the test. During the test the readings were stored for the development of the uncertainty calculations, allowing extracting the data of active, reactive, apparent energy, power factor, effective voltage and effective current according to table 3. Active power is the power used. By a device for producing useful work, apparent power is characterized by the product of RMS voltage and RMS current and power factor, in simple terms, indicates how efficient an electrical device is.

Table 3. Sampling data collected within one hour interval.

<i>Hora</i>	<i>W</i>	<i>Q</i>	<i>S</i>	<i>FP</i>	<i>V<sub>RMS</sub></i>	<i>I<sub>RMS</sub></i>
19:00	3	0	3	1	99,7 V	9,90 A
19:01	17	0	17	1	99,2 V	9,92 A
19:02	31	0	31	1	99,5 V	9,91 A
19:03	48	0	48	1	99,72 V	9,90 A

19:04	64	0	64	1	99,79 V	9,89 A
19:05	82	0	82	1	99,82 V	9,96 A
19:06	98	0	98	1	99,93 V	10 A
19:07	116	0	116	1	99,75 V	9,93 A
19:08	131	0	131	1	99,69 V	9,90 A
19:09	149	0	149	1	99,68 V	9,92 A

The behavior of the effective voltage during the test as a function of the time of application of voltage and current in the prototype can be observed in figure 3.

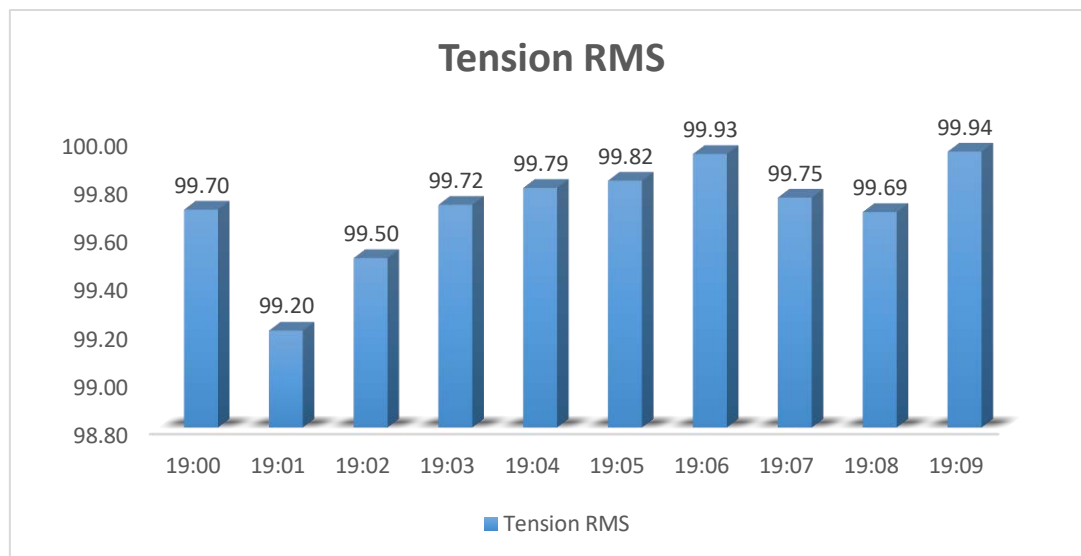


Figure 3 - VRMS behavior as a function of time.

Figure 3 shows the collection of the first ten samples at one minute intervals, at the end of the test the meter presented the value of 987 Wh of energy. With the obtained data it is possible to calculate the total uncertainty of active energy. The calculation of the uncertainty percentage found was described by the equation below:

$$\sigma_{\text{total}} = \left(1 - \frac{987}{1000}\right) \cdot 100 = 1,3\%$$

(Equation 1)

The actual condition test was performed based on purely resistive loads. The load used for this test was a 1000 W / 220 V semi-automatic washing machine. For measurement standard a digital voltmeter and a fluke 302 + ammeter was used, the load was monitored for approximately ten hours to better observe the behavior of meter, the results collected can be seen in table 4.

Table 4. Active and apparent power, power factor, Vrms, Irms and consumption extracted by the prototype.

Active power (W)	Apparent power (VA)	Power factor (%)	VRMS (V)	IRMS (A)	Consumption (Wh)
981,03	1245,42	78,77	214,76	5,80	18,00
976,02	1198,13	81,46	214,66	5,60	18,31
975,96	1216,49	80,23	214,84	5,66	18,62
971,29	1205,75	80,55	214,67	5,62	18,92
969,79	1212,47	79,98	215,08	5,64	19,23
966,94	1157,09	83,57	214,88	5,38	19,53
996,30	1255,34	79,37	215,11	5,84	19,84
979,09	1232,63	79,43	214,91	5,74	20,15
985,13	1275,79	77,22	215,26	5,93	22,92
959,77	1115,99	86	215,06	5,19	23,22

After observing the performance presented by the meter and the measurements obtained, it is possible to prove that the low cost meters have a good performance compared to commercial meters. In order to further explore the capacity of the meter it is proposed for future work to increase the connectivity capacity of the equipment with communication modules and network protocol for long distance readings and increments in programming to obtain not only the electrical quantities but also the values related to the consumption in kWh.

## 5. Conclusion

According to the project development, we can conclude that the results obtained in the meter tests corroborate the theoretical prediction, proving that it is possible to develop a electricity meter with a maximum error of 2% and characteristics that fit within the acquisition standard of signals in accordance with current national technical standards. To validate the meter, tests were performed in the laboratory and under real domestic use conditions over a period of time where it was possible to observe the working characteristics of the prototype. Among the tests performed, the test of the influence quantities stands out, presenting satisfactory results with an uncertainty calculation of 1.3% of variation below the value determined by technical standard. The total uncertainty calculated for the prototype was 1.463% below the stipulated value of 2% according to the electricity distribution procedure in the national electric system.

From the observations during the operation of the meter it was possible to diagnose small delays in the data collection of the electric grid as a function of the sensors used, since they have losses considering that they are not ideal components, making visible that an improvement of the system can be achieved. since more accurate sensors, resistors with smaller tolerances and a dedicated microcontroller can be used to reduce calculated uncertainty errors. However, the errors obtained can be considered insignificant, enabling the consumer to make a good study of the quantity of energy consumption. Based on the results, it was possible to verify the prototype acuity compared to the commercial meters used as standard, but it is important to stress that the project is not intended to show the tariff values of energy consumption but

the possibility of developing a low meter. cost with equal performance compared to commercial meters governed by standards.

In future work, hardware with dedicated components for use and calibration, associated with the use of reactive energy, apparent energy, effective voltage, effective current and frequency, will be made or improved. And as future work and approval with bodies accredited by INMETRO.

## **6. Acknowledgement**

I want to thank God for doing this work to my family and to the teachers. MSc. Livia da Silva Oliveira, Prof. Esp. Aristeu Souza da Fonseca, for the support and guidance provided in the preparation of this work.

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# **Implementation of 288 KWP Photovoltaic Solar System On-Grid in a Manaus Industrial Polo Company**

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## **Abstract**

*The rational use of electricity is practically mandatory, due to the current moment in which the country crosses, mainly due to the reduced reservoir levels of the hydroelectric plants, and where there are high costs in the production of its fuel inputs. fossil fuels, and recent tariff adjustments that the government has been approving year after year, making conventional energy increasingly expensive in the country. Companies and households focus on looking for ways to dodge electricity inflation through clean and renewable energy sources, as is the case here, of photovoltaic solar energy. Aiming to supply about 70% of the electricity bill of a Company of the Manaus-AM Industrial Pole, this work proposes a 288 KWp photovoltaic solar system, consisting of 900 330 W photovoltaic panels, accompanied by 10 Inverters. 30 KW each, connected to the Amazonas Energia Distribution Network, featuring an On-grid solar system, and becoming the largest executed solar energy project in the Amazon and Northern Brazil. The implementation of the system seeks to make feasible and solve the high cost of the electric bill with the application of a solar system, and analyze its investment, financial return and clean energy generation for the next 25 years.*

**Keywords:** Electricity; Solar energy; Photovoltaic panels; On-grid

## **1. Introduction**

Over the years, humanity has become more dependent on electricity, both in terms of housing and work.

It is worth remembering that the use of polluting energy sources to meet the growing demand for energy directly impacts the environment, thus affecting the present and future generations [1]. In this scenario, we enter with renewable energy, reducing environmental impacts, using clean and sustainable energy, as is the case in Brazil, photovoltaic solar energy [2].

The sources of energy generation are mostly indirect forms of solar energy (hydro, biomass, wind, among others). Over the years, along with the development of industries and equipment, there has been an exponential growth in the application of photovoltaic energy, presenting itself as one of the best and most advantageous reliable alternatives for reducing electric energy inputs [3].

The conversion of solar energy generation in Brazil has high potential, where the average daily average irradiation varies between 4.2 and 6.0 Kwh / m<sup>2</sup> per day, thus, maintains that housing projects should be focused on finding solutions for avoid or minimize expenses with environmental conditioning, provide alternatives to the use of electric water-heated showers and reduce energy expenditure on equipment [4].

## **2. Theoretical Referential**

Rationalizing energy use is an economic and environmental necessity. In the case of electricity in particular, the water crisis that has occurred in recent years reveals the fragility of the water supply system in some regions and also the risks of falling electricity supply or increasing tariffs with more intense energy injection. in carbon at SIN. Although many do not believe it, there is a finite horizon in the power generation capacity that needs to be respected as the environmental impacts of building hydroelectric reservoirs are high. Thermoelectric plants, which send energy to the grid in the country to complement the supply of hydroelectricity to the population, in most cases, employ fossil fuels that are intense in GHG emissions, although there are some that run on renewable sources [5].

### **2.1 Solar Energy**

Photovoltaic solar energy is defined as the energy generated through the direct conversion of solar radiation into electricity. This is done by means of a device known as a photovoltaic cell that acts using the photoelectric or photovoltaic effect principle [6].

The photovoltaic effect is generated by the absorption of sunlight, which causes a potential difference in the structure of the semiconductor material. A photovoltaic cell does not store electrical energy, it only maintains a flow of electrons in an electrical circuit as long as light falls on it. This phenomenon is called “Photovoltaic Effect” [7].

### **2.2 Photovoltaic Solar Panel**

Solar panels, or modules, are the main components of the photovoltaic power generation system. These are formed by a set of electrically associated photovoltaic cells in series and / or parallel, depending on the voltages and / or currents determined in the project. The set of these modules is called photovoltaic generator and constitute the first part of the system, that is, they are responsible for the process of capturing solar radiation and its transformation into electricity [8]. Figure 1 below represents an electrical diagram of an on-grid photovoltaic system.

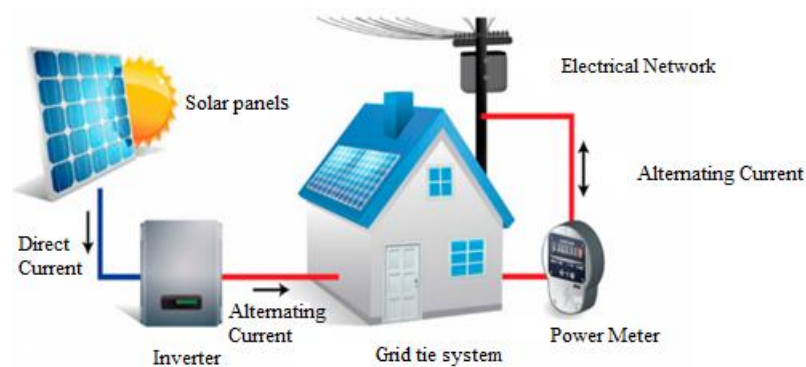


Figure 1. Photovoltaic electrical diagram, on-grid system

Source: <http://www.ecomais.ind.br/energia-solar>, 2019.

### 2.3 Systems connected to the utility grid (ON-GRID)

They are those who work concomitantly with the power grid of the power distribution company. Briefly, the photovoltaic panel generates electricity in direct current, after converting it to alternating current, is injected into the electricity grid [9]. Such conversion occurs by the use of the frequency inverter, which performs the interface between the panel and the power grid [10]. With these systems, which work from the array of solar panels installed on the roofs, the so-called solar panel, consumers are able to generate all the energy they consume and thus save up to 95% on their electricity bill [8].

## 3. Methodology

Data and technical information on design and installation are presented here; individuals and legal entities involved; component specification; commissioning tests.

The electricity projects of this project were prepared under the minimum acceptable technical and safety conditions, in compliance with ANEEL Normative Resolution No. 482/12, of April 17, 2012, and ANEEL Normative Resolution No. 517/12, of December 11th. 2012. NDEE-002 - Low Voltage Electricity Supply - Individual Buildings. Standard NBR-5410 - Low voltage electrical installations from ABNT. NR-10 - Regulatory Standard on Safety in Electricity Facilities and Services, and Ordinance no. 598 amending NR-10.

The connection point to the utility network will be at medium voltage, 13.8KV, through a 3.25mm<sup>2</sup> insulated copper cable underground branch from the S / N utility pole to the inbox where the meter installed in the sheltered substation measurement booth, giving full access to the utility.

Indirect type (kWh) metering for the consuming unit shall be bi-directional, as recommended by PRODIST - Module 3 - Section 3.7, ie measuring the active energy injected into the grid and the active energy consumed from the grid. EletrobrásDistribuidora will promote the replacement of the installed unidirectional meter by the appropriate bidirectional meter.

#### 4. Analysis and Discussion of Results

In the months of June, July and August of 2018, that is, in the period when the photovoltaic solar system had not yet been installed, there was a large expense in the local electricity bill, totaling the three months, costing to the owner, a total of R \$ 83,121.53 (eighty-three thousand, one hundred and twenty onereais and fifty-three cents). These amounts of the electricity bill are, respectively, R \$ 27,017.71, R \$ 26,491.40; R \$ 29,612.42.

With the high values of the electric bill, the solution found to reduce expenses was the investment in the solar system. Looking at the customer's case, a system of 288 KWp was calculated, which would be enough to reduce 70% of its electricity expenses. This system has been implemented, with a total of 900 330 W solar panels, along with 10 power inverters that transform DC (DC) into AC (AC), which is used in corporate homes.

It can be observed the subsequent months of September, October, November and December 2018, and analyze the high amounts still paid on account of electricity, which are, respectively, R \$ 24,141.79; R \$ 27,465.79; R \$ 22,718.96; R \$ 21,867.24.

In December 2018, there was a reduction in the electricity bill, which, being a motorcycle production company, noted that in December the production was reduced, and consequently, the amount electricity and also, to compensate for the reduction in December, January had an increase in production and its energy expenses, returning to higher values. As usual, production increases or decreases according to demand, so the months of February and March had significant reductions due to low production of motorcycles. The values for January, February and March, respectively, are R \$ 29,429.47; R \$ 18,037.74; R \$ 15,812.27.

The project for the execution of the work had a total duration of two months, which were April and May, a period that was still being calculated the electricity bill in a conventional way, ie, buying energy from the local electricity distributor. In Figure 2, we can see the site with the successfully installed solar system, ready to generate power in subsequent months. The months that began to generate their own energy were from June 2019.



Figure 2. Factory with solar system installed.

With the project completed and ready to generate electricity, the electricity bill data for June, July and August 2019 were collected, and there is a large positive impact on the reduction of the electricity bill of

the site, as we can see in Table 1.

Table 1. Electricity bills from June to August 2019.

Month	Invoice Total
June	R\$ 13.686,71
July	R\$ 15.220,91
August	R\$ 7.765,43

\* Values in Brazilian Real

With the use of the solar system, there is a huge difference in the electricity bill. We can make the comparative of the year 2018 from June, July and August 2018 and Table 1, which show values from June, July and August 2019. At the same time of the year, with the same values of factory production. This difference is best explained visually in Figure 3, comparing economic expenditures without the solar power system and the photovoltaic solar power system.

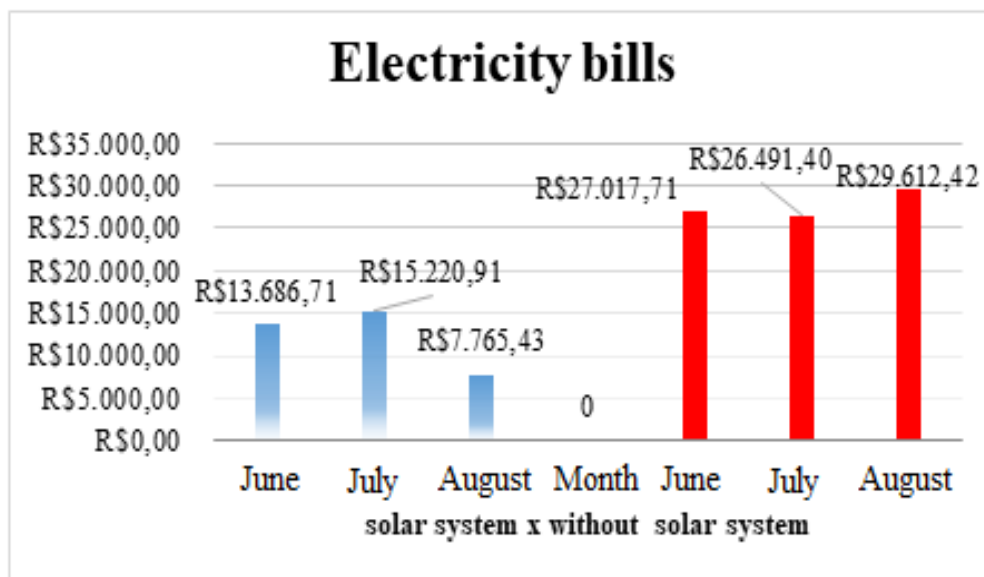


Figure 3. Comparison of solar and non-solar expenses.

\* Values in Brazilian Real

Figure 3 shows the amount of electricity spent on the site, significantly reduced after the use of the solar system, generating its own electricity and, comparing the months of August 2018 and the month of August 2019, there is a difference of R \$ 21,846.99 (twenty one thousand, eight hundred and forty-six reais, and ninety-nine cents), which in terms of percentage, means an economic reduction of approximately 73.7%, reaching the expected results. , which were calculated to reduce 70% of the values of the electric energy bills.

To obtain this photovoltaic system, there was an investment of R \$ 800,000.00 (eight hundred thousand reais), which will have its financial return, PayBack, according to the values reduced by more than 70%, estimated in approximately 3 years. as shown in Figure 4, estimates.

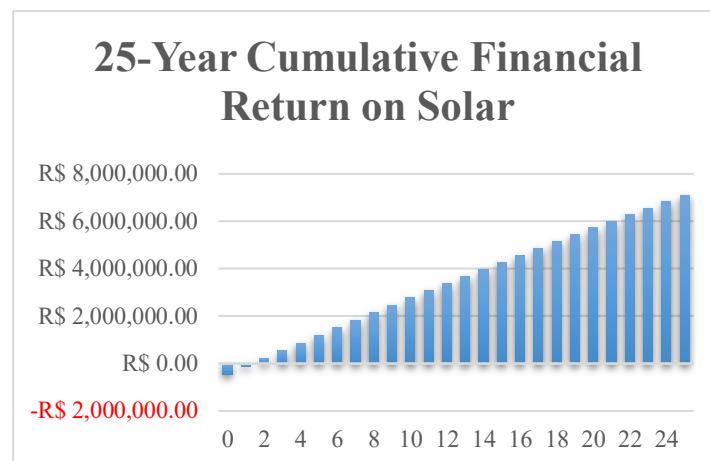


Figure 4. Estimates of financial return.

\* Values in Brazilian Real

Figure 5 provides a comparison of how much would be spent on conventional energy for 25 years, and how much it is estimated to spend during these 25 years (warranty time of solar panels) with the solar system.

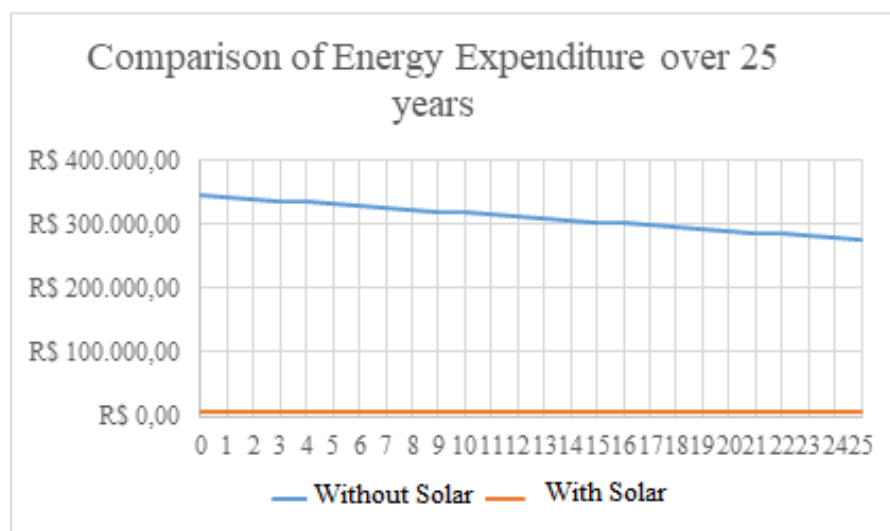


Figure 5. Comparison of expenses with electricity.

\* Values in Brazilian Real

Thus, by analyzing the estimates, the electricity bills will be reduced to less than 10,000 reais per month, causing profit, generating electricity and, being self-sustaining, ceasing to emit CO<sub>2</sub> in the atmosphere and generating credits in the power utility distribution network. local electricity.

## 5. Conclusion

Alternative sources of renewable energy, such as solar energy, demonstrate more efficient electricity generation processes compared to fossil fuel-generated energy distributed by the country's electric utilities. In the solar energy system, its use and generation of electricity in a distributed way, have great advantages in terms of reduction of the electric bill compared to the expenses of the conventional

transmission and distribution system, besides allowing generation credits to the owners. , which are obtained by the surplus energy generated by the solar system, thus, lowering values in future electric bills that will be calculated by the utilities, because even with the solar system, even reaching the maximum generation efficiency, the fee is still paid dealership minimum, which varies prices, if speaking of homes and businesses. The investment for a solar power system is high, but considering its cost-effectiveness, it is clearly noted that the financial return is huge, calculating the lifetime of the equipment, which lasts 25 years.

Therefore, analyzing the results, it can be seen that the values obtained are satisfactory, just compare August 2018 and the same month 2019, when the solar system was already generating its own energy, with an economic reduction of over 70% of the value. paid when you did not have the solar system in question. By analyzing the electricity bills before and after the project, we clearly see the advantages of solar energy, but even to obtain such a system, whether residential or industrial, the values for acquisition are still very high, however, with the advancement of technology that is increasingly developing, the values for acquisition become more accessible to consumers of electricity in general.

## 6. Acknowledgment

To MSc. Livia da Silva Oliveira, for supporting the development of this article.

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# **PDCA Cycle Application in Management of Industrial Processes in a Manaus Industrial Pole Factory**

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## **Abstract**

*This study aimed to study and monitor the implementation of the PDCA method. (Plan, Do, Check, Action) Through action research. It was found that achieving the best results required the use of Quality Tools (Ishikawa Diagram, 5W and 2H, Brainstorming, 5S) providing more accurate data for better decision making. The study had bibliographic research and data comparison, providing references to diagnose the root of the problem presented in the production process related to the aesthetic quality of the finished product (Lithium Ion battery for mobile). Using the 5S program to implement and guide employees in new work habits, ensuring product and process quality, avoiding waste and enabling continuous improvement.*

**Keywords:** PDCA; Portable Battery; 5S.

## **1. Introduction**

In today's industrial market competitiveness is increasingly fierce, finding a differential to stand out in the midst of so much technological innovation is to ensure business survival. Seeking strategies for continuous improvement without losing quality is the most appropriate option, however, to ensure better use of quality resources and without raising costs, planning is required, and a simple and easy-to-apply option is the PDCA cycle. Do, Check and Act) which is an effective option, created to ensure that there is

organization in the company, applying basic management and administration concepts, with a simple and easily used structure. The easy applicability of this method is the reason for its great use in companies where it is performing a detailed analysis of the production process to identify and solve problems with low cost with the help of quality tools for generally satisfactory results and may seek continuous improvement.

Second [1] continuous improvement can be defined as a process involving the entire organization around a broad process of incremental innovation. It is a simple concept and low investment, but with great difficulty of implementation and maintenance. It is an essential tool for business survival as it is a vehicle for positive change to be maintained and taken as a reference.

Second [2] process is a combination of the elements, equipment, inputs, methods or procedures, environmental conditions, people, and process information or measures, for the purpose of manufacturing a good or providing a service.

Thus, this article seeks to insert the PDCA method, demonstrating the steps of each activity and the results achieved for problem solving, from its origin to the options and possible outcomes, creating possibilities with emphasis on the low cost of application.

## **2. Theoretical Foundation**

In this article through theoretical framework some concepts will be presented for a better understanding of the project under study, supporting the analysis of the results of this research.

### **2.1 PDCA Cycle**

According to [3] continuous improvement is an endless process, questioning and requesting, and this nature is revealed in the PDCA Cycle, where the method is traversed in a circular manner. A fundamental principle for the PDCA is interaction, once the hypothesis is confirmed (or denied), running the cycle again will imply a greater and more concrete knowledge of nonconformity.

Second [4] The path that leads to success in achieving continuous process improvements is one that combines the two types of management, maintenance and improvements, using the PDCA cycle.

Sengundo [5] The PDCA cycle provides a systematic means to envision continuous improvement and consists of 4 steps, identified as follows: Plan (P), Do (D), Check (C) and Act (A).

According to [6] the PDCA cycle prevails from a sequence of fact-based, data-driven logical procedures that aims to locate the root causes of a problem and then eliminate it. In this cycle, quality tools will act as tools for collecting, processing and disposing of information, enabling reliable decision making.

Second [7] Describes the steps of the PDCA cycle as follows:

PLAN: Identify objectives and actions that are required to deliver expected results as per the customer's wishes and organizational policies;

DO: Make actions that have been planned be implemented;

CHECK: Monitor and measure processes and products with respect to policies, objectives and requirements and report results;

ACT: Implement actions that continually promote process performance improvement.



Figure 1- PDCA cycle.

Source: adapted from [8].

## 2.2 Ishikawa Cause and Effect Diagram

Second [9] The Ishikawa Diagram is also known as Fishbone Diagram and Cause and Effect Diagram. It is a tool that helps in identifying the causes of a problem and analyzes the factors surrounding the process. For this method every problem has causes that must be analyzed and eliminated in order to remedy the problem. The diagram is made in the form of a graph, which has the purpose of organizing the problems in various processes. It is used for quality control management and its structure considers possible causes of problems.

Method - Identifies all causes involving the method being used at work. It is used to design the product or service;

Material - Identifies the causes involving the material that is used in the work. It is the materials that make up the products;

Labor - Identifies the causes that involve the attitudes of employees. Refers to the people who participate in the process;

Machine - Identifies the causes involving the machine being operated. It is the equipment used in the manufacture of products, especially those that may be causing the problems;

Measurement - Identifies the causes involving the measuring instruments, verifies if the monitoring is being performed. These are the measures taken during the manufacture of the products;

Environment - Identifies the causes that involve the environment and the work environment.

## 2.3 5W2H (What, When, Why, Where, Who, How, How Much).

According [10] 5W2H is a management tool that we can use in the collection acquisition application, allowing the elaboration of a good action plan and this tool allows the structuring of thought in a well organized and materialized way before we implement any solution in business.

Table 1 - 5W2H Methods Description

	<b>5W2H Method</b>
<b>What</b>	What action will be performed
<b>Who</b>	Who will perform; join the action
<b>Where</b>	Where will the action be performed
<b>When</b>	When will the action be performed
<b>Why</b>	By whom the action will be performed
<b>How</b>	How the action will be performed
<b>How Much</b>	How much does it cost to perform the action

Source: Adapted from: Behr (2008)

## 2.4 Brainstorming

Second [11] Brainstorming is used to facilitate the generation of ideas. Second [12] Participants are encouraged to express any ideas they can think of during a brainstorming session. Second [13] By giving due attention to group ideation processes, they can provide a basis for organizational innovation. In addition, some of the important factors for creativity such as autonomy at work, a risk tolerant environment and open communication are also important to support innovation.

## 2.5 Paret Graph

Second [3] Pareto Chart In any breeding process, it is worth distinguishing between what is important and what is least important. Distinguishing the few vital questions from the very trivial ones. Sorting information items into the types or causes of problems in order of importance.

Second [14] says that The Pareto Diagram is conceptually related to the Pareto Law which gave an interpretation for the area of quality, which was also known as the "rule 80-20". According to this rule, 80% of defects are related to 20% of potential causes. This diagram is a representation of the occurrence frequencies in descending order, showing how many results were generated by type of defect. (...) Therefore, the Pareto diagram allows organizing the data, establishing priorities and guiding the corrective actions of the improvement team.

## 2.6 Check Sheet

[15] Verification sheets can be used for process interpretation as well as control instrument. Data collection plays a major role, as it needs to be performed with extreme rigor, protection and dedication.

## 2.7 5S Program

According to [16] the program was created by Kaoro Ishikawa in 1950 in Japan, probably inspired by the need to organize the nation's war against the Allied forces. Due to its great efficiency in reorganizing companies and the Japanese economy itself, the 5S is still considered the main tool for quality and productivity management in this country.

Second [17] The 5S denomination is due to five words beginning with the letter "S" in Japanese, which describe the program steps: Seiri (organization and disposal), Seiton (tidiness), Seiso (cleaning) , Seiketsu (standardization) and Shitsuki (discipline). Adapted to the west the five words were understood as five senses.

### **2.7.1 Seiri**

It is about keeping in place only what is necessary and appropriate for the activities that will be performed. Discarding what doesn't fit and reallocating what can be used in another sector, making it more visible what will be useful in the process [16].

### **2.7.2 Seiton**

Seeks to leave everything in its place to make it easier to find and make it faster and more efficient to use. Facilitating rapid identification and preparation for systemic use of objects [17].

### **2.7.3 Seiso**

Aims to provide an ideal environment for full quality. The work environment and the things in it should be kept clean, and the destination for the trash should be found, each responsible for its space [18].

### **2.7.4 Seiketsu**

Aims to keep the first three steps of the 5S program on a continuous basis. With the principle that a mind free of foreign elements makes work better. [17]

### **2.7.5 Shitsuki**

Represents the need to re-educate and improve our positive attitudes. One must keep the order acquired and always seek to improve the organization, gaining the ability to do things the right way even if not noticed by anyone. [18]

Second [19] At each stage of the 5S one must first act curatively and then preventively, because it is necessary to reverse the status of the organization and prevent it from returning to the previous status.

## **3. Application of Study**

The research was carried out in a factory located in the Manaus-Am Industrial Complex. In which the process of assembling portable batteries and energy storage solutions is performed. The study will look at a portable mobile battery assembly line, where there is excess rework, resulting in higher costs for the company. An internal study was carried out, which proved the seriousness of the problem, thus, defined in a meeting with the management and the team responsible for the line under analysis, the importance of a solution to this problem. The implementation of the PDCA cycle (Plan, Do, Check and Act) was defined.

### **3.1 The first phase of the PDCA cycle (P) is the problem identification.**

To perform this step a detailed analysis of the material taken to be reworked was processed, after the collection of this material was performed a brainstorming. It was found that the critical factor in the rework was the excess of cosmetic defects, where an investigation was made in each step. from the production line, from various points of view, collecting data for analysis and setting a goal. After collecting data in all sectors and defining the problem to be solved, the Pareto diagram was used to

classify the degree of importance of each problem and for an easier visualization of the problems encountered and together with the use of the Ishikawa diagram. potential causes of a particular problem and opportunities for improvement.

As the activities progressed, it was defined the use of the 5W2H tool and the 5S implementation to establish a planning, execution and monitoring schedule of the project steps. Thus, defined the action plan with the team.

### ***3.2 Second Phase (DO) Following the preparation of the Weekly Action Plan by the Team.***

The first action was initiated, to set the date for the beginning of the training and study of the 5S method to the employees of the sector. At this stage, the importance of the 5S Program, the current situation of the process, was presented, presenting the problem to the employees of the sector. of photos and graphics for easy viewing.

After setting the training method and the dates. Where emphasis was given to each stage and divided the training weekly.

### ***3.3 Third Phase (Check) In order to maintain the 5S Program***

Measures were established to maintain and analyze the process continuously, bringing the team closer together and maintaining the means for a cycle of improvements. Defining a person to be responsible for monitoring development and providing technical support when needed. This stage also uses weekly brainstorming to provide data exchange and suggestions with industry employees.

### ***3.4 Fourth Phase (Action) After the implementation of the 5S program***

which was defined as the tool to solve the problem encountered in the case analysis, there was a meeting with the 5S Implementation and Training Team, technical responsible for monitoring the analyzed line and the management of the company where the results were discussed and also decided the time that audits would be held, where it was proposed to be performed once a month to improve and monitor the program and to adapt employees to the new reality.

In order to verify the process standardization, the established improvements were applied by the 5W2H method, which classified the verified items and the employees' development in order to check the results and correct any process failures.

## **4. Analysis of Results**

The main difficulties found in the study are related to the services provided by employees without training and process care. The negligence of some of the employees regarding the handling of the product during the assembly process directly interferes with the aesthetic quality presented to the finished product, generating an increase in the rework volume.

To solve the problems found, the PDCA cycle was implemented. Which counted on the aid of quality techniques. That with the action plan established the implementation of the 5S program. And with proper monitoring and monitoring of each phase in the search for improvements and problem detection,

conducting monthly audits focusing on the standardization of the process and the improvements applied.

Table 2 - PDCA cycle

<b>P</b>	<b>Problem identification: Cosmetic defect.</b>
	<b>Goal:</b> Eliminate cosmetic rework.
	<b>Process Analysis:</b> Disorganized work environment.
	<b>Method:</b> Brainstorming, Verification Sheet.
<b>D</b>	<b>Empower:</b> qualified employees with the 5S methods course. Continuous Updates. Meetings with technical staff and auditors. 5S team training
	<b>Execution:</b> Action plan and presentation of 5S steps to employees Monitoring by the technical team.
	<b>Measure:</b> Through check sheet.
	<b>C</b> <b>Compare:</b> Monitor through graphs with the indicators and results obtained.
<b>A</b>	<b>Act:</b> Conduct periodic audits and meetings to monitor the process and analyze possible improvements.

Source: Own Author

## 5. Final Considerations

The need for improvements and quality in finished products led to the search for solutions. And to meet these needs was implemented the PDCA method, identifying and monitoring each step, after the implementation and standardization of the process and its activities was essential to set goals and plan to keep continuous improvement and seek more and more satisfied customers, ensuring a product with customer quality and financial return to the employer.

Through this research, we presented some of the challenges of the industrial sector, detailing existing methods and tools that can help in solving problems in the industrial sector. And especially to guarantee opportunities and means for continuous improvement and maintenance of the results obtained during its implementation.

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# **Implementation of the TN-C-S Scheme in an Ungrounded Low Voltage Electrical Installation in Manaus / AM**

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## **Abstract**

*This paper is intended to formulate a hypothesis for the implementation of a grounding system in a low voltage electrical installation in the city of Manaus. According to ABRACOPEL and PROCOBRE 48% of Brazilian properties do not have a protection conductor and according to NBR 5410 and NBR 5419 the grounding system is of crucial importance, both for the protection of the building, as well as the human being; Inserted in this context, the present article seeks to report a method applied by the author for the implementation of a reliable grounding system that fits the Manaus Electric Power System.*

**Keywords:** Electrical installation; Grounding; Low tension.

## **1. Introduction**

The Brazilian Association for Awareness of the Hazards of Electricity (ABRACOPEL) and the Brazilian Copper Institute (PROCOBRE) performed in period of August to September 2016 a field research [1], being validated by the Qualibest Research Institute. This Research found that 48 % of houses and

apartments in Brazil do not have a grounding system. Such a situation carries very serious risks to the life of the human being and to the property as a whole. The annual statistics of ABRACOPEL for the year 2018 [2] reports that 59% of accidents of electrical origin are due to shocks and fires, 38% current overload, and 3% related to atmospheric discharge. Already in the yearbook for 2017 [3] is reported 52 occurrences of death by shock in the northern region, where 13 occur in the state of Amazonas. There are also 58 fires by short circuit in the Northern region, where 18 occur in the state of Amazonas, representing a rate of 31.03%.

The idealization of this article originated from a practical problem that was solved by the author where was required the installation of an electrical device of protection against surge, and for this the grounding conductor was required. It was thought of two method that would solve this problem, however the most easy, trustworthy and safe was the implementation of the TN-CS system, as provided by NBR 5410 [4].

The implementation of this system has serious risks and needs a set of measures to ensure protection. For this reason, this scheme is not very suitable for low voltage installations, however, in this article will be observed the application of this system in the city of Manaus, presenting justifications that guarantee their effectiveness.

This article will be organized through a normative approach on the implementation of this system, highlighting the required requirements and how they will be applied. In another section will be presented the methodology applied in the implementation of this scheme followed by a discussion of the results, where we will have a critical analysis of the safety of this system, inserting analysis parameters of other authors.

## 2. Theoretical Referential

### 2.2 TN-CS Grounding Scheme

The grounding schemes present in item 4.2.2.2 of NBR 5410 [4] are divided into three Groups: TN, TT and IT; where the first has three subdivisions: TN-S, TN-C and TN-CS. In line 'b' we have the caption for each letter:

First Letter: State of input in relation to the ground.

- T: A point directly grounded;
- I: Isolation of live parts, or grounding by impedance;

Second Letter: Situation of the masses of the Installation in relation to the ground.

- N: Ground connected to the point directly grounded in the supply;
- T: Directly grounded masses, regardless of eventual grounding;

Third Letter: Arrangement of neutral conductor and protection conductor.

- C: Function of neutral and protection combined in one conductor (PEN);
- S: Neutral and protection function provided by different conductors.

The TN-CS scheme has function of neutral and protection combined in the same conductor in part of the installation, in other part, we have its separation. As a rule, this separation should always occur posteriorly.

The standard scheme can be seen in Figure 1:

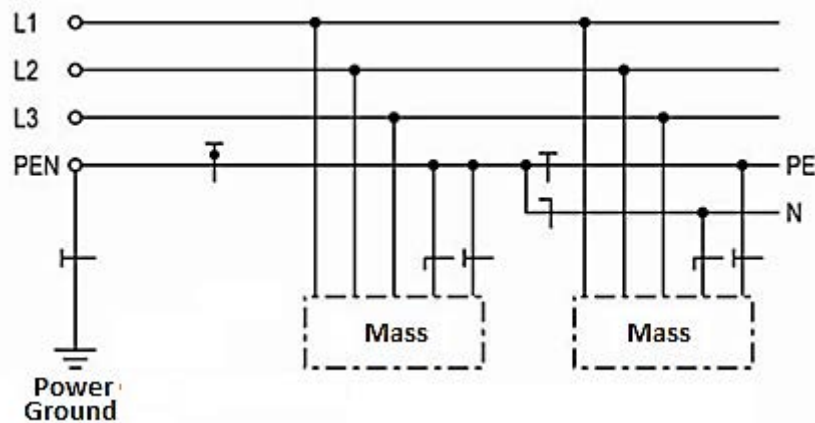


Figure 1. TN-CS scheme

Source: NBR 5410 - Item 4.2.2.2.1

It is possible to observe that the PEN conductor symbology is different from other symbology. This conductor serves as grounding and as neutral until it is divided into neutral (N) and protection (PE) conductors. In the installation performed by the author was used the present grounding scheme.

## 2.2 Manaus City Electric Power System

The Electric Power System (SEP) “is a system that connects energy producers and energy consumers to suppress yours demands by transmitting that energy through transmission and distribution lines, raising and lowering voltage levels through of power substations and transformers” [7].

To delimit the subject, this article will focus on distribution, more specifically, by analyzing the Amazonas Energia Distribution Networks Procedures Manual [10], this manual aims to establish criteria and procedures for urban air distribution projects, highlighting the basic criteria for sizing, protection and installation pertinent to medium and low voltage networks.

In Item 8.1.1, it is stated that in the low voltage distribution network the neutral must be multi-grounded. This feature ensures quality grounding of the power supply. As previously seen, the neutral can be grounded or not in the power supply, however in Manaus city the neutral is multi-grounded, ensuring low resistance value, besides promoting equipotentialization of the System.

In Item 8.3, line 'a' we have the grounding requirement of neutral at every 200 meters, and according addendum of this manual [11], there is a prescription of the use of 3 to 9 rods of 5/8” with 2.4meters.

## 2.3 PEN Conductor

The use of multi-grounded neutral makes the TN-CS scheme very suitable for use. In item 5.1.2.2.4.2 of NBR 5410, sub-paragraph 'b' we have the recommendation to grounding of the protection conductor as many times is necessary, fulfilling the role of “multiple grounding” [4]. In the case under study the protection conductor is in conjunction with the neutral, so this recommendation also applies to it. In the following paragraph we have a requirement directed to the PEN conductor, which vetoes its use for electronic equipment interconnected or shared by signal lines based on metallic cables; also, is required equipotentialization with the building if it has another grounding system or if it has a lightning protection system[5]. Such requirement can be obtained in item 5.4.3.6 of the referred standard [4].

Another important requirement is found in 6.4.3.4.1 [4], which establishes the minimum section for PEN conductors, where for copper conductors is 10 mm<sup>2</sup> and for aluminum conductors is 16 mm<sup>2</sup>. For the dimensioning of the PEN conductor section we must use the later item, where there is a requirement that the conductor insulation be compatible with the maximum voltage it can withstand. Therefore, for the implementation of this article was not allowed a neutral conductor, which would become PEN, with smaller section than the required in norm.

The item 6.4.3.4.3 of this norm prohibits the connection of neutral and protection conductor after it has been separated, as can be seen in Figure 1. The following item emphasizes that this separation must be performed in distinct bars [4].

The use of the neutral conductor as a PEN conductor, in the absence of grounding in a low voltage electrical installation in Manaus has safe and protection, where according to the city's SEP has the multi-grounded neutral, fulfilling the normative requirements regarding the PEN conductor. Can be stated that the Neutral, in such condition, has resistance equivalent to that required by the PEN conductor in item 7.3.3 [4].

In line 'e' of item 5.1.2.2.4.2, we have the requirement of an overcurrent protection device (Thermomagnetic Circuit Breaker) and a differential-residual current protection device (Residual Differential Switch, IDR or DR). Regarding the DR, in sub-paragraph 'f' we have two hypotheses for its installation. In the first hypothesis (Note 1) we have the use of DR as a divider element, where the protection conductor passes outside the DR and the neutral conductor passes inside it. The splitting occurs by means of the DR, and after that, reconnection of separate conductors is not allowed, as has already been explained. In the second (Note 2) we have the PEN conductor as Neutral and the independent protection conductor, with resistance compatible to DR (similar to the TT scheme) [4].

In Annex G of the NBR 5410 [4], we have Figure G.1, which corresponds to the hypothetical equipotentialization of the TN and TT scheme. Figure 2 shows the image corresponding to the TN scheme.

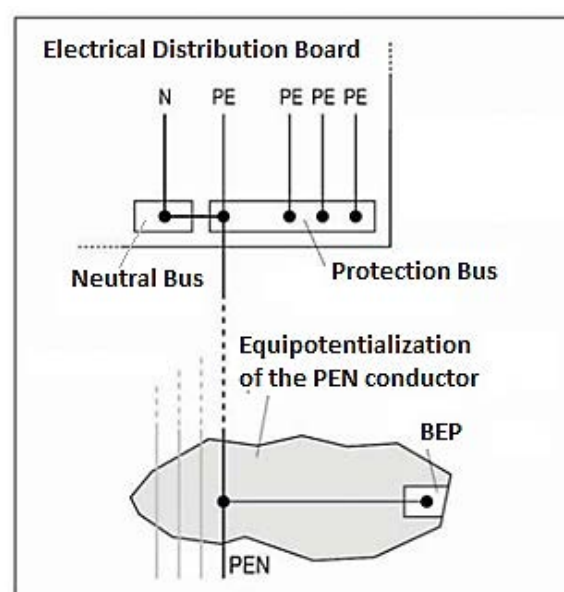


Figure 2. Hypothetical derivation of the PEN conductor.

Source: NBR 5410 - Annex G1 - Image G.1

## 2.4 Residual Differential Switch (IDR or DR)

In item 6.3.6.2 [4] there are parameters to be considered in the act of assimilating the DR with the Breaker. These parameters inform about the requirements of the IDR, where it must withstand overcurrent and short circuit current, especially in the absence of the circuit breaker. In summary, the rated current of the DR must be equal to or greater than the rated current of the upstream circuit breaker. Such observation ensures that the DR will not be damaged in the presence of a short circuit or overheating. Next you can observe the principle of internal operation of the DR.

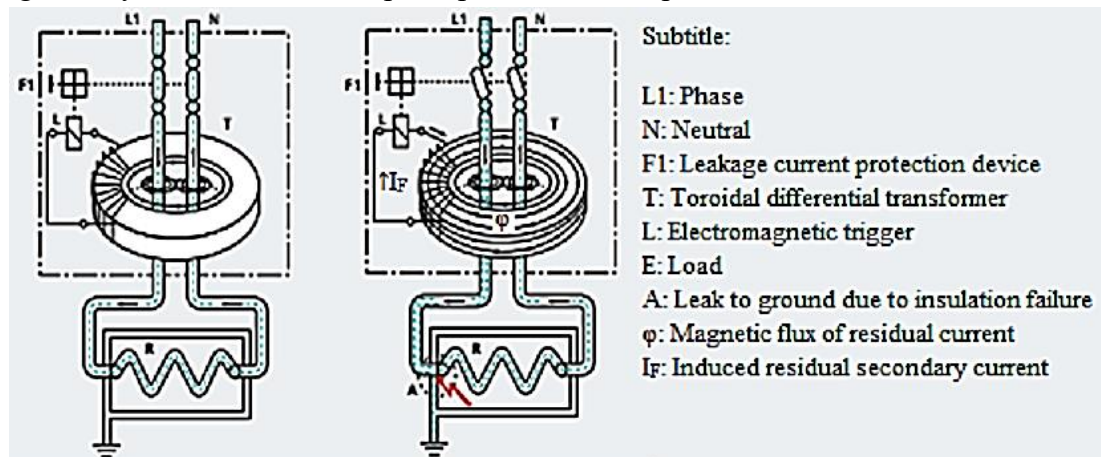


Figure 3. Internal Scheme of a Bipolar DR

Source: Siemens Catalog - DR Devices - 2017 - <[www.siemens.com.br/protecao](http://www.siemens.com.br/protecao)>

In Figure 3 it is possible to analyze the internal principle of the Residual Differential Breaker, where the rectangle written with dash and dot represents the IDR and the Resistor would represent the installed load. There are two inputs at the top: L1 and N, representing a phase and Neutral, standard inputs for a bipolar DR, below, we have an electromagnetic trigger that detects leakage current by magnetic induction principle.

The Faraday-Lenz law or electromagnetic induction law postulates that the variation of magnetic flux on a surface induces current in a conductor, which is called induced electromotive force. The reverse is also valid, this being the basic principle of the induction motor, where an alternating current applied to the stator, promotes the movement of the rotor. In the toroidal transformer, the principle resembles, where we have the electromagnetic trigger (L), which is activated when there is a variation of the flux in the ferromagnetic core toroid. [18]

Alternating electric current passes through the toroidal core, feeds the load and returns to the core; if the current that fed the load returns without deviation, it will have the same intensity and therefore we will not have magnetic induction; however, if there is a deviation in the current that is feeding the load, regardless of the direction, this deviation will induce a variable magnetic flux, which in turn will promote an electromagnetic flux in the winding coupled with the trigger, triggering the DR.

Since it is an alternating current, this principle should be understood as a vector sum, where it is approximately zero when there is no deviation; if a deviation occurs, the vector sum becomes nonzero. The amplitude of this difference is directly proportional to the induced current in the secondary winding that powers the trigger; The trigger has a set value from 30 mA (Human's minimum sensitivity to electric

shock).

As already stated in the standard, DR protects against direct and indirect shock, and is required to be used. In summary, the IDR is triggered in the following cases:

- Contact of the Phase or Neutral Downstream Conductor with the protection conductor;
- Contact of the Phase Downstream conductor with Neutral Upstream conductor;
- Contact of the Neutral Downstream conductor with Phase Upstream conductor;
- Contact of the Phase or Neutral Downstream Conductor with structure grounded in getaway.

The “structure grounded” can be either a grounded carcass, as well as a person or animal which is not isolated. It is notorious that the DR does not protect against shock of phase and neutral downstream, because the current flowing through the conductor returns by the other.

### **3. Methodology**

#### **3.1 Study site and hypothesis construction**

The implementation of this system took place through a service carried out through the company DL Reformas e Construções, where the author worked in the management of the reform under supervision of the Technical Responsible for the execution. The renovation was carried out in the Residential Condominium Manaus Park, located in the Nossa Senhora das Gracas neighborhood, in the municipality of Manaus-AM.

The building had a structural type Lightning Protection System (SPDA), so that the structures of the beams, pillars and counter beams all were grounded. The possibility of a structural grounding was considered, however, given that the apartment was on the 4th floor, the suggestion was ignored as this would result in a high resistance of grounded.

Given the impossibility of making a grounding system by rods, and the impossibility of connection of protection conductor in the bar of equipotentialization, it was thought of the implementation of the TN-C-S scheme through the method presented in this article.

#### **3.2 Study Overview**

There are many risks from lightning in a building [12]. Through NBR 5419: 2005 [5] it is possible to verify several requirements that seek to mitigate such risks. To this end, the author points out a series of procedures that ensure the viability of a structural grounding and by means of IEC 62305-4 he informs about the risks concerning electronic and electrical equipment. The most noticeable advantage in structural grounding is the possibility of equipotentialization, so it is possible to make this grounding in an apartment, however the apartment “(...) is not fully protected, neither against the unwanted effects of lightning on the structure, nor against damage to electronic equipment (...)” [12]. Regarding the application of grounding in a health facility, the normative prohibition on the use of the TNC scheme was found, where its use is criticized for being incompatible with the IDR and for not presenting safety for fault current, voltage harmonics and phase unbalance [13]. Such arguments are useful to distinguish the TNCS and TNC scheme, where the former allows the use of residual protection devices, thus depending on the location of its installation, will be protected against certain anomalies. Through ABRACOPEL's

statistical survey concerning the years 2015 and 2016, a study was conducted on the effect of not using a residual protection device, resulting in the significant number of deaths due to the pathophysiological effect of shock [14]. In addition to the statistics of this yearbook, the normative obligation regarding the use of DR was emphasized. It is noteworthy that the DR should not be used in the TNC system, since as the Neutral conductor and the protection conductor can be summed up in one, the reference point is equivalent between Neutral and Protection, therefore in the possibility of a current deviation the DR would not detect. However, given the mandatory use of DR, implementation in this article does not become expensive to use. As for the design of low voltage electrical installation for buildings, a study was conducted showing the importance of complying with standards [15], with the NBR 5410 as fundamental. It is also informed about the residual differential protection device and the electrical surge protection device, where its normative obligations are described and how they should be installed according to the standard.

Through the NBR 5410 was ratified the importance of normative observation, to ensure a standard in residential electrical installation and add safety [16]. The author seeks to describe the grounding systems and detail each protection device. This document has the peculiarity of not only stressing safety, but of establishing the importance of a standard in the installation, bringing the design focus to the standard requirements.

On the importance of safety in the exercise and application of electricity, the author proposes a bibliographic research [17], having as major contribution the distinction of the main changes of NR10 (2004) [6]. The relevance of this document applies to the purpose of the paper to propose a safe method for implementing the TN-C-S scheme.

#### **4. Analysis and Discussion of Results**

As already mentioned, this article aims to justify the proposal to implement a grounding system based on the TN-CS scheme, which is suitable for the city of Manaus.

One of the problems of the implementation of this scheme is the grounding quality of the Neutral, since as seen in Figure 1, the PEN conductor is grounded in the power supply, fulfilling the role of Neutral and Protection conductor, so its resistance must be such that meet as a protection conductor. Based on this, the Neutral conductor cannot simply be used as a PEN conductor because the required resistance of the neutral conductor is different from the resistance required for the Protection conductor.

To ensure system security, the Tetrapolar IDR was used immediately after the General Thermomagnetic Circuit Breaker. The connection between these and how the TNCS scheme was implemented can be seen in Figure 4:



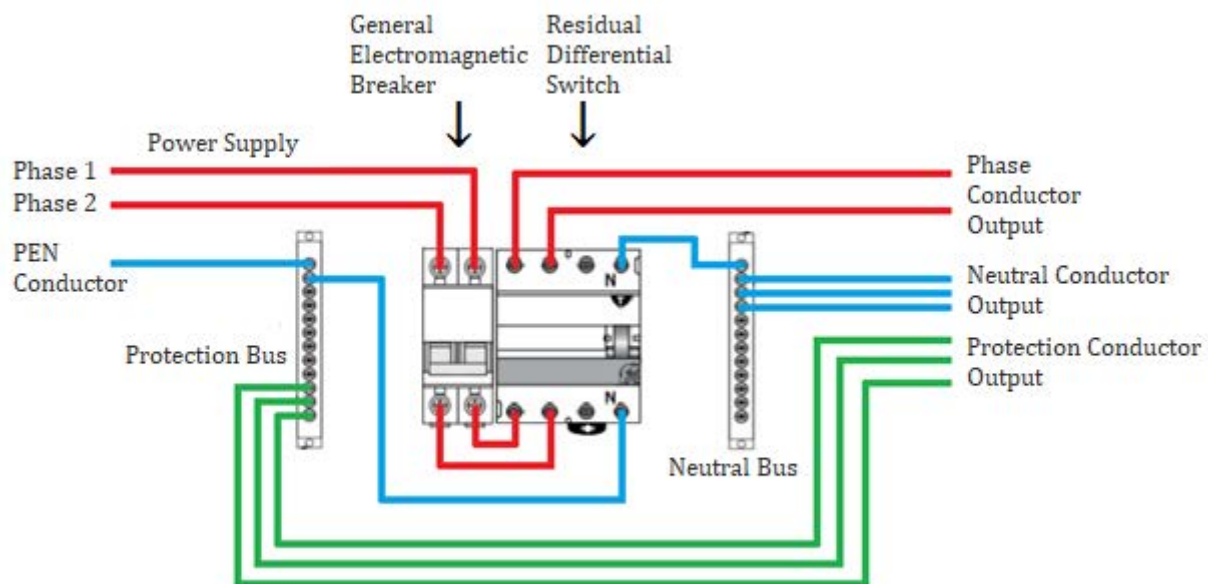


Figure 4. Breaker Arrangement and DR for TN-CS Schema Implementation

In Figure 4, we have the blue PEN conductor, denoting that it previously played the role of Neutral conductor. From this, the PEN conductor was connected directly to the Protection bus, fulfilling the requirement of NBR 5410 [4], where it says that such conductor should pass outside the DR, as previously described.

From the Protection Bus, the PEN conductor was directed to the input of DR. Such connection represents the branch point seen in figure 1, where the PEN conductor is divided into Neutral and Protection.

In the hypothetical situation of not using the DR, we would have a very serious problem, because the PEN conductor would be directed to the protection bus and then to the neutral. So, in the hypothetical situation of a PEN conductor break, we would not have a short circuit, and since the neutral and protection bus are connected, all grounded ground would be energized and could easily cause an electric shock to a person who not isolated.

Another problem that should be avoided is the grounding of neutral after the DR, this would cause the protection conductor and Neutral conductor to be associated again, making them similar to the PEN conductor at the input. The problem that occurs is the non-tripping of the DR in situation of contact of the phase and neutral upstream and downstream, or downstream and upstream, likewise with the contact of phase and protection conductor.

This error could result in the death of a person if they are not isolated when having direct or indirect contact with a charged conductor. therefore, this connection is prohibited.

Regarding the quality of the neutral conductor that would become the PEN conductor, the Manaus distribution system promotes the multi-grounded neutral, which is suitable for this implementation. The Neutral conductor section is an only limitation for this implementation and can make it costly as it should be at least 10 mm<sup>2</sup>.

## **5. Conclusion**

The present article addressed the method applied by the author to solve the demand for a protection conductor in a building that did not have it. To apply this method, it was necessary a normative technical support that guaranteed quality in service and customer satisfaction. In the search for this support, the idealization of this article was started.

Therefore, in addition to a method, it is possible to obtain from this article a normative mapping regarding the subject in question, where each statement was justified by norms and scientific principles.

The conclusion that the developed method meets the requirements required by norm, cooperated to validate the importance of this article for low voltage installations in Manaus.

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# Perspectives of Prospective Teachers on Zoom as a Transformative Teaching Methodology

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## Abstract

*In the Bachelor of Education (BEd) Programme at the University of Trinidad and Tobago, prospective teachers are exposed to 'zoom' classes. This study investigated the perspectives of full-time and part-time prospective teachers with regard to classes conducted via web conferencing, with particular reference to zoom. It examined students' views on the merits and demerits of the use of zoom by instructors. A mixed-method design was utilized as the appropriate design to determine prospective teachers' viewpoints and beliefs, as well as the advantages and disadvantages of classes conducted via zoom. Data were gathered using an online survey, semi-structured interviews with focus groups and reflective posts on Canvas. Data analysis included a combination of quantitative and qualitative approaches. The results indicated that most prospective teachers prefer a combination of zoom and face-to-face classes, while some have a preference for face-to-face classes only. Others desire face-to-face classes together with an integration of different aspects of technology. Some participants lamented about their personal levels of proficiency with web conferencing. The merits and demerits were equitable, based on the maturity of the prospective teachers when the opinions of full-time and part-time students were considered. The conclusions were that zoom classes were satisfying for some prospective teachers whereas others perceived them as convenient and 'a line of least resistance'. The findings have implications for the quality of classes conducted solely via 'zoom' on a consistent basis.*

**Keywords:** prospective teachers, perspectives, zoom, mixed-method

## Introduction

Exploration of the task of preparation of teachers remains high on the agenda of educational researchers mainly because those involved in the process are always seeking new ways and means to improve the teaching/learning process. They continuously seek answers to challenges presented in the implementation of teacher education programmes.

Teacher Education continues to undergo transformation in countries all over the world and Trinidad and Tobago is no exception. The University of Trinidad and Tobago (UTT) plays a significant role in the implementation of a BEd programme which is designed to equip candidates with the necessary knowledge, skills and attitudes to become teachers in the education system. This course of study is provided at three campuses in the Centre for Education programmes (CEP), two of which are located in Trinidad and one in Tobago. The programme is offered on both a part time and full time basis in Trinidad and part time in Tobago. This study was conducted with both full time and part time students at both campuses in Trinidad.

Menter (2017) underscores the value of teacher research as the conduit through which teachers are able to channel information to other teachers and researchers about their experiences and life in the classroom which seem to become more complex with every generation.

## **Context**

From inception UTT implemented face-to-face teaching methods in the CEP, but there has been a shift in 2018-2019 to “leverage digital technologies” (UTT: Our National University, Moving Forward, p.2) into online learning, more particularly zoom and blended learning. As enunciated in this document, the emphasis of the UTT is on research and development, for the purpose of providing solutions to the challenges in our education system. To achieve this goal, UTT is determined to carry out its responsibility to deliver world-class teaching, learning and pedagogical competencies to students.

With this vision, each programme area within the UTT has been advised to utilize technologies such as web-conferencing and blended learning. Following this directive, the CEP has encouraged faculty to integrate technology in the implementation of their respective courses.

Guided by this directive and in keeping with modern trends, classes are scheduled in face-to-face sessions as well as online learning via Zoom and the Canvas platform. But, such implementation is not without impediments for both students and faculty. One also has to keep in mind that simply changing teaching strategies to improve academic learning could be challenging as there will always be resistance to change (Fullan, 2007), by those who prefer to remain in their comfort zone.

## **Purpose of the Study**

The purpose of the study was to examine the perspectives of prospective teachers regarding instructors' use of zoom as a medium for teaching. It explored their beliefs about the advantages and disadvantages to them. It also investigated their practical knowledge of the meaningfulness of classes conducted via zoom, as opposed to face- to-face classes.

## **Significance of the Study**

This study fills gaps in the research with regard to web conferencing and zoom in particular. It serves to generate feedback data to inform programme improvement at the University of Trinidad and Tobago, as

well as illuminate other educational institutions concerned with teacher education. It provides information that can guide national policies, and contributes to the literature locally and internationally.

## **Research Literature**

### **The Impact of technology**

Changing the landscape in any sphere of education suggests changes in environmental and social structures. Gumpert and Chun (1999) suggest that the impact of technology on the life of those engaged in academia is so overwhelming that it is necessary to reflect on the dynamic changes in the mode of teaching and learning. It is also important to consider the overall impact of technology on the wider society.

Cloete (2017) reflects on the use of technology in education, particularly the impact of online learning including the strategy of blended learning. She notes that the impact of technology in education is not linear, but as much as it presents various opportunities, it also poses several challenges and “differs from context to context” (p. 1). A major problem is that infusing technology in education goes way beyond its use as a tool for learning because of its role in reshaping culture and its link to social development. For this reason, continuous reflection is recommended throughout implementation if change is to be meaningful. Personnel must be empowered with the requisite skills. Cloete (2017) notes that, “skills are as important as hardware” (p. 1), while Beetham & Sharpe (2007) affirm a new pedagogy to meet the needs of the digital age.

According to Verene, (2013), “Online education lacks the rhetorical presentation of a face-to-face lecture. Instead, online education reduces students to clients and consumers of information that is available worldwide and decontextualizes content to information that assumes one size fits all” (p. 303). In his argument, Verene (2013) stresses the importance of the presence of the teacher in the classroom and perceives teacher absence as a negative factor in any form of distance education. He is not passionate about online learning, as he believes the whole process of online learning reduces education in its true form to educational management. Contrary to his belief is the view of other researchers, such as Wang (2013), who report on the success of the mastery of skills via video conferencing technology (Alnemary, Wallace, Symon, & Barry 2015). Given the pros and cons of online learning, implementation of its use in teacher preparation may be precarious, but given the global advancements, it is inevitable.

Gleason & Greenhow (2017) in their research with robot-mediated communication (RMC) found that RCM “offers several advantages over traditionally used videoconferencing systems” (p. 173). Barkely, Cross & Major (2014), and Scott (2015), share alternative views on impact online learning. Like Verene (2013), Gleason & Greenhow (2017) emphasize the absence of the real presence of students as a factor that impedes learning. They believe that the mere virtual social presence of students has negative effects on students’ engagement in learning and ultimately on their academic achievement.

However, Bransford, Brown, & Cocking (2000) emphasize the potential of technology to help learning, but only when used properly. They discuss video use in the classroom and the importance of interactivity in helping students to learn by being able to re-visit and review the material. With regard to students’

preferential mode of learning using technology, De Boer (2013) argues that that many students choose distance mode over face-to-face because of flexibility around work and family commitments.

### **Prospective Teachers**

The prospective teachers who pursue the BEd programme at the UTT are generally considered as the younger generation who are literally growing up in a digital world. They seem to be consumed by the technology provided by the internet. Prensky (2001) refers to today's student population as "digital natives" because they were born in the internet era and seem to have developed a synergistic relationship with the internet.

These postulations concerning students presume that they are intrinsically motivated enough to study on their own and in their own time. There is also the assumption that face-to-face learning and online education are indistinguishable when compared. In a study, Verene (2013) found that, "The guiding principle is that anything that can be accomplished in the traditional classroom can be done electronically" (p. 297). But, he argues that information could be stored via technology, but construction of knowledge and especially a lecture, cannot be replicated online.

### **Research Questions**

1. What are prospective teachers' perspectives with classes conducted via zoom web conferencing?
2. What are the beliefs of prospective teachers on the merits and demerits of the use of zoom as a mechanism for teaching?
3. What are prospective teachers' practical knowledge of classes conducted via zoom?

### **Participants**

Purposive sampling was used to select the participants in the study. They comprised prospective teachers in two full-time and two part-time classes of the Year Two cohort, at the University of Trinidad and Tobago. The sample consisted of ninety-six (96) participants who belong to two different campuses, but data were received from eighty nine (89) individuals. There was a significantly higher number of females than males, as more females are registered for the programme. Their ages also varied significantly as the prospective teachers who attend part-time classes are generally more mature than those attending full-time.

### **Data Collection Procedures**

A mixed method approach was considered appropriate to determine the views, perspectives and practical knowledge of prospective teachers. An amalgamation of quantitative and qualitative data gives a more robust account and more in-depth, richer understanding of the issues addressed in the research (Johnson & Onwuegbuzie, 2004). It affords corroboration and clarification, thus making findings more authentic. An on-line survey, with both open and closed ended questions, was conducted to collect statistical data, which were computed for confirmation of information. Creswell (2015) notes that surveys can be administered to a sample or an entire population of people in order to ascertain and determine the characteristics, opinions, attitudes or behaviours of the population. Details gathered from semi-structured

interviews with both individuals and focus groups served to authenticate the particulars (Cohen, Manion, & Morrison, 2007) and maintain the direction of the study. Reflective writings further verified the data, which added to the credibility of the research.

Focus groups interviews were conducted on both campuses with twelve groups, some of which were larger than others, as the sizes of classes varied. The aim was to acquire intimate information on prospective teachers' perspectives, beliefs and practical knowledge in an open and a non-threatening environment. Interviews were audio recorded, with the consent of participants. The information was transcribed verbatim, and transcripts were returned to group leaders who liaised with peers of the respective focus groups to verify the accuracy of data. Meetings were also held with the group leaders for consultation and further verification of data. Prospective teachers participated voluntarily and were assured of anonymity and confidentiality as advised by Miles, Huberman & Saldana (2014). Participants voluntarily posted their reflections online on Canvas or sent them via emails. The different methods of data collection procedures facilitated triangulation as well as established authenticity.

### Analysis of Data

Quantitative data were collated and analysed using descriptive statistics to formulate a summation of the information. The qualitative data, which were read reiteratively for depth of meaning, confirmed and substantiated the statistical data with the further elaborations, thereby establishing credibility and deeper understanding. Using Creswell's (2012) process for data analysis, codes and categories were constructed and reconstructed, eliminating redundancies and searching for commonalities, outliers and new insights. Themes emerged and congruent verbatim remarks were identified.

### Findings

The data revealed that one hundred percent (100%) of the prospective teachers are au courant with the fact that the University of Trinidad and Tobago is shifting into technological techniques, especially with the use of Zoom as a medium for teaching. But, even though prospective teachers are cognizant of this, seventy-three percent (73%) prefer face-to face instruction while forty-two percent (42%) prefer only zoom classes. However, ninety-two percent (92%) indicated that their preferred mode of instruction is blended learning, which includes both zoom and face-to-face learning. The data, as outlined in the Table 1 below, has implications for the mode of teaching and learning adopted by the university.

**Table 1: Prospective Teachers' Perspectives about Zoom**

<b>Perspectives</b>	<b>Percentage (100%)</b>
Need for technological competence in the 21 <sup>st</sup> Century	100
Preference for zoom as a medium for teaching and learning	42
Preference for face to face teaching	73
Preference for a blended approach	92



### Advantages

All participants (89) found that zoom conferencing is convenient for them while (68) persons found it cheap and accessible. Seventy-eight (78) of them found it flexible and allowed for embarking on a personalized learning journey. Sixty-three (63) persons said that zoom allowed them to function in their homes, a comfortable learning environment. Eighty-two (82) individuals were happy about the availability of recordings, which they were able to view at their convenience. Fifty-seven (57) of the prospective teachers indicated that independent learning was facilitated (Table 2).

**Table 2: Advantages of Zoom Identified by Prospective Teachers**

Advantages	No of Participants (89)
Convenient	89
Cheap and Accessible	68
Flexible for a personalized learning journey.	78
Comfortable Learning Environment	63
Availability of Recordings	82
Independent Learning Facilitated	57

Excerpts from direct quotes, which demonstrate the advantages of the use of zoom for prospective teachers, are outlined below.

- 1. It is convenient and flexible for me . . . can connect with a guest speaker from anywhere in the world to contribute to discussions.*
- 2. I greatly appreciate the fact that the work is online and hence it is very convenient.*
- 3. As online conferencing sessions can be recorded for future reviews, I can replay the recordings to make notes.*
- 4. I can access zoom from anywhere to my comfort. It took the stress off me . . . since I attended class from the comfort of my home.*
- 5. I can access the information anytime . . . it is readily available for me online.*
- 6. I benefited from a comfortable environment in the safety of my home . . . I was able to concentrate without any distractions and saved on transport.*

### Disadvantages

As shown in Table 3 below, sixty- nine (69) participants found that there was limited monitoring of student particularly when classes were large, while forty-one (41) individuals believed that there is a tendency to procrastinate as recordings are always available. This implies that a high level of self-discipline is required. Fifty-four (54) prospective teachers outlined that there is more or less an absence of informal cues such as body language, facial expressions and the affective/humane aspect. This suggests that instructors are unable to effectively gauge participants' understanding. In addition, thirty-six (36) maintained that misunderstandings are not readily clarified since many students are reluctant to ask questions during zoom sessions. Seventy-five (75) individuals lamented that there is a lack of social skills

as well as difficulty with peer and group activity. Sixty-three (63) participants bemoaned that they are constrained by unstable internet connection.

**Table 3: Disadvantages of Zoom Identified by Prospective Teachers**

Disadvantages	No of Participants (89)
Limited monitoring of students (large classes)	69
Procrastination	41
Absence of informal cues (body language, facial expressions, affective/humane aspect)	54
Misunderstandings are not readily clarified	36
Lack of social skills & difficulty with peer and group activity	75
Unstable internet connection	63

Below are some literal comments, which prospective teachers identified as the disadvantages of the use of zoom.

1. *It was not a very fulfilling experience for me . . . I felt that the online classes really took away from the impact of the lesson . . . relationships became strained.*
2. *I may not be able to get immediate feedback from our lecturer if we do not understand a point and need clarification.*
3. *For me zoom is more teacher-centred. The teacher acts as a sage on the stage, rather than have the students participating.*
4. *Videoconferencing is lacking the aspect of personal interaction with students . . . I do not feel comfortable to ask questions.*
5. *I don't get to work in groups which always give me a little more confidence. . . . group work is very rewarding.*
6. *Instructors do not have the opportunity to read students' body language and facial expressions of whether they are interested and understanding, what is being taught.*

The verbatim statements authenticate the data in Table 2 and 3. They serve to corroborate the statistical data as well as establish credibility (Creswell, 2012). Also, the integrative method allowed for confirmation of the truthfulness and accuracy of the data. Collaboratively, the data facilitated a clearer understanding and enabled new insights. In addition, the capacity for a more robust analysis of data was amplified.

### Themes that Emerged

Four themes that emanated from the data are as follows: 1. *Combinatorial Hybrid Approach* 2. *Proficiency not Product* 3. *Flexible Learning Pathway* 4. *Internet Connectivity and Instability*. Participants indicated that there are merits as well as demerits to instruction conducted through zoom. The data revealed that the majority of prospective teachers prefer a combination of zoom and face-to-face

classes. Prospective teachers prefer social interaction, proficiency, meaningful understanding, which can be facilitated better via a hybrid, blended approach. While they appreciate flexibility in learning experiences via zoom, they experienced challenges, particularly unstable internet connectivity. The verbatim remarks which substantiate, support and reflect the themes, are outlined below.

### **Theme 1: Combinatorial Hybrid Approach**

- 1. I prefer a combination of online classes and classes conducted via zoom. Having a combination allows the instructor to meet with the students and clear up any misconceptions they may have about assignments and content . . . Classes via zoom can be used to reinforce content and to have extra materials that students need to study . . . Whereas being present in class, they retain more.*
- 2. My choice remains that of a blended teaching and learning approach. My reasons for this approach are the teaching landscape is rapidly changing due to the technological rise of the 21st century and traditional face-to-face sessions provides more collaboration, and instant feedback.*
- 3. These real-time conversations in class with lecturers help deepen understanding of course content and bridge the gap between experiential learning and real world applications. Zoom is a good platform for learning . . . but when they are blended, learning is more appealing . . . I like both together.*
- 4. I must mention that I support a blended approach as I do personally experience the benefits of both traditional face-to-face and online sessions.*
- 5. Students are able to work alongside each other in face-to-face classes through group work or other activities, which aid in developing social skills as well as being able to learn from each other. This may be much easier to explain certain things in person but zoom also aids in learning.*
- 6. I prefer face-to-face class together with zoom sessions . . . the social interaction concept is diminished or eradicated in the online sessions. The online classes are great since they can be accessed 24/7, and they are necessary.*

### **Theme 2: Proficiency not Product**

- 1. I prefer to attend my class, gain meaningful understanding, converse with my peers and the teacher, ask any questions . . . get feedback right away, and be able to work in groups and build my social and communication skill . . . in a student-centred class . . . constructivism . . . no amount of zoom classes can replace a teacher teaching in front of a class.*
- 2. The face-to-face preference I have is simply because of the authenticity in delivering a class in person . . . Stemming from my own experiences, students are better prepared for the world in face to face classes, as there is the reality in the classroom with the students, interactions and authority.*
- 3. I do prefer face-to-face classes because it is what I am more comfortable with and it is easier to communicate with peers and the lecturer. It is also easier for me to learn and understand . . . face*

*to face learning is more effective and efficient for my learning style.*

4. *Face-to-face classes boost collaboration and creativity through the ability to share ideas more freely. Meeting in person helps you detect body language, feelings, tone, and reactions, which can often be misinterpreted through digital means . . . students can engage in free and open discussions with their peers as well as the teacher for feedback. Teachers can also engage students in physical resources for them to manipulate.*
5. *I enjoy face-to-face classes because I learn better from someone in person. This way consists of more hands-on activities and more strategies, which keep me engaged in the lesson. Physically seeing the lecturer keeps me focused . . . and interaction with my peers deepens my understanding.*
6. *I would rather have classes that are conducted via face to face because I am able to focus more on what is being taught as there are fewer distractions available. It also allows questions or concerns that I may have, to be addressed immediately. Activities can be conducted more effectively and efficiently in a face-to-face classroom setting which promotes social interaction and engagement. This makes the lessons and concepts more meaningful, in my opinion, as I would be more likely to remember what I would have learned.*

### **Theme 3: Flexible Learning Pathway**

1. *These forums facilitate convenience and flexibility as recordings were always accessible and allowed me to plan my day and study time, without having to leave home, as opposed to being obliged to sit in a classroom.*
2. *It was convenient for me whereby I did not have to drive to get to classes. Zoom was easily accessible, once I had internet, I could either use my laptop or my phone to log on.*
3. *Zoom allows me to access the information anywhere and anytime at my convenience. It saves me time and money, as transportation fees are very costly.*
4. *Zoom allows for any inconvenience that may arise. It can be used in the comfort of my home.*
5. *The technologies are very interactive, useful and convenient. It allows for a level of comfort and I can view the lecture in my own time.*
6. *It creates an opportunity for me to access information easily and I can study and learn at my own pace. I believe zoom is convenient and easy to use.*

### **Theme 4: Internet Connectivity and Instability**

1. *I feel frustrated with technical difficulty . . . It does not lock in my attention.*
2. *Sometimes the wifi signal drops and I am unable to access my zoom classes.*
3. *When the internet connection is not good, there is distortion and information is not being heard clearly. It is also distracting . . . also timing is a problem.*
4. *When my internet is not working, I can't access anything and when I have questions about the content, I cannot receive feedback immediately.*
5. *It is an obstacle when the internet is down, as I procrastinate and do not find the time to view recorded sessions.*

6. *I face the problem of having internet disruptions, which cause me serious distress.*

## Discussion

The data revealed that zoom allows for teaching to be accessible from different localities, which are comfortable and convenient to prospective teachers. There are also merits and demerits to the use of online conferencing. Most prospective teachers have indicated a preference for blended learning, that is, a hybrid model of face-to face and zoom classes. But the culture of teaching and learning that prospective teachers experienced previously influences why many have a proclivity toward face-to-face classes. Other factors may be attributed to the level of difficulty of the course or the quality of interest in the subject matter. A major contributing factor is the proficiency of the instructor and whether he or she is creative, motivating and inspiring.

One of the most salient requirements for effective zoom sessions is a stable and reliable internet connection. Many participants indicated that they experienced unstable internet connectivity which led to their frustration. This influenced a preference for face-to-face classes. In addition, instructors as well as prospective teachers need technological skills and competencies to navigate the multiple features of zoom efficiently. There were deficiencies as many features such as creating and managing break-out rooms, which could optimize learning, were not used by instructors. Participants complained that they had not received maximum benefits and experiences of the virtual meetings. This impacted on their preference for face-to-face classes.

On another note, prospective teachers who are registered as part-time students, are usually mature persons, some of whom are working parents. They would be predisposed towards zoom or online learning due to time constraints and family commitments. For them, zoom sessions are also cost effective and allow for flexibility as recordings are available at their convenience. However, while recordings may be more suitable for some individuals, there is the drawback of a lack of participation, and the complaint that feedback is untimely.

Self-learning may be a sensitive issue, particularly with the millennials of today, as procrastination is likely to result. A challenge for prospective teachers, therefore, is that of responsibility, self-discipline and self-regulation. With zoom, the onus is on prospective teachers to participate fully, or mute/unmute their videos and audios during conferencing. Therefore, a major concern is self-discipline to sustain engagement throughout sessions. Also, there is also the issue of wise choices and self-reliance because of temptation of other websites such as Facebook, Instagram, as well as other distractions on mobile phones. In addition, while assessments give an indication of academic success, compliance together with engagement time and meaningful contextual learning with zoom seem unpredictable. Furthermore, there are limitations via zoom for the portrayal of social presence and personal dispositions, which may negatively impact self-esteem and self-efficacy as well as the academic performance of prospective teachers.

As web conferencing with zoom is a fairly new phenomenon for teaching and learning at the university, encouraging both prospective teachers and instructors to buy into change may be an issue. Fullan (2007) acknowledges that resistance is always associated with innovation and change. Also, time may be a critical factor in terms of readiness, preparation, planning and organization. Instructors must therefore

adopt a reflective approach as well as receive frequent feedback from prospective teachers if transformation is to be facilitated. Unique individualistic concerns also need to be addressed. How to adapt teaching through zoom to meet the needs of all learners, to differentiate instruction, to engage in hands-on learning are other considerations. A question that arises is whether web conferencing constrains or boosts creative thinking, one of the twenty-first century skills, for both prospective teachers and instructors.

## Conclusion

Face-to-face classes combined with zoom sessions are more favourable for prospective teachers. However, the learning environment created through zoom must be facilitated by reliable high speed internet, as well as a high degree of proficiency not only by instructors, but also by prospective teachers.

## Recommendations

Zoom has many features, but professional training is required to develop the skills and competencies for both prospective teachers and instructors. Therefore, workshops and tutorials need to be conducted with prospective teachers at inception at the university. In fact, ongoing support is required to develop capacity, which is necessary for effectiveness, efficiency and optimization of learning.

In addition, practical staff development sessions are required for instructors, so that there is skilful use of all features, as the effective use of zoom comes through practice not only for prospective teachers but also for instructors. If instructor knowledge is minimal, there will be limitations to the use of zoom and its operatives. Moreover, when classes are huge, there should be support by technical staff during the sessions. In addition, an evaluation on whether the logistics of zoom can cater for all courses, such as practicals in a laboratory for the hard sciences, is recommended. Using zoom makes online teaching and learning interactive and collaborative for the younger generation who are comfortable with emerging technologies, but proficiency and expertise are required if a hybrid approach is to be sustainable.

## Future Research

There is need for future research such as instructors' perspectives on the use of zoom. It will be useful to investigate the preferences of part-time and full-time students as well as make a comparison between the technological competencies of part-time and full-time prospective teachers. In addition, many institutions are shifting into teaching and learning through robot-mediated communication (RBC), hence an examination into its viability may prove interesting.

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# Human Resource Dynamics and Total Quality Management Achievement in Technical Institutions in Kenya

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## Abstract

*Total quality management in Japanese industrialization can be realized through human resource in Technical training in Kenya. The purpose of the study was to evaluate the influence of human resource dynamics on the achievement of total quality management in technical institution trainings Kenya. Resource Dynamics and total quality management theory guided the study through mixed methodology approach and concurrent triangulation design. From a population of 1664 respondents, 499 (70.14%) participated where 16(30%) were principals and 31(30%) student were purposively sampled. 76(30%) Heads of Departments and 374(30%) lecturers were randomly sampled. Interrogation was through questionnaires, interview guides. Piloting of instruments using Cronbach alpha scale tested on Validity and credibility. Qualitative data was analyzed thematically and quantitative data using Statistical Package for Social Sciences. Human resource influences total quality management at 56% and the study recommend improvement on staff motivation in all Technical Training Institutions in Kenya.*

**Key words:** Total, quality, Human Resource, Influence and achievement.

## Introduction

Transition from secondary education to the tertiary education and training has been met with high expectations from many Countries in Africa and other developing Countries. Majority of the youth have not been absorbed into skill-based institutions implying that supply of human resource from these institutions have remained low indicating that, only a small proportion of Kenyan population have been benefiting from these institutions. Human resource leaving technical institutions should portray unique characteristics of quality that meets market demands and beyond. Member countries of the United Nations are committed to quality and equitable provision of education (World Education Forum, 2015) under the Sustainable development goals agenda and Vision 2030. However, the Global Monitoring Report on Education for All (UNESCO, 2007) shows a global enrolment of over 512 million students in secondary schools by 2005 with only 10% joining post-secondary TVET programs. These population have risen gradually and by the end of 2014, enrolment in TVET institutions was over 207 (51%) million globally. Over 7 (41%) million were from Sub Sahara Africa (UNESCO, 2016). Implementation of TQM has been undertaken as a stop gap measure of tapping the high percentage of the youthful generation into skill-based training.



## Statement of the problem

Total quality management has been cherished in Japan, United Kingdom and the United States of America through human resource commitment to quality. This has not been the case in TVET institutions an Industry capable of training workers in the Kenya industrial sector. The dynamics employed on human resource in TTIs is relatively unsatisfactory. An unstable human resource due to poorly handled dynamics on workers can slowly lead to poor role modeling among the workforce leaving TVET institutions. This encouraged an evaluation study on the influence of human resource dynamics I TTIs in Kenya.

## The Concept of Human Resource and Total Quality Management

Services given by workers in firms and institution of learning can be regarded as a precious resource to its growth and development making workers an intangible resource felt at or seen at the end. The dynamics of activating human beings to make them resourceful and useful service providers is a key concern in management. Managers require active and supportive teams of employees in order to realize their production potential. Revathi (2015) observe that, satisfaction of employees enhances their loyalty to the customer much better in those firms that have embraced TQM. Total quality management procedures are implemented by the human resource who eventually determines the degree of influence in an institution.

The employees are more satisfied when they interact and learn from colleagues in other institutions during benchmarking. Revathi citing Yusof and Aspinwall (2000) point that, satisfaction of the human resource creates a culture of teamwork, desire for continuous learning and improvement that finally brings success to the firm. The dynamics of staff training and retraining of workers helps in updating their skills on emerging trends and activates towards the delivery of training curriculum. Zakuan, Zamari, Muniandy, Sulman, Shoki, and Zaidin, (2012), explain that, training boosts employees' efforts towards improvement and performance. Employees in TTIs require quality training in order to meet and exceed the desired customer expectations. Training on quality standards is a crucial requirement on the success of TQM (Jamali, Ebrahimi and Abbaszadeh, 2010). The dynamics of staff recruitment and employment can determine the nature of efficiency and return this investment.

The characteristics of teaching staff, gender balance and age structure and retirement contracts basis have greatly influenced management issues in higher education in Tanzania. This has promoted retention of trainers as pointed in the Education Sector Report (Republic of Tanzania, 2013) in Tanzania. In the same vein, the number of pupils under one teacher determines the efficiency and end results of training (World Data Atlas, 2017). This student- teacher ratio is a good measure of working conditions which influences the achievement of TQM in an institution. Tanzania has a teacher to student ratio of 26:1 as compared with OECD countries at 15:1(UNESCO-BREDA, 2009) and developed countries recording as high as 3:1 of Critical Success Factors. By 2012, Kenya had a ratio of 41:1 at secondary level, 56.6:1 for primary and an adult literacy of 78.02% by 2015 (World Data Atlas, 2017). This data shows high numbers is under one teacher in Kenya which could be more stressing and likely fail to satisfy the employee or the learner. High levels of teacher to student contact can be perceived to produce more competent employees.

Wanderi (2015) explain that, employee training focusing on quality management determines the effectiveness of an organization's quality management initiatives. Employees thus need to understand their role towards the achievement of TQM during its implementation stages. Two elements must be born in mind when training employees on quality. Knowledge and understanding of the quality management process together with understanding of the quality management tools (Omware, 2012) must be factored during the implementation of TQM. These elements should be conceptualized at the initial stages of TQM implementation through the support of managers or the leadership of the institution. Leaders who appraise their employees through feedback system progressively motivate them towards greater achievement. Appraisal of workers based on their output, period of stay, contributions and participation in the overall development creates a dynamic lifestyle in an institution. Leaders, who organize award ceremonies, offer presents and recommendations, boost the participants towards individual as well as institutional achievements. This is a way of creating a favorable learning and training environment in a school (Mutua, 2016). Provision of adequate teaching and learning resources makes the teachers' job satisfying and drives them towards achieving the desired goal.

### **Theories of TQM and Resource Dynamics**

The study was guided by Crosby theory of TQM (Bowen, 2013) which advances at correcting errors which may affect the success in the management process. Errors require corrections through continual improvement which encourages the performance of tasks by the workers. Identification of errors in the management by the leader and correction can be achieved through motivation of the human resource. The resource dynamics theory by Zimmerman (Agarwal, 2015) guided the study in accomplishing training needs to students and their trainers through satisfying their demands and those of the society. The guiding principle in the resource theory is the functionality of a resource to the users' satisfaction.

### **Research Methodology**

The study was conducted through mixed methodology approach which combines quantitative and qualitative research techniques of collecting and analyzing data. Results were merged during discussions in order to arrive at the final conclusions and recommendations. Concurrent triangulation design was used during data collection, analysis and interpretations. The study population included 52 principals, 260 Heads of Departments, 1300 lecturers, 52 trainees from TTIs that are over 10 years in operation. These institutions have deeper experience in handling resources and can offer substantial information in TQM studies. In this study, 30% of the participants from each category were sampled to come up with a sample for the study. Data was analyzed as per objectives. Regression Analysis (Creswell, 2014) method was used to analyze quantitative data. Qualitative data collected through interviews and open-ended items was analyzed according to themes and triangulated with quantitative data during discussions. Nigatu (2009) point that, qualitative data collected according to themes can be grouped and summarized for interpretation.

### **Results and Discussions**

The main objective of the study was to assess the influence of the human resource management on the achievement of TQM in TTIs in Kenya. Five aspects of human resources management and their influence on TQM were interrogated in the study. The five aspects were: motivation of workers, staff training and retraining, teamwork work, giving incentives and performance of trainees. Student leaders were sampled to participate in the study in order to convey the views of their colleagues as consumers of services procured by the management of the institution. These findings were analyzed using SPSS software and the results were presented on Table 1.

**Table 1: Motivation and the Achievement of TQM**

Statement	Type of Response	f	%
Indicate the level of motivating staff on the achievement of TQM in your institution	Below average (1)	40	11.4
	Average (2)	59	16.9
	Neutral (3)	143	40.9
	Above average (4)	87	24.9
	Excellent (5)	21	6.0
	<b>Total</b>	<b>350</b>	<b>100.0</b>

**Source: Field Data (2018)**

Table 1 shows that, 143 (40.9%) were neutral, 99 (28.3%) negative and 98 (30.9%) positive. These results are agreeing with Pal (2005) that, lack of proper motivation leads to poor performance in an institution. This rating was a negative showing low influence of motivation on the achievement of total quality management. Studies conducted by OECD (2009) points on the appraisal of employees in an institution.

**Table 2: Training and the achievement of TQM**

Statement	Type of Response	f	%
Indicate the Level of influence of staff training/retraining on the achievement of TQM	Below average (1)	45	12.9
	Average (2)	49	14.0
	Neutral (3)	156	44.6
	Above average (4)	93	26.6
	Excellent (5)	7	2.0
	<b>Total</b>	<b>350</b>	<b>100.0</b>

**Source: Field Data, (2018)**

Table 2 shows that, 156 (44.6%) were neutral, 94 (26.9%) negative and 100 (28.6%) positive. These results imply that, training and retraining of the human resource is low. These findings differ with Zakuan et al (2012) that, training boost employee effort towards improvement and performance. Training and retraining of employees promote the updating of knowledge and skill development on the trainer thus building confidence in the performance of duty.

This would imply that there is need to invest more on training and retraining in order to achieve the requirements of quality in the institutional management of technical training institutions. These study

findings are in line with Zang *et al* (2000) that, investment on training has not been well implemented in technical training institutions. A well-trained workforce should offer quality service which should eventually influence the achievement of TQM in an institution. The results agree with Zabadi (2013) that, TTIs should give employees full potential to develop their potential under TQM. The employees gradually develop a sense of quality work and results. The study shows a normal distribution of responses of explaining that training and training of the human resource influences the achievement of total quality management in technical training institutions. However, there was a high frequency of participants with a neutral view that training and retraining influences total quality management.

The aim of a technical training institution should be to impart knowledge and skills within programmed schedule under a supervised curriculum. Trainees should be assessed and performance scores given as a measure of what level one attains after completion of that course. Lecturers offer services of training and would expect to be motivated by the results of their work. Other members in the institution who participated during the training process would also like to be associated with good performance of their trainees. The study interrogated on the influence of human resource dynamics on academic performance. The main aim of training is to provide new knowledge which is measured in terms of performance of the trainee. The observations made on results of performance after trainees sit for national examinations were analyzed using the SPSS version 23.0. and the results are presented on Table 3.

**Table 3: Academics Performance**

Required Data	Score	f	%
Academic performance for 2017	30-40	26	7.4
	40-50	39	11.1
	50-60	140	40.0
	60-70	127	36.3
	70-100	18	5.1
<b>Mean=3.18 SD=0.936</b>	<b>Total</b>	<b>350</b>	<b>100.0</b>

**Source; Field Data, (2018)**

Table 3 shows that, 140 (40%) of sampled participants had a score of 50-60% which could be viewed as neutral level. This would imply that, the influence of academic performance on TQM indicating that more work needs to be done to influence the quality of performance. Table 3 also shows that a total of 65 (18.5%) participants rated at 50% and below indicating that the sampled participants scored low performance in academic work and thus negatively influence the achievement of total quality management in the institution. This low performance can be compared with low levels of training and retraining of staff which eventually influences the achievement of TQM negatively. These study findings indicate that, performance scores of 60 and above were positive which supported the idea that, academic performance has been influencing the achievement of TQM in some of the sampled technical training institutions. These findings are in agreement with Zakuan *et al* (2012) that, good performance highly influences the achievement of total quality management in technical training institutions. These study findings indicated a mean score of 3.18 and a standard deviation of 0.936 which is slightly higher than

3.0. These findings, therefore, indicate a positive rating by the participants on the idea that academic performance through human resource dynamics has been influencing the achievement of TQM in that, teaming up talents and experiences of individuals' leads to the achievement of good performance in the institution. These teamwork leads to good performance which should be the goal of TQM in an institution.

Most of the participants suggested that they feel appreciated when their performance in academic was recognized by the top management. This brings more trainees closer to their trainers and finally towards the total quality management in the institution. Achievement of quality management could be through the dynamics of monitoring class attendance for both trainees and their lecturers. Bowen (2013) explains that, monitoring is a key component on the achievement of TQM in an institution. This is reflected on the academic achievement by the trainees after passing in national examinations. The study findings show that, academic performance had a mean of 3.18 and a standard deviation of 0.936 the achievement of TQM has been realized from good academic performance. The results of the study indicate that, most of the participants fairly support the idea that, academic performance would influence the achievement of total quality management.

The results of the study agree with Zabadi (2016) that, quality displays certain degree of objectivity and subjectivity in performance which can be felt and sensed. These findings also show that, the human resource satisfactorily fulfills the needs of their customers in most of the TTIs through good academic performance. Rivathi (2015) points that, satisfaction of employees creates a culture of teamwork in an organization.

Teamwork enhances achievement of TQM through the achievement of good at the end of the training process. The study also interrogated team building activities in Technical training institution among the human resource as a dynamic activity used by managers in order to achieve quality outcomes. The participants recorded their views on the influence of institutional human resource dynamics on total quality management in technical training institutions. The study was guided by the null hypothesis that: *Ho Human resource dynamics does not influence the achievement of TQM in TTIs in Kenya*. The findings of this study are presented on Table 4.

**Table 4: Team building and the Achievement of TQM**

Statement	Response		f	%
Indicate the influence of team building on the achievement of TQM in your institution	Below average	(1)	29	8.3
	Average	(2)	47	13.4
	Neutral	(3)	173	49.4
	Above average	(4)	90	25.7
	Excellent	(5)	11	3.1
	<b>Total</b>		<b>350</b>	<b>100.0</b>

**Source. Field Data, (2018)**

Table 4 shows that, 173 (49.4%) participants were neutral, 76 (21.7%) negative and 101 (28.8%) were positive on the influence of team building on TQM. This implies that, teamwork needs to be enhanced by

the management of TTIs in Kenya. The study findings are not in agreement with Rivathi (2015) that, satisfaction of employees enhances their loyalty to customers. HODs were interrogated an interview guide and data arranged according to themes, grouped and analyzed according to themes. One HOD explained that:

*“Motivation leads to high productivity and commitment in the institution. Motivation is very pertinent because the demands of TQM are always extra duties therefore some motivation would enable the implementation faster and better” (Male Lecturer, HOD).*

This positive view shows that, motivation is crucial with the view that the achievement of TQM but it is considered as an extra duty to the trainer. Motivation improves their morale making workers more dynamic and willing to do extra work. These findings are in line with Revathi (2015) that, satisfaction of employees enhances their royalty to the management of the institution. Another HOD held a negative view that,

*“The motivation given in our institution is minimal and needs to be improved to make the workers feel appreciated” (Female lecturer, HOD).*

These study findings indicate that, motivation makes workers feel appreciated, improves student-lecturer interaction and bonds workers and trainees towards the same goal in an institution. These study findings are in line with Mutua (2016) that, advising leaders towards organizing award ceremonies and prepare recommendation workers to workers in order to boost their individual participation. The study also obtained findings from the participants' view on training of workers in relation to performance standards in technical training institutions. TVET Act (Republic of Kenya 2013) gives powers to the top management to ensure that, the human resource undergoes training on new trends in lie with the industrial sector. One HOD explained that:

*Training and retraining enable the staff to be updated with the current technology and service delivery is enhanced (Male lecturer, HOD).*

These study findings are in agreement with Omware (2012) that, managers of institutions should invest on making workers understand the QMS and tools of QMS in order to enhance the manager-employer support. The quantitative study findings similarly show that only 100 (28.6%) participants were of the positive view. The views of this HOD are in agreement with Zang *et al* (2010) that, staff training is an investment which is a critical component in the achievement of TQM. One principal explained that:

*“Human resource dynamics has been a perfect tool for measuring participation and a lot has been achieved through realization of a certain goals due to team spirit” (Female principal).*

The sampled principal acknowledges that, human resource dynamics can be a good tool and teamwork also helps on the realization of institutional goals. This would imply that, the goal of achieving TQM can be successful through teaming up of the principals and the employees in an institution. This was supported through the explanation another HOD that,

*“Academic performance has been encouraging and good performers have been recognized although not well rewarded. After good performance, team building towards such results have not been there at all” (Female Lecturer, HOD).*

These findings differ with Mutua (2012) that, job satisfaction is a driving force towards the achievement of total quality management. Mutua (2012) observes that, motivating the human resource through academic performance creates a sense of teamwork among the trainees in the institution and improves interaction between lecturers and trainees. Team building has been poor or not done at all as explained by male lecturer that:

*“Team building activities are still below average and team building activities has been conducted once since I joined the institution”* (Male lecturer, HOD).

These study findings indicate that, team building has not been popularized in all institutions offering technical training. This was witnessed by a lecturer who has been in the institution for more than 5 years having witnessed only one team building activity. In order to establish the relationship between the influence of human resource dynamics and the achievement of TQM, the study findings were analyzed using the SPSS software to obtain results through regression analysis as shown on Table 5.

**Table 5: Coefficients of Performance and Resource Dynamics**

	Un-standardized		Standardized		Sig.	95.0% level of Confidence	
	B	Std. Error	Beta	t		Lower Bound	Upper Bound
Achievement of TQM							
(Constant)	-.645	.738		-.874	.405	-2.313	1.024
staff distribution	.035	.132	.040	.266	.796	-.264	.334
Motivation of staff	-.063	.235	-.063	-.270	.793	-.595	.469
Training staff	.326	.190	.316	1.718	.120	-.103	.756
Giving incentives	.661	.227	.624	2.906	.017	.146	1.175
Team building	.270	.211	.214	1.280	.232	-.207	.748

**Source. Field Data, (2018)**

Table 5 shows that, at the 95% level of confidence of all the variables considered under human resource dynamics ranges between 0.334% and 1.175% (0.0334 to 0.1175). This range of 0.469% is less than 0.05% level of significance. This implies that, the null hypothesis:  $H_0$  *Human resource dynamics does not influence the achievement of TQM in TTIs in Kenya* is rejected. The results of the study show that, there is a relationship between the two variables and therefore human resource dynamics influences TQM in TTIs in Kenya. However, staff distribution, motivation and team building were poorly rated. The study findings similarly indicate a significance of 0.004 on the dependent variable performance over the independent variable human resource dynamics. A significance of 0.04 is less than 0.05 indicates that the test rejects the null hypothesis and accepts the alternative that, Human Resource dynamics influences the achievement of TQM in TTIs in Kenya. These results support the quantitative and qualitative findings that, human resource though positive, it requires to be enhanced in technical institutions in Kenya. Findings from the principals confirm that principals agree with the opinion that human the resource strongly influences the performance in the institutions and along the same line influence the achievement of TQM.

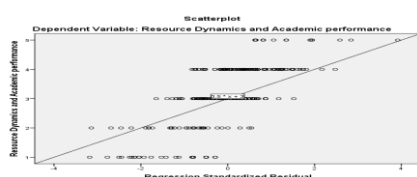
A model summarizing these findings was extracted using the SPSS to show the relations of this prediction. These are presented on Table 6.

**Table 6: Model Summary**

R	$r^2$	Adjusted $r^2$	Std. Error of Estimates	$r^2$ Change	f Change	df1	df2	Sig. f
0.903a	0.815	0.712	0.554	0.815	7.938	5	9	0.004

**Source. Field Data, (2018)**

Table 6 shows that, regression ( $r^2$ ) of 0.85 was obtained after analysis which indicates a strong relationship between human resource dynamics and the achievement of institutional academic performance. Academic performance is one of the variables under the study under the achievement of TQM. Table 12 show that, the relationship indicates a significance of 0.004 thereby rejects the null hypothesis. These findings indicate a positive score that the human resource strongly influences the achievement of TQM in technical institutions in Kenya. These findings are in tandem with Zabadi (2013) that, given opportunity, workers become conscious of quality work and thus influence the achievement of total quality management in the institution. Table 12 shows that, 0.815 (81.5%) regression scores for the relationship between performance and team building indicating positive results. This implies that team building activities were strongly influencing the performance in the sampled institutions. Table 6 shows that,  $r^2$  of 0.815. This value is greater than 0.6 showing a strong relationship between mobilization of teams and the achievement of TQM among the in the sampled Technical Training Institutions.



**Figure 1: Resource Dynamics and Academic Performances**

**Source. Field Data (2018)**

Figure 1 shows a regression ( $r^2$ ) of 0.528 is slightly lower than neutral (0.60) for this study indicating a negative influence on the achievement of TQM. This implies that, team building among the employees would require more consideration than the current level in order to make workers more supportive. These findings are not in line with Wanderi (2015) which observes that, satisfying customers intensifies worker participation. These results show slightly low achievements of TQM in many TTIs in Kenya. The results of the analyzed data show that, 37.5% of the participants positively supported team building as influential



towards the achievement of TQM, 46.9% of the participants with a neutral view about motivation, 36% were above average and 14.4% of the participants rated motivation negatively. This was supported by the qualitative data from the participants who affirmed that, motivation is very pertinent because the demands of TQM are always extra duties; motivation is minimal and needs to be improved. Responding to training of employees, 47.6% were of neutral view; 26.4% of the participants positive and 26% negatively responded on the influence towards total quality management.

On the other hand, qualitative analysis confirmed that team building was noted that, team building has made communication easier hence realization of a certain goals. Other participants asserted that, there has not been any team building at all. The regression on a prediction on the hypothesis that, *Human resource dynamics does not influence the achievement of TQM in TTIs in Kenya* was rejected. Regression ( $r^2$ ) indicates 0.815 higher than neutral (0.60) indicating strong influence on the achievement of TQM. In some institutions the influence was rated below neutral (0.6) level implying need to prioritize on human resource dynamics by the leaders in TTIs. The study results show low influence of human resource dynamics towards achievement of TQM in TTIs in Kenya.

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study sought to evaluate the influence of institutional resource dynamics on total quality management in public TTIs in Kenya under the following objectives: To determine the influence of the financial resource dynamics; to establish the influence of the human resource dynamics;

### Human Resource Dynamics and Achievement of T. Q. M

The results of the study show a standard deviation of 1.014 indicates a big deviation from the mean evaluation of the responses from the participants. Motivation was negatively evaluated at 74% towards the achievement of TQM. A standard deviation of less than 1.0 is high leading to a conclusion that managers have not been using incentives towards the achievement of TQM. Team building activities indicate a regression ( $r^2$ ) of 0.528 which is lower than Mean score (0.6) rejecting the null hypothesis  $H_0$ . *Human resource dynamics does not influence the achievement of TQM*, was rejected. The findings of the analysis using regression ( $r^2$ ) of 0.815 areas above neutral (0.60) level of the study hence the study concluded the influence as positive.

### Conclusions

The study was carried out to evaluate the influence of institutional resource dynamics on TQM in public TTIs in Kenya. From the study the researcher concludes that the influence of resource dynamics on the achievement of total quality management stand at between 60 and 70 % in public TTIs in Kenya. The study however concludes that, human resource dynamics has been low citing motivation, use of incentives, team building, training and retraining and academic performance.

### Recommendations for Practice and Theory

The Top management should improve the level of human resource dynamics in order to tap the potential contribution of the employees towards the achievement of total quality management in Technical Training Institutions. Improving on levels of motivation by giving incentives, team building activities on regular basis and other human resource dynamics should be enhanced.

### Recommendation for Further Studies

Whereas the study concludes that human resource dynamics influences the achievement of total quality management, the researcher recommends an in-depth on participation of the local community in the achievement TQM in TTIs in Kenya.

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# Optimization of the Perfumery Industry Production Process with the Replacement of Raw Material

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## Abstract

*The present work tends to investigate the lean production through the materials needed for the manufacture of perfumery products (cologne, deo cologne, eau de toilette), reduce its costs significantly, by proposing coherent substitutions to those used regularly, bringing improvements and productivity with the help of Kaizen tools. According to this comparison between inputs and their possible substitutes, all their processing and production are decisive for a more viable option according to the research theme and the viability of lean production in the most varied types of products, in the field of perfumery. In the differences between the given raw materials and the cost benefit, it is possible to promote higher productivity, without changing the performance of the products, even if there is a slight oscillation, but fulfilling the right role to the consumer, enhancing the ecological awareness and generating greater profitability.*

**Keywords:** Perfumery products; Substitution of inputs; Product performance.

## 1. Introduction

With the fierce dispute between countries for leadership in world consumption of perfumes, Brazil has been in first place since 2011 (but data was established in 2014), which also offers considerable positions as 2nd in specific products male, female, etc. Currently 4th in beauty product consumption, and 10th in dermatological by-products.

However, in addition to the risk of the cooling of the national general market and the obstacles caused by the oscillation of inflation, prices tend to increase, value-added competition with international brands and the current economic instability index make companies tend to dry their production in a fixed way, but without losing its quality, otherwise, it would have harmful consequences to the profitability of the organization in the medium term.

To defend against competitive forces, [1] proposes that industrial companies adopt, among others, three generic competitive strategies: cost leadership, differentiation or focus. Some companies base their competition strategies on controlling, maintaining, and tracking production costs in order to maximize results by reducing costs or even conforming to market rules.

Others seek, through systematic procedures, excellent products and techniques, to offer products with different characteristics compared to the competition. There are also companies that disseminate their strategies aimed at serving a specific segment or type of customers [2].

Among this leadership in perfumery consumption, over 60% is focused on the national perfumery itself, and in this ranking, the main domain is between Natura (direct sale) and O Boticario (sale by franchise and currently also by direct sale). Direct selling, which would be another determining factor for increased product consumption and accessibility to consumers.

The need to cut costs and maintains or increase profitability creates a look at production as a whole, and tends to wipe out sectors, costs, and materials.

This work aims not only to evaluate lean production methods in the manufacture of perfumery products, but also to suggest notions for such direction in order to improve treated physical resources as material for the production of the product in question.

For [3], Strategic Cost Management (GEC) results from the combination of three underlying themes on strategic management found in the literature. These are: (i) value chain analysis, a set of value-creating activities from basic raw material sources to product delivery in the hands of the consumer; (II) strategic positioning, choosing how the company will compete, either through lower costs (cost leadership) or through superior products (differentiation); and finally, (III) cost drivers, factors that interrelate in a complex way, causing costs for the company.

Evaluating all materials used in its manufacture, there is a large financial investment in inputs to bring the desired quality and configure this same quality in a particular product within the brand.

This article gives absolute advantages over the cost reduction of a company, sheds light on the process in which a perfumery product is manufactured and improves productivity without significantly losing its quality.

## **2. Theoretical Reference**

### **2.1. The Perfumery Market**

This product is part of this market every product that aims to perfume the body be it a perfume, cologne or cologne [4].

If Brazil's cosmetics market is already the third largest in the world, the perfumery category is already in first place in the world ranking since 2010. Brazil is the country that sells most perfumes and deodorants

in the world, ahead of the United States and France, two traditional fragrance markets [5].

According to the Brazilian Association of the Personal Hygiene, Perfumery and Cosmetics Industry [4], between 2003 and 2008, a strong increase in the Brazilian perfumery market was identified and, in 2009, the segment reached US \$ 4.81. billion, reaching a 13.1% share of the world market. By 2010, that number had risen to \$ 6.10 billion, a 33 percent increase that pushed the country to the top of the US-led ranking.

According to data from [6], in 1985 there were 100 new releases of perfumery products. Ten years later, in 1995, more than 200 new products were launched. In 2009, when this scenario underwent a sudden change, we had approximately 900 new and similar perfumes entering the market that year. In 2011 there were over 1000.

This growing movement in the number of launches feeds back, as with the hot market more companies want to be part of it, bringing more companies into the game and consequently more products. Just as organizations already in this lucrative market drive more and more investment into the creative and marketing industries, making launches more frequent and more profitable. Only Natura, for example, launched in the last half of 2011 19 new perfumes in the market.

Another fact that illustrates the rapid growth of this category is the strong increase in its penetration, recorded by [5]. Currently the northeast has more than 80% penetration, which means that more than 80% of the population uses perfumery products. In the southern region this data is lower, but still growing. The maturation of the market, coupled with the good economic times in the country, allowed consumers of all classes to include in their basket products such as perfumes and colognes.

Through a benchmarking survey conducted by the Massachusetts Institute of Technology (MIT) that resulted in the publication of the book "The Machine That Changed the World" in 1992 by authors Womack and Jones, lean manufacturing gained prominence and spread worldwide. . The focus of the research was to identify companies that applied in their activities the concept of doing more, with less and less.

## ***2.2 Raw Materials and Supplies and Their Contextual Comparatives***

### ***2.2.1 Absolute ethyl alcohol***

It is regular ethyl alcohol at the level of 98.5 to 99% abv, but because it does not have the necessary lightness and amenity, treatment for adequacy excluding industrial denaturants and dilution through hydration to the level 72% is essential. essential oil is used since, if using essences, the level of dipropylene (which is a suitable type of alcohol functional for chemical aromas) would aid in the dilution of this alcohol. If there is not the whole process described, it is entirely excluded its use in this follow-up.

### ***2.2.2 Rectified ethyl alcohol***

This alcohol is also a safe source because it was exposed to the following distillations, a process called rectification. It can also be obtained from other sources such as cassava, for example, but because it contains 95.6% concentration, it needs hydration, which can be done in the same way as in absolute alcohol, but without the need for treatment to suit it. , since it contains no denaturants and is also suitable for general human consumption.

### **2.2.3 Cereal Ethyl Alcohol**

It is ethyl alcohol with the same or similar properties as regular ethyl alcohol, but obtained from sources such as corn, giant transgenic rice (Brs Ag) or wheat starch.

This being a hydroxyl attached to saturated polycarbons. Corn ethanol will be the proposed objective of the topic.

### **2.2.4 Corn Ethyl Alcohol**

Resulting from the fermentation of properties present only in cereals, the fungi die and the alcohol is separated and distilled to obtain "alcohol 96" because it contains 4% hydration, which may vary depending on the purpose and demand (about 70% for products). of perfumery). This alcohol has intense volatility and does not harm dermatology, its ethanol extraction process tends to be longer and although its consumption is not harmful, it can bring long term health problems, except in dermatological use these alcoholics They are more productive, with less quantity, higher yield and faster fermentation, which makes it more accessible.

### **2.2.5 Deionized water**

It is water without mineral salts and where ions are removed that would alter a certain commercial purpose with it. Water is passed through the process called deionization that occurs through two specific systems: One is by passing through ion exchange vessels in the reverse osmosis equipment, where all the ions are removed, and this removal stabilizes the water for various purposes. The second is through the evaporation / condensation process of the generated vapors, which would significantly remove the ions, making them suitable for their transformation into raw materials.

This potabilization method consists not only in removing the present salts, gases like carbon, where their tolerance according to what is considered potable for the productivity in question according to ANVISA RDC Resolution No. 48 of October 28, 2013, is not more than 0.5 mg / l, as well as aerobic-type microorganisms not limited to 100 cfu / ml and total absence of faecal coliforms on a scale of every 100 ml.

Pharmacotechnically, constituents such as those mentioned and others of lower expression, in addition to health problems, especially dermatological, would cause technical problems in the finished product and in the medium term, the loss of space in the market in which the given product (s). (s) are targeted.

Another factor that brings advantages is the conductivity balance, which indirectly would contribute to the "harmonization" factor of the product content, in addition to the physicochemical and microbiological quality of the raw material.

### **2.2.6 Distilled water**

In turn it is obtained when a non-pure water (with dissolved substances) is condensed and boiling separates most mineral salts (distillation does not evaporate all salts), gases and residual substances that may exist in a regular water. .

In processing, if there is a distillation uptake (similar to the extraction of essential oils) the purity of the water is almost identical to that of deionized water, but this system requires more production slack, since

the accumulation of water subsequently treated fractional distillation is slower than regular distillation, that is, where water is boiled at a certain temperature so that there is general cleanliness in its matter and the minimum tolerance of residual substances that would not affect the final quality is regulated. of the product that will compose. The process is therefore simple and economical.

### **2.3 Essential Oil x Essence**

#### **2.3.1 Essential oil**

It is the material extracted from a given raw material, whether vegetable or even animal, that concentrates all the properties offered by the organic factor, that is, derived from its exuberant chemical composition. These oils can range in price from affordable to unfeasible, such as “oud” or even rose essential oil, which, due to the symbolism of this flower, the difficulty of extraction, the extremely sensitive raw material and the minimum yield, makes it one of the most expensive in the world and makes the products that contain them more expensive.

#### **2.3.2 Essence**

It is a mixture of oily and / or aromatic compounds of synthetic origin that may also contain natural by-products to produce the aroma of a given raw material as well as dipropylene for stability of its final product. Here there is no presence of the assets present in the plant or raw material as those extracted directly from them as is the case with essential oils. The essences have only olfactory qualities, i.e., aimed at trade, which does not change the quality of products manufactured from their use. In the case of rose, the aroma of its oil can be imitated through this process which, although apparently complex, is generally more affordable, which consistently lowers the cost of the final product.

### **2.4. Production Cost**

The cost variable addressed by the present study refers to "the value of goods and services consumed in the production of other goods or services" (Mattos and Toledo, 1998, p. 19). Total and variable costs increase with production. In the short term, production costs are analyzed with respect to total cost, marginal cost and average cost.

Cost has two components: fixed cost and variable cost. Fixed costs are costs that do not vary with the production rate. Variable costs are the costs that vary with the use of variable inputs in the production process [7]. Thus, the total cost is the sum of the fixed cost and the variable cost [8].

The marginal cost, according to [9] is the cost increase caused by the production of an extra unit of product. In other words, it indicates how much each unit increase in production costs. In addressing cost systems, a cost system consists of a general principle and costing methods. The principle is related to the definition of the most appropriate information to the needs of the company. In general, the principle guides the analysis of direct and indirect cost portions that should be taken into account.

Costing methods deal with the operational part, that is, the processing of data and information. According to [10] costing principles are linked to the objectives of cost systems, where they are related to the objectives of cost accounting, namely: inventory valuation and control and decision-making aid. After presenting the costing principles, this paper approaches the absorption costing method and the target



costing, adopted empirically and disposed in the literature as a distinct view of cost appropriation to the products, treated below.

Given the literature search, two costing methods are prominent: absorption with evolution to activity-based costing and variable costing. For [11] as a common point is that they are concerned with the management of indirect costs. As the main difference is that each of them can produce different information that will meet different needs.

Absorption costing consists of the appropriation of direct costs and indirect costs to the elaborated products. Fixed costs are allocated to products through apportionment, variable costs are allocated directly to products, and expenses are carried to the income statement. According to [12] absorption costing, because it is more conservative, makes entrepreneurs more relaxed, because all costs were appropriate and, as a result, the parameters for sales price formation would be better based.

Absorption costing is one that charges all costs in the manufacturing area to the cost of products, whether these costs are defined as direct or indirect, fixed or variable, structural or operational costs. According to [11] the procedure is to make each product or production (or service) absorb part of the direct and indirect costs related to manufacturing. The following figure schematically represents the absorption costing method.

### **2.5 Process Optimization**

Nowadays, it is undisputed the importance of organizations to adapt to environmental changes; Consequently, actions need to be foreseen and proposed to minimize their likely impacts on the company. The concept of flexible organization implies an organizational structure capable of identifying and classifying organizational processes within the company. Identify the production and support processes and classify them according to their strategic relevance to the organization. [13].

This segregation is performed according to each business model and sector in which the company is inserted. According to [13], "This definition takes into account the business branch of the organization in order to subsidize the delimitation of the productive and strategic processes. "Once known the relevance of each process becomes possible to draw a strategy for outsourcing activities that do not add value to processes strategic aspects of the company, as well as the processes considered of support. [13] describe the sequence as follows: necessary actions to adapt the organizations to the concept of flexible organization: Environment and its strategic elements; Permanent interaction with the market and customers; Structuring of activities by processes; Subcontracting, partnerships and outsourcing; Form of use of people; Application of information technology resources; Economic management and evaluation; Excellence benchmarks.

## **3. Methodology**

Firstly, there was a bibliographic research on the proposed theme and, according to it, the profitable potential in the Brazilian perfumery business tends to contribute positively to the commercial movement. This data was linked to the application of Kaizen, in the context of productivity improvements in

question, where it was concluded that, taking the common areas between companies in the perfumery sector, there is a range of possible cost reductions related to raw materials and materials, paramount in any production in this field.

Knowing that there are three raw materials and main materials, it was possible to replace them with similar ones without losing performance of the products, thus keeping it competitive. According to the accuracy described on chemical / productive value of similar inputs, it was possible to make a careful comparison between them and attest their potential, and ensure their substitution without problems.

## 4. Application of Study and Results

### 4.1. Process Structure

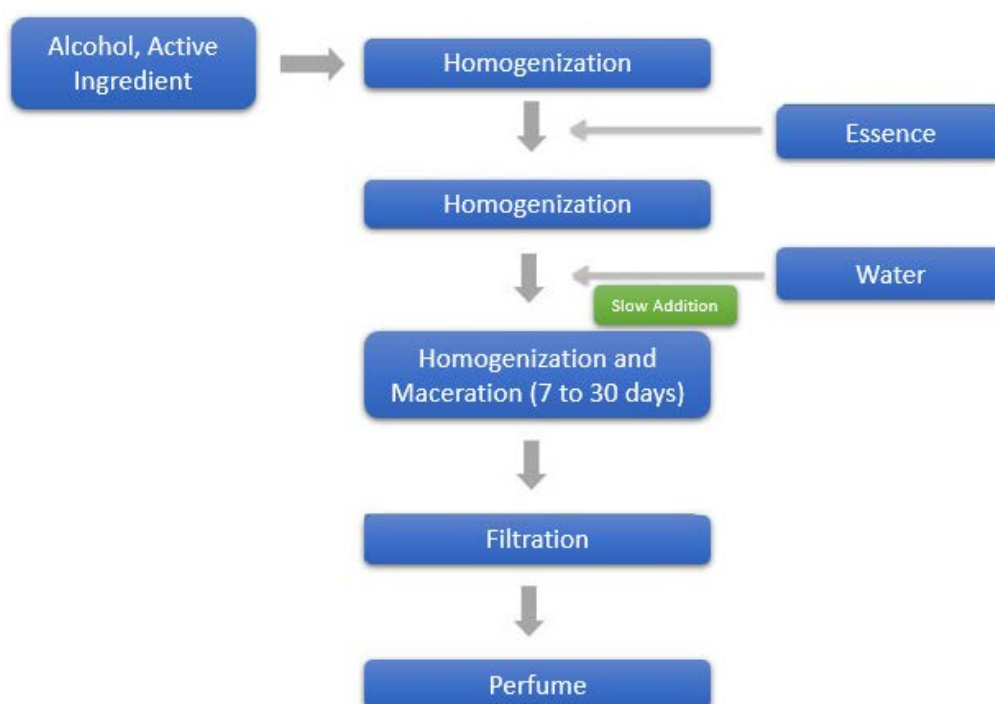


Figure 1 – Perfume manufacturing process

Source: Own Author

The materials are used three, to give a perfumery structural body, which are: rectified ethyl alcohol, deionized water and blend of essential oils. In this case, it is optional to use dipropylene as a solvent, since the maceration time and the alcohol itself try to replace it.

After this, the product should be "resting" for a week to a month, so that not only the essential oils, but also the chemical compounds involved (alcohol and water) interact.

Distilled-rectified ethyl alcohol, deionized water and essential oil can be quietly replaced by anhydrous cereal-corn alcohol, distilled water and mostly essence.

The process (the processes are similar from business to business) starts with alcohol as this is the main volatile material, heavier oils for fragrance durability and optionally adding other active ingredients that accompany them in a ton for first homogenization which will later receive the essential oil or essence for the second homogenization.

In this case there are solvents such as dipropylene present in essences further facilitating the next homogenization. The water, which must be deionized or distilled for the removal of salts, is gradually added in the last homogenization, to control the texture and the adherence of the water itself to the predecessor mixture and passed through the maceration phase, which lasts between 7 and 30 days. , which allows proximity to the final product, after which the product is filtered through an electric filter and inspected so that there is no residue resulting from the previous processes.

After this the mixture is ready for the processes of transformation into finished product: The material is put in its regular container either of glass or plastic, which in factory, is generally called "glass" or "container" and thus fitted and blended for be dispatched in logistics and directed to the customer.

#### **4.2 Problem Identification**

Ethanol productivity and its origins.

Common Sugar Cane - Regular Ethyl Alcohol / Absolute Ethyl Alcohol / Rectified Ethyl Alcohol: Regularly Used in Perfumery.

1 tonne produces between 85/90 liters of ethanol;

Your fermentation 38/45 hours.

Corn- Cereal Ethyl Alcohol / Corn Ethyl Alcohol: Suggested Substitute

1 tonne produces between 400/480 liters of ethanol;

Your fermentation 10/12 hours.

Regular ethyl alcohol produces 5 times less with one ton, which increases the need for more planting space, makes the outsourced product more expensive and contributes to ecological degradation. Your fermentation period is three times longer, which could possibly delay a certain demand for your outsourced product and make up for poor productivity.

The deionized water goes through an ion exchange process, where in the end all the minerals present for desalination are removed in a specific reverse osmosis equipment, which would be an extra expense its outsourcing and the suitability of this raw material would be more. time consuming than the proposed method.

The essential oil, which in turn goes through numerous processes suitable for a particular type of raw material, and which needs a certain amount of it for the extraction of its product, which is ecologically harmful, as in addition to areas degraded to Their crops, many of these oils, are extracted with a whole living structure or plantations, and due to the low yield, thus making the product more expensive, in addition many plants (raw materials) produce their extraction point seasonally or annually, being still more difficult to acquire your oil. Essential oils have an advantageous chemical structure by aromatic rings, which have sensory benefits, but which in popular perfumery, are not of paramount importance.

#### **4.3. Improvement Proposal**

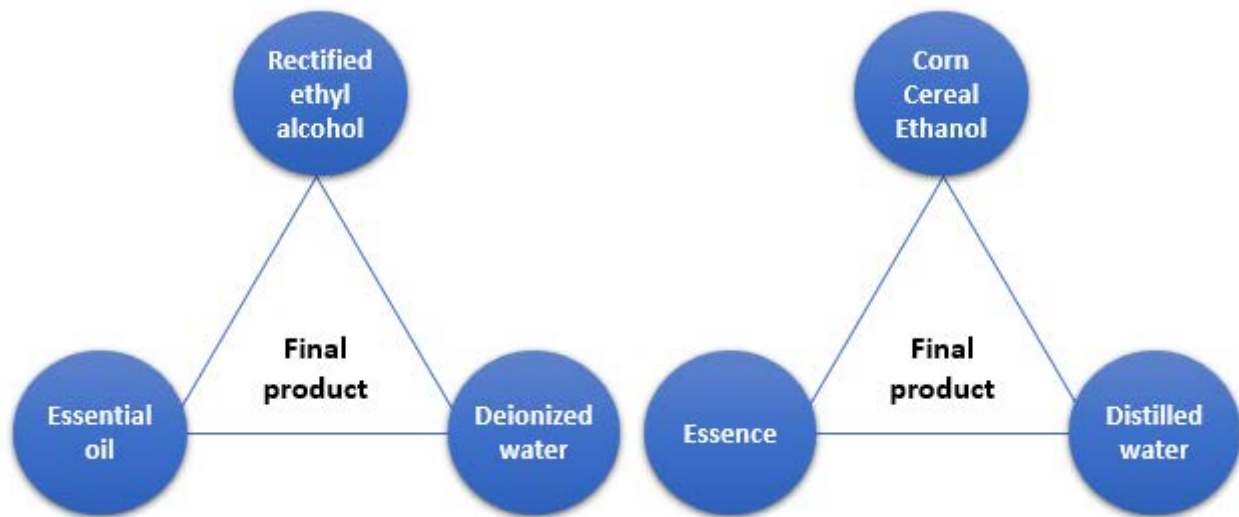


Figure 2 - Replacement structure

Source: Author

With the replacement of its main inputs, these, the most expensive and important ones in the perfumery sector, there were gains not only in cost reduction with cheaper products, shorter waiting period for outsourced inputs, faster processes and decrease in expenses with assets. extra chemicals, but also in the environment in general. Grain-derived ethyl alcohol from maize waste is a more productive source in every way, so cost-effective, and thus more economically less expensive.

Distilled water (which is cost-effective and easy to process) brings the advantages in the perfume industry, practically the same benefit as deionized water, which usually comes as an outsourced product cost. Essences (product which mimics the aroma of certain raw materials or essential oils) is also cheaper and has solvents that accelerate the process already in the industry, further optimizing productivity.

## 5. Results and Discussions

In the comparison, between the alcohol regularly used in the current perfumery and the corn-based cereals ethyl alcohol, suggested in the research, there were no observable changes in the final result of the finished product, although the productivity is more advantageous with the proposed alcohol in relation to its fermentation period and quantity acquired. The distillation process does not require major complexities in the deionization process, which is more expensive, time consuming and insignificantly in the productive context in question, more advantageous.

Essential oils contain a more complex chemical structure but are fully reproducible olfactory. Containing in their formulation, often solvent compounds, such as dipropylene, the essences intensify and accelerate the maceration process, reducing it by a week, previously longer due to the structural density of essential oils. Essences are more economically accessible because of their relative ease of production.

## 6. Final Considerations

In the main production processes of the product in question, there were no significant or even noticeable

changes, with the substitution of regular inputs by the optional substitutes gains in the invested income, the more accessible value with both alcohol and essences, and self-production of distilled water instead of purchasing deionized water from suppliers. Other gains in the process period, both in materials, due to faster fermentation, thus the extraction of an optimal substituent of rectified ethyl alcohol, and in the reduced maceration period of one month to between 5 and 7 days, due to solvents. present in essences. The reduction of the ecological impact and the stimulation of the productivity with all these factors, is considerable the investments in these materials, which would promote a reduction between 15 and 25% of the expenses in the sector.

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# **Application of PDCA Cycle Methodology in Management of Continuous Improvement in Receiving and Movement Logistics**

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## **Abstract**

*Logistics is one of the main processes within organizations, because it is possible to store different types of items in stock. However, maintaining management is not a simple role, as the process needs to be integrated with the quality, storage and accuracy of stored resources, which are as high as possible, and this makes it a bigger challenge for the vast majority of organizations. The present work aims to propose an application and management of the PDCA cycle methodology for greater efficiency in the receiving and handling sector, reducing costs and controlling container yard operations, without major investments, just by using the PDCA and some Quality tools.*

**Keywords:** Logistics, Receiving and Moving, PDCA Cycle, Quality Tools, Accuracy.

## **1. Introduction**

Logistics has been the main management of the supply chain, as it is through it that the planning, implementation and control of all storage flows are efficiently and economically possible for raw materials, semi-finished materials and finished products, as well as as the relative information, from the source to its consumption, because the purpose is to meet the requirements of customers. (OAK, 2002).

According to NOVAIS (2004) the concept of logistics was mainly in military operations. When deciding to follow with their troops followed a definite line, the generals should have, before their troops orders, there was always a group that performed the locomotion, at the right time, ammunition, food and all

medical supplies and help for the battle. . Because this service was only supportive, without much strategy and no influence on battle winnings, military logistics teams worked in the dead.

Industries that aim to remain competitive in the market place processes in continuous improvement methods, so that all sectors become lean to ensure the success of the strategy. The receiving and handling cycle needs to become a fully streamlined process for the use of improvement tools to assist in the management of procedure development actions that can minimize the lead time between receiving and moving materials to production.

The justification of this paper seeks to demonstrate how it is possible to use one of the main quality management tools through the Plan, Do, Check and Act (PDCA) cycle can be used in Logistics Management, proposing a continuous process improvement, identifying and / or eliminating / decreasing divergences that directly affect the outcome of the logistics process within the company. The general objective proposed in the paper is to demonstrate means of continuous improvements in the receiving and movement logistics with the aid of the PDCA Cycle tool, separating them into three main specific objectives: to seek the main divergences, to propose ways to achieve results and to describe how The PDCA tool can be deployed in the industry.

## **2. Theoretical Reference**

### **2.1. Logistics and Supply Chain**

According to DASKIN (1995), he explains that logistics is a form of planning between physical operations involving warehouses, transport networks, vehicles, etc., as well as systemic information in management processes, processing and data. Where are indispensable for the raw materials and finished products that control the physical and temporal limitations of an economic aspect.

NOVAIS and ALVARENGA (1994), defined that logistics can be divided into three types: logistics in the industrial system, supply logistics and distribution and marketing logistics, where it has been admitted the dealings of identification of consumer requirements, paying attention to market and the needs customers expect.

According to CORRÊA and XAVIER (2013) is the estimated activity to move and establish inventory positions within the supply chain. That is, logistics work can include product or input transportation, fleet control and material handling, demand and / or supply planning, and logistics service management.

### **2.2. Receiving and Handling**

According to SANTOS (2001), the receipt of material and / or raw material is the progress of the logistics sector, is the sum of operations that includes the recognition of all material that was received, so it is possible to compare tax documentation with the physicist, thus releasing for qualitative and quantitative inspection of materials and approval of the same.

For DIAS (2012) companies that have stopped inventories give rise to extra expenses and their movement is performed when it is necessary to consume. In order for the raw material to become a product, some basic elements for its manufacture are needed: man, machine and / or material to be monitored.

DIAS (2012) also concludes that the general inventory can be moved / dynamic, physical movement can

control all storage and even dispatch the material, being performed with the following equipment: transport, fixed and mobile cranes, lifts, industrial vehicles such as trolley. of various types, terex, positioning equipment, containers and other structures can support the operation.

### **2.3. PDCA Cycle Methodology**

MARSHALL JR. (2008) tells us that the PDCA cycle is a management method and that promotes the improvement of activities, as practicing continuously can provide improvements and regularization in the organization, thus validating the systematization of all actions if they were effective in the process. .

AGUIAR (2006) tells us that the survival of an organization needs the efficiency in which it has to respond to the needs of consumers. The PDCA cycle is a method of analysis and process change by which planning does not happen once. PDCA aids control and helps to make each process go as smoothly as possible. The management system that applies the PDCA cycle must face challenges of this methodology.

According to CAMARGO (2011), Total Quality Control is a method that is the most used because it promotes behavior in the supply chain, as it promotes continuous quality improvement, thus increasing process efficiency and production. it can thus have a cost reduction, which leads to increased profits and market conquest.

### **2.4. Quality Tools**

According to MARIANE (2005), clarifies that to conduct processes and manage decisions with increased corrections, it is necessary to obtain information that is obtained through these processes, thus having a correct analysis of the data. For this you can use the efficient techniques called quality tools.

Kume (1993) tells us that statistical methods are tools for the efficiency of improvements in the production process and reduction of defects. However, it is necessary to remember that quality tools need to be used correctly, as misuse can cause the expected result not to be obtained. Quality tools and methods such as: Brainstorming, Ishikawa Diagram, Cause and Effect Diagram, 5W2H, Flowchart, PDCA Cycle and others are the most used.

### **2.5. Accuracy**

According to CORRÊA, CAON and GIANESI (2001) tell us that the term used as accuracy means to have quality in what is right and accurate, to do right the first time. It is necessary to perform calculations of both physical values and records and that both are equal or as similar as possible. The movement of materials or items as they are also called in stock needs to be done in real time so that accuracy in stocks can be maintained.

BALLOU (2006), states that there are four fundamental factors within the accuracy of inventory they are: purchasing, moving / storage, storage and product delivery. In order for these factors to function properly, logistical planning is required and that it has symmetry with all other processes.

## **3. Tools and Methods**



The present work was carried out within the framework of a large stock of material imported from a multinational industrial hub of Manaus. The approach taken to compose the improvement actions was the brainstorming tool to make everyone contribute to the process improvement by suggesting ideas to make the study viable, the Inventory Layout to verify if it is correct or requires modifications, Tack production team, to perform material delivery synchronization, as well as the use of the Mizusumashi System (productivity increase), Kanban which is essential for information flow control and material flow regulation to determine the activities they need developed as clearly as possible by all parties involved in the operation. The logistics of receiving and moving has as its main customer production, which leads the company object of study has adapted to the demand of its customer and changing working methods, in order to meet the needs efficiently.

The approach adopted came with the following steps: Diagnosis of the real and planned situation through in-process studies, proposal for continuous improvement through the PDCA cycle for the receiving and moving materials sector. Analyzes were performed with the help of the Ishikawa Diagram and submitted to an action plan in which it was used to maintain control of each step.

#### **4. Application of the PDCA Cycle Study in Managing the Continuous Improvement of the Receiving and Movement Process**

The organization object of the study has as its main activity the logistics of receiving and moving materials. The study unit has great difficulty and suffers large variations in its inventory control, from the arrival of containers at the docks to the final customer. Where five (5) phases are established within the stock. These are: 1st phase - receiving materials, where the storage process in the system is performed; 2nd phase - is when it generates a service report, where the deadline for customer service is stipulated, where the material needs to be deconsolidated and collected because the R.A informs the exact time when the material goes to the production line; 3rd phase - Picking where the material is separated by orders, quantities, models and categories as critical and non-critical; Phase 4 - is the transport or as is also known by the company Milk Run which is the method of accelerating the flow of transport to the productive sector and; Phase 5 - is Production, after the material goes through the previous phases finally reaches its destination, where the raw material finally forms into a finished product.


##### **4.1. PLAN**

At this stage began the study of continuous improvement, where a technical team was defined together with the process managers. The planning was done in stages, because after analyzing the actual situation verified in loco of the process compared to the predicted one, it was possible to identify operational failures that prevent the process from becoming efficient and agile.


Using the brainstorming tool it was possible to perform an analysis on top of all proposed ideas and select the best ones to implement continuous process improvement. Figure 01 shows how Brainstorming was performed and what ideas were accepted for the study.

1.Topic:	<b>IMPLEMENTATION OF KANBAN LOGISTICS OF RECEIVING AND MOVEMENT AND MIZUSUMASHI SYSTEM</b>					
KANBAN						


  

2. Audience:	Beginner	Intermediate	Advanced
Receipt and movement logistics			

3. Content Structure:	List	How-To	Q&A	News	Definition	Opinion/Why
No items can be received or moved without kanban						

4. Content Medium:	MRP system	SAP system	MACRO WORKSHEET
Information Transmission - Electronic Kanban			

5. Ideas:	Brainstorming
Ideas for receiving and moving materials	Waste of available time (standby)
	Loss of transport
	Lose in material handling
	Daily Item List on D-2 for Inventory

Figure 01 - Brainstorming for KANBAN / Mizusumashi Application

Source: Own Authorship (2019)

After the brainstorming, a schedule for follow-up of the activities was carried out with the names of their respective responsible with established deadlines for each action that was planned as shown in figure 02. The schedule lasted four (4) months for implementation, testing phase. and studies to obtain results.

SCHEDULE																			
Activity / Task	Responsible	Comments	Deadline																
			July				August				September				October				
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1. Identify possible inventory waste;	Project Manager	Conduct time study within stock;																	
2. Hold a meeting every 15 days, showing what was found during the study review;	Project Manager / Area Manager	Presentation to process managers																	
3. Reorganization of stock layout to facilitate material movement;	Project Manager / Area Manager	Take area measurements and see if they can be improved																	
8. Biweekly meeting (15 days);	Project Manager / Area Manager	Presentation to process managers																	
4. Study of times and methods of receiving raw materials;	Project Manager	Check production time and adhesion time for each production line and compare how long inventory takes to fulfill																	
5. Presentation of the proposal for continuous improvements in the receiving and handling process; - Replacement of fortnightly meeting	Project Manager	Present the proposal that best suits the process to managers																	
6. PDCA cycle implementation with continuous improvement management - Kanban	Project Manager	Start deployment and awareness of employees and managers																	
7. Test Phase for continuous improvement deployment;	Project Manager	Conduct process testing to obtain expected results																	
8. Biweekly meeting (15 days);	Project Manager / Area Manager	Presentation to process managers																	
9. Perform the PDCA Cycle Spin to verify that the implemented actions are getting results;	Project Manager / Area Manager	Collect information and verify results are being obtained as planned																	
10. Biweekly meeting (15 days);	Project Manager / Area Manager	Presentation to process managers																	
11. PDCA cycle implementation with continuous improvement management - Mizusumashi System	Project Manager	Start deployment and awareness of employees and managers																	
12. Test Phase for continuous improvement deployment;	Project Manager	Conduct process testing to obtain expected results																	
13. Biweekly meeting (15 days);	Project Manager / Area Manager	Presentation to process managers																	
14. Perform the PDCA Cycle Spin to verify that the implemented actions are getting results;	Project Manager / Area Manager	Collect information and verify results are being obtained as planned																	
15. Delivery of the Project of Continuous Improvement of the Process of Receiving and Movement of Materials;	Project Manager / Area Manager	Report Delivery and Finalization of the Continuous Improvement Project																	
16. Biweekly meeting (15 days).	Project Manager / Area Manager	Presentation to process managers																	

Figure 02 - Activity Schedule

Source: Own Authorship (2019)

#### 4.2. DO

After preparing the Schedule and defining the team in which to act in the implementation of the study, hears a presentation meeting to managers and process managers, showing what will be done and what

benefits the study will bring to the sector. This step is where all planning needs to be carried out and activities have been prioritized according to the defined action plan. Figure 03 shows the identification of the problems and their causes.

Activity / Task	Responsible	Deadline
<b>1. Identify possible inventory waste</b>	Project Manager	15 days
Lots waiting for availability of resources to be processed, off-batch items waiting for collection to advance the picking area, collaborators finalizing formatting and deconsolidation of materials.		
<b>2. Loss of Transport</b>		
Timeless transport and out-of-specification routes		
<b>3. Loss in Material Handling</b>		
Usually caused by operators, where it is possible to observe the oscillity.		
<b>4. Daily List of Items in D-2 for Inventory</b>	Project Manager	15 days
The items are scheduled in the container pull always 2 days in advance, predicting the possible R.A that are scheduled		

Figure 03 - Problem Identification

Source: Own Authorship (2019)

In the first 15 (fifteen) days of the study, it was possible to identify the major problems that directly affect the Imported DCC, thus, it was possible to perform the activities that were scheduled in the schedule such as the reorganization of the company's movement layout structure, facilitating the company's supply routes, the realization of times and methods in stock with the operators in the deconsolidation, formatting and material collection part.

Implementation of Kanban continuous improvement for information flow control and material flow regulation. The purpose of the implementation is to signal the consumption of a product through a more advanced process, where it is possible to signal the programming the exact quantity and in real time the material showing if it has already been deconsolidated, formatted and collected by the operation. Rotation of the PDCA cycle needs to be performed at each stage for errors to be evaluated and not to compromise the study. Figure 04 shows the Kanban functions and the rules for their use.

KANBAN FUNCTIONS	RULES OF USE
Provide information about picking up or transporting.	The subsequent process picks up the number of items indicated by the kanban in the preceding process.
Provide information about production.	The initial process produces items in the quantity and sequences indicated by the kanban.
Prevent overproduction and excessive transportation.	No items are produced or shipped without a kanban.
Serve as a manufacturing order affixed to goods	It serves to affix a kanban to the goods.
Prevent defective products by identifying the process that produces them	Defective products are not sent to the next process. The result is 100% defect-free merchandise.
Reveal existing issues and keep track of inventory	Reducing the number of kanbans increases your sensitivity to problems.

Figure 04 - Kanban System Rules and Functions

Source: Kanban Functions and Rules (Ohno 1997, p.48)

Continuous process improvement was initiated by material scheduling, where advance scheduling of at least 4 days prior to material pull was established, with this new system in anticipation pull processes Mizusumashi system can be applied within the logistics, because with time and method studies it can be seen that operators lose about 15 to 35% of total work time due to lack of a process flow. With Mizusumashi it was possible to define a car supply route so that the Just-in-time philosophy can be put into practice. Figure 05 shows the flow in which the material needs to be taken, respecting the lead time and tack time of each process so that it does not delay the following processes.

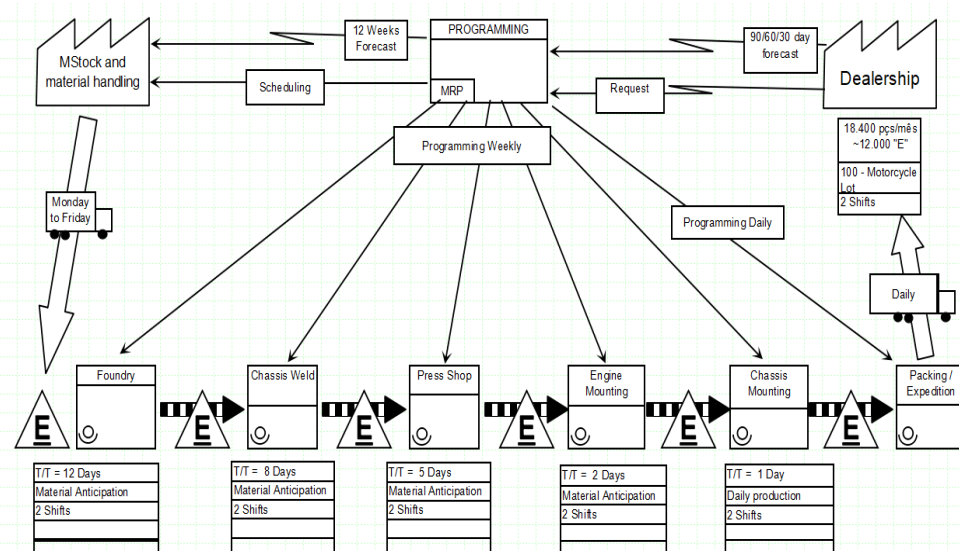


Figure 05 - Flow Implementation - Kanban / Mizusumashi for Continuous Improvement

Source: Own Authorship (2019)

### 4.3. CHECK

For the verification of the third phase of the PDCA cycle, a technical team was defined where the project manager performs a monthly audit, together with the area responsible for monitoring and developing the implementation of the implemented improvements. The audit was assisted by the Checklist and all results were presented in a formal meeting to the respective heads of each area involved.

The results achieved in the audit verification were quite satisfactory for those involved in the process and the person responsible for the study. In figure 06 the Checklist shows the questions that were applied in the application audit phase.

Yes	No	Initiation Phase
x		1. Is the continuous improvement proposal achieving expected results for the organization?
x		2. Will strategic resources be available to conduct the project?
x		3. Have all employees been oriented towards continuous improvement being applied to the process?
x		4. Is the strategy and scope of continuous improvement clearly defined?
x		5. Does the proposal enable results and return on the expectations of the organization?
x		6. Is the qualitative and quantitative assessment of continuous improvement consistent?
x		7. Has a preliminary risk assessment been carried out? Is the certainty of the estimates sufficient for the level of risk that the organization can tolerate?
x		8. Were key stakeholders and stakeholders adequately involved?
x		9. Will the team need any form of support, training, direction and / or follow-up?
x		10. Is all the relevant information needed to proceed with the improvements available and organized?
GP Signature:		
Space for justification if project is aborted		

Figure 06 - Verification Phase Checklist

Source: Own Authorship (2019)

### 4.4. ACT

After the verification and audit phase of the application process, there was a results presentation meeting, where the study leader presents the results obtained during the period of continuous improvement application. In these meetings it is possible to verify the execution of each step of the process and whenever possible make the PDCA cycle rotate for better results. The employees were trained and oriented on the application of the new methodology applied to the process.

At this stage it was possible to correct the failures that were hindering the expected result, and thus new actions to correct errors could appear. The study obtained a satisfactory result, because with the management of continuous improvement through the PDCA cycle, the improvements are being significant for the process of receiving and moving materials. In this way, inventory can have employees and managers who can identify the problem and suggest changes in the rate at which material flow occurs.

## 5. Results and Discussions

The work developed allowed the application of new methodologies within the inventory and management of the PDCA cycle with the managers responsible for the area. The application of Kanban and the Mizusumashi system allowed for an easier and simpler supply route for production fulfillment reporting. The application of Kanban allowed the flow that was developed to become agile for service, from material scheduling to final customer arrival (production). The indicator in figure 07 shows from July that was the beginning of the study until its conclusion in October, where the control became satisfactory, because the errors were treated in the first month, causing the PDCA cycle to spin. and make the logistics process effective.

GOAL MONITORING - INDICATORS									SUBTITLE	
IDEAL: M = Monitoring indicator for administration and decision making. M1 = Indicator for monitoring results generated and controlled by third parties, without the possibility of interference in the Factory. SD = No data input to generate indicator									Answered:	😊
									NOT MET:	😞
UNITY SECTOR	INDICATOR	OBJECTIVE	TREND (BEST)	GOAL	IDEAL	JULY	AUGUST	SEPTEMBER	OCTUBER	OBS
TRACK	Track attendance	Show yard performance as service times deliver containers		50 CNTR	45 CNTR	😞	😊	😊	😊	
						43 CNTR	46 CNTR	47 CNTR	46 CNTR	
RECEIPT	Amount of Service on Receipt	Show material pickup performance		50 CNTR	45 CNTR	😞	😊	😊	😊	
						43 CNTR	45 CNTR	45 CNTR	45 CNTR	
DESCONSOLIDATION	Material taken from KD'S to be placed in carts / pallets / basketballs	Show D4 material deconsolidation performance		D-4	D-4	😊	😊	😊	😊	
						D-4	D-4	D-4	D-4	
FORMATION OF MATERIALS	Time to send materials for collection	Ensure shipping and track materials until delivery to next phase - collection		D-4	D-4	😊	😊	😊	😊	
						4 days	4 days	4 days	4 days	
MATERIAL COLLECTION	General Productivity	Ensure shipping and track		TACK Each Line - 100%	TACK Each Line - 100%	😞	😊	😊	😊	
						89%	100%	100%	100%	
PICKING AND EXPEDITION	Production Service	Meet the production service according to R.A		100%	100%	😞	😊	😊	😊	
						83%	100%	100%	100%	

Figure 07 - Verification Phase Checklist

Source: Own Authorship (2019)

The company object of the study had no performance indicators to follow the processes and therefore the errors became constant, as they had no proper monitoring and no records, with the application of Kanban and the Mizusumashi System it was easier to apply indicators<sup>1</sup> and define goals and guidelines for inventory.



## 6. Final Considerations

To be successful in the implementation or implementation of any study and / or project is essential the involvement and commitment of all involved. The project manager needs to learn every detail of the process from the operators, as no one better than them to explain the failures, difficulties, and any issues related to the industry. It is important that managers in each area have the ability to listen and motivate their employees, so that if they are resistant to change, they can get around the situation. During the study the main difficulty encountered in making the improvements was the resistance of some managers and employees.

During the study, the company may set up a technical team to carry out the work and together with those responsible for each operation. The technical team became the main key to the changes that will still occur in the company, because thanks to the study the expected improvement was obtained. Material handling and storage control is a tool that enables greater efficiency in logistics control, as it is possible to facilitate the entry and exit of materials, preventing them from being stored in stock for too long. The company achieved greater return on how to allocate its resources and work for FIFO, improving the quality of its services and showing its true service capabilities.

## 7. Acknowledgments

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# **Implementation of Time and Method Studies for Improvement Continues in Productive Efficiency of the Mini System Production Line**

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## **Abstract**

*This article discusses the relevance of implementing a proposal that aims to apply the study of times and methods in the production line of the Mini System, a device that promises a sound with more power, quality and functionality produced by a company from Manaus Industrial Polo. The overall objective is to show that by calculating production times and methods it is possible to increase the company's capacity and reduce labor. The specific objectives are: to map the productive process; measure operation cycles, through time and production lead time; identify bottlenecks and constraints; identify losses; and propose improvement actions. Therefore, the methodology used was a biographical research, carried out through systematic studies in books, articles and websites; This was followed by field research through data collection in the Mini System assembly operation, focusing on the analysis of the total time spent on the production line. The results achieved with the study were put into practice, showing positive changes in efficiency, increased production, reduced labor and financial savings.*

**Keywords:** Times and Methods; Continuous improvement; Productive efficiency.

## **1. Introduction**

The present study was conducted in a Manaus Industrial Pole company that is one of the leading manufacturers of consumer electronics in the world and is among the national market leaders for LCD / LED and laser multifunction televisions. In Brazil this company has two industrial complexes located in

Manaus / AM and Campinas / SP and operates in the following areas: mobile telephony, smartphones, audio and video products, white line, air conditioners, monitors, projectors, laptops, printing, hard drives and optical discs; and is the country's pioneer in the manufacture of tablets, LED and 3D technology TVs and the provision of devices with access to Internet content.

The main focus of this work is the Mini System production line in the company's industrial complex in Manaus / AM, located at Avenida dos Oitis, nº 1.460, Industrial District. This pole has a built area of 10,354 m<sup>2</sup> (34,000 m<sup>2</sup> total land) and the main economic activity is the manufacture of television sets, mobile phones, tablets, home theater and mini system. To this end, it has a team of 5,000 employees and has revenues of US \$ 500 million to US \$ 2.8 billion.

In times when the economic crisis affects production in all companies in the Manaus Free Zone, it is very important to work with lean production processes. The study of time and methods is becoming increasingly necessary today, due to the great demand imposed by the globalization of production and distribution, being part of a package required by companies, with emphasis on the needs of rationalization, productivity and quality.

In order to become effective and competitive in the market, the company needs a good control of its production processes, reflecting directly on the client its improvements in quality, costs, deadlines, safety, etc. Because one of the main causes of problems in companies' production lines is having multiple employees perform the same task differently without standardization.

We can gain control of process standardization by studying time. According to Slack et al (2002), time study is a work measurement technique for recording the times and work rate for elements of a specialized task performed under specified conditions and for analyzing the data in a timely manner. get the time needed to get the job done with the set level of performance.

The product must meet customer requirements and is produced by a stable or replicable process. More precisely the process should be able to operate with little variability around the target or nominal dimensions of product quality characteristics. Statistical process control is a powerful collection of problem solving tools (this work will primarily use the time and method tool) that is useful for achieving process stability and improving capacity by reducing variability.

Thus, this work deals with process stability by monitoring the production time of each operator for a given operation, identifying the possible influences of common or special causes that may alter the quality and production capacity, regarding their uniformity of production. production.

## **2. Theoretical framework**

### **2.1 Statistical Process Control**

Statistical Process Control is a tool with statistical foundation, used as an aid in both quality control and process steps, especially in repetitive production processes. Stabilizing routine processes is one of the most important items for companies as it ensures that product reliability is achieved.

According to Montgomery (1996) variability is the same as waste of money, time and effort. For this reason, one of the most accepted definitions for quality is precisely the reduction of this variation, that the lower, the better the trust and acceptance of the product or service that makes CEP one of the main tools

for solving this type of quality. problem.

Toledo (2006) lists the fundamental principles for implementation and management of Statistical Process Control, as follows:

- a) Think and make decisions based on data and facts;
- b) Separate cause and effect, always seeking to know the fundamental origin of the problems;
- c) Recognize that variability exists in production by managing it through priority reasoning;
- d) Rotate the control cycles: PDCA Cycle: Plan, Do, Check, Action; permanently and methodically, aiming at continuous performance improvement;
- e) Define the next process / stage / post and the expected quality as the customer of the previous stage.
- f) Create mechanisms to instantly identify foci and sites of dysfunction, correcting them in time to avoid damage.
- g) Create permanent education and training mechanisms for the workforce aimed at participatory management and self-control.

There is no miraculous formula, where their use guarantees immediate solution to all problems of a process, but the use of some methods is the most rational, logical and organized way to define the genesis of these problems, their extension and the best way. to address them, especially by helping to achieve systems that ensure continuous progress in quality and productivity standards at the same time.

## **2.2 Times and Methods**

To talk about the study of time, it is important to mention Taylor's studies, as he was one of the leading theorists to study time in problem solving, proposing that the highest rate of inefficiency in companies was directly related to wasted effort. human (LOPETEGUI et al., 2014; TAYLOR, 1990).

Already the study of movements was started by Gilbreth when using his technique in a film camera with the objective of studying the movements required for the execution of each. He advanced on Taylor's studies and created a set of movements that he listed as fundamental and necessary for the worker to perform operations on manual tasks. (Maynard, 1970).

For Furlani (2011) the study of times and methods is an instrument that has the objective of eliminating the waste of operational effort, adapting the tasks, training and specialization of the team and establishing work execution norms. Barnes (1977) confirms this by ensuring that the study of times and methods aims to improve working methods, increasing the productivity of an operation, lowering costs and improving product quality.

This Statistical Process Control tool can be characterized as a system study that has three factors: identifiable points of entry; transformation and output. establishing standards that facilitate decision making (FURLANI, 2011). This procedure ends up favoring the increase of productivity and supply of information regarding the times, in order to analyze and choose the best method for use in the production process.

## **3. Methodology**

To build this work, a visit was made to the Mini System assembly operation for data collection. involving

the total time spent on the production of these devices. According to the general objective, we propose to obtain quality and productivity indicators, as well as to analyze the balancing and standardization generated in the production process. After the analysis, the results were compared, trying to demonstrate the gains with the process improvement. For that, the Statistical Quality Control was used, mainly the time and methods tool.

#### 4. Problem identification and study application

The Mini System assembly line has a capacity of 2000 devices per day; It had 94 operators and had an efficiency of 70.3%, that is, it had an imbalance in the process of its activities, because its structure did not present adequate conditions for a good production. This can be seen in the figure below.

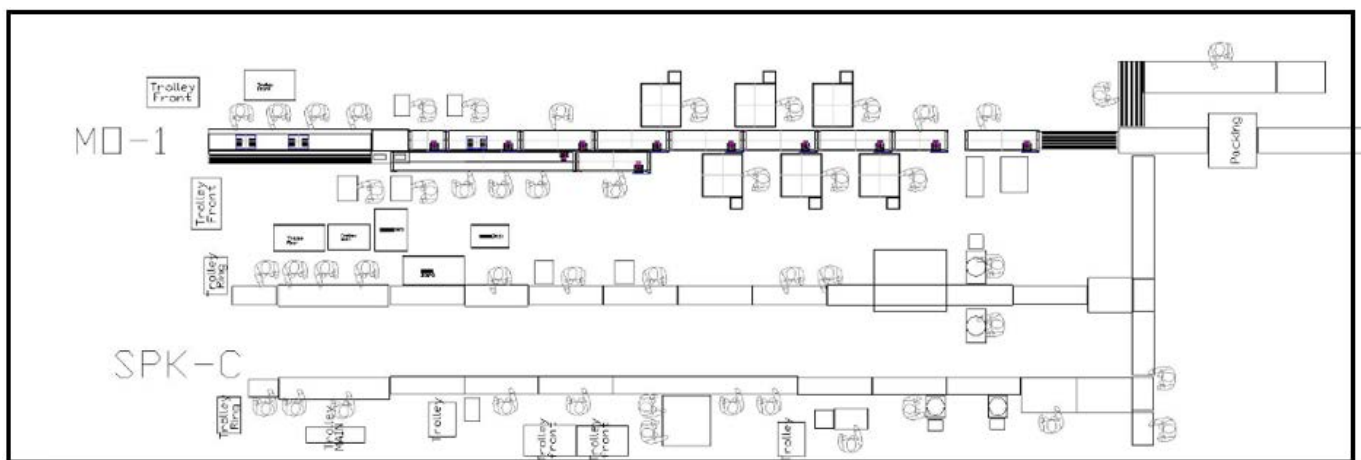


Figure 1: Mini System Production Line Layout (Before)

Source: Own Author

Another problem that was identified in the process was the amount of movement waste, as the devices were taken from the treadmill for assembly and then returned to the same treadmill, causing operators discomfort, quality problems and ergonomic shoulder and arm problems. number of times they loaded the device to assemble and test the assembly cells, as shown in figure 2.



Figure 2: Mini System Mounting and Testing Cell (Before)

Source: Own Author

Given this situation and through the information obtained, a time study was performed to verify all jobs and check which bottlenecks in the process, in order to present a proposal for improvement. The figure below shows a chart with job data, where each bar is equivalent to one job and the time spent at each job, showing more time wasted than necessary, since the rates are quite high.

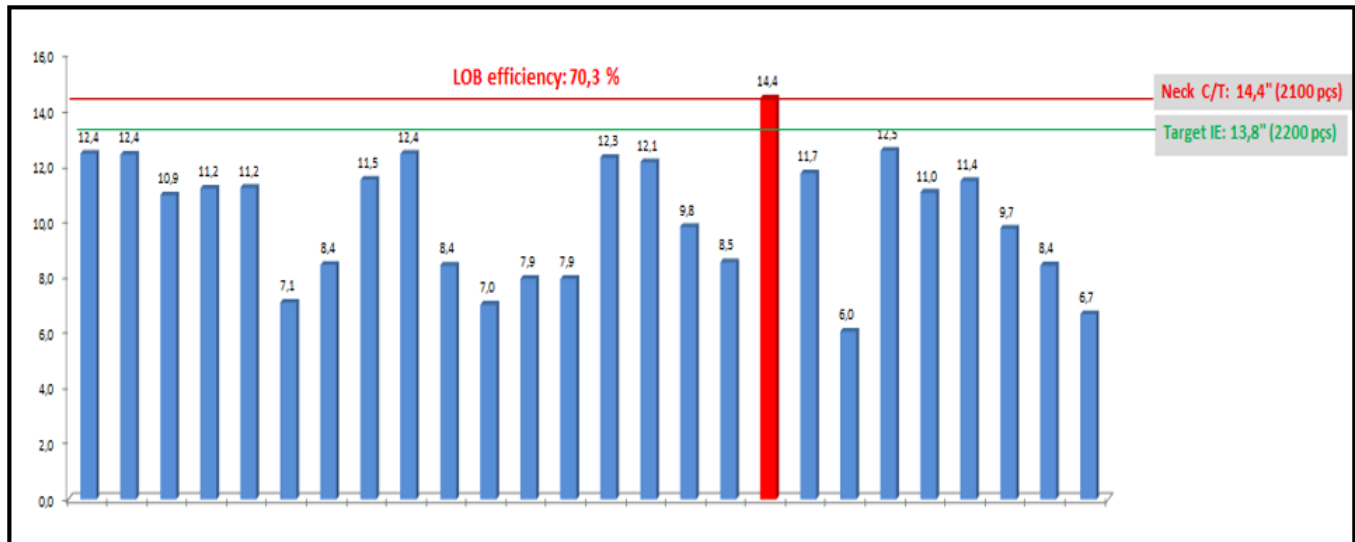


Figure 3: Graph with job data

Source: Own Author

After analyzing the times of each process, it was necessary a meeting with the sectors responsible for each area of activity (Mechanical Engineering, Electrical Engineering, Quality, Production and Innovation). Where built a schedule of activities to be performed after the commencement of the collective holiday of production, so that changes were tested as planned.

## 5. Results and discussions

After the implementation period, the most important innovation was the new audio testing concept for the Mini System, where the device would be tested on an eight-sided carousel and thus eliminated movement waste (belt grip and placing on same treadmill) and the ergonomic problem (loading the product to test and assemble) that was in the process.

Another important change was the introduction of conveyors to eliminate the quality problems that were in the process. This was because there was also a high rate of damage (beaten and scratched) in the speaker wood, because they used roller mats that transferred the product pushing, which favored the damage to hit each other, because it is a very fragile material that should have less manual process. See the figure below for how the eight-sided carousel test cell works.



Figure 4: Eight-Sided Carousel Test Cell (After)

Source: Own Author

These proposed improvements would bring more operator comfort, product quality, productivity and labor reduction, as the results of the company's indicators sought to produce more using less labor. To do so, innovation would be the main strategy to achieve this company's goal.

To represent the proposal of the new layout, a 3D presentation was built in AutoCAD, in order to provide a better visualization of how the new process and the new audio test concept in Mini System would look, as can be seen in the figure below. .

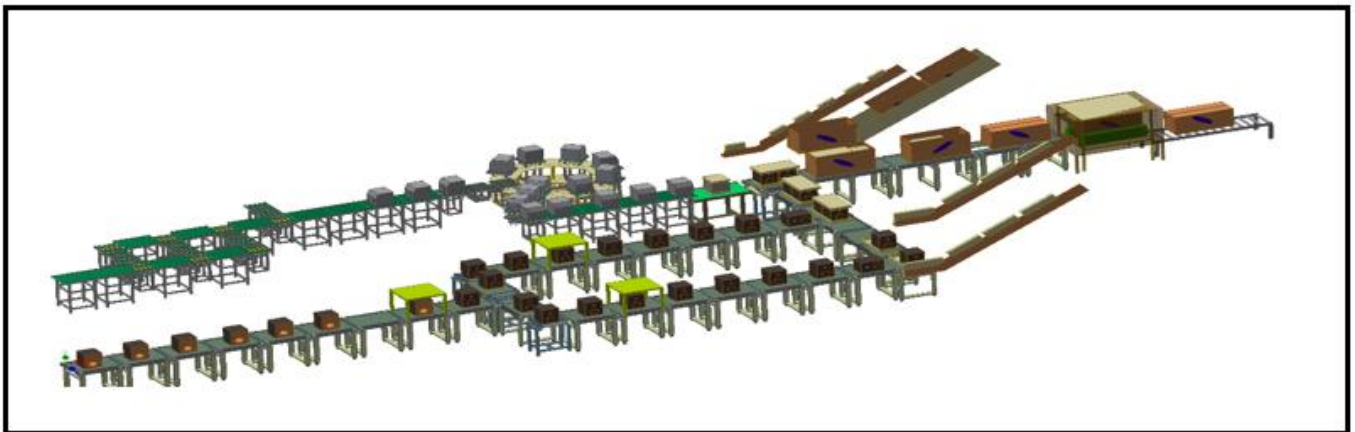


Figure 5: Proposed New Layout 3D Mini System production line

Source: Own Author

As a result, a new time study was carried out to apply the new process, which showed an improvement of 85.4% in efficiency, i.e. an increase of 18% compared to the previous process. It also showed an increase in production of 1000 pieces and a reduction of 28 operated, which equals a saving of 95,617.47 reais per month. Figure 6 shows the job data graph after the changes, where you can see the decrease in time spent on all jobs after the changes are implemented.





Figure 6: Graph with job data (After)

Source: Own Author

## 6. Conclusion

New work tools emerge from the adoption of technologies, causing changes in the scenario of organizations. In many cases, operators view the acquisition of new tools, or any other kind of change as a negative factor, and companies see it as an expensive process, especially if the objectives are not clear. By analyzing the current method employed in the Mini System production process, it was possible to realize that it was configured as an unbalanced process, requiring a detailed analysis of the entire production process and the creation of a new proposal. This proposal allowed for changes mainly in the new audio testing concept for the Mini System, which is now done on an eight-sided carousel, eliminating waste and ergonomic problems. Another change was the introduction of automatic conveyors eliminating quality problems and breakdowns.

According to this research, it was observed that the company referenced in the research is able to receive the tools shown in this paper, since the changes implemented generated results that can be qualified as satisfactory, considering that, besides the savings provided by the reduction time and labor required to manufacture the equipment, increasing productivity and consequently the company's production capacity. Due to the positive results offered by the implementation of the new tools, the company showed interest in the implementation of new improvements seeking the reduction of production costs (as a consequence of the reduction of production time) and the increase of quality and productivity. For the current situation of the company, the process improvement will be implemented to study the layout of the other headquarters and to introduce new products in the production line.

Given this, it is possible to state that the objective of the study was achieved through the application of quality concepts and tools such as the Study of Times and Methods, which allowed an analysis of all operators' movements, the creation of a layout change proposal, the implementation and monitoring of results. Following the implementation of the proposal, a new study was performed and an 18% improvement in efficiency was verified; increase in the quantity of parts produced, reduction of labor and cost savings.



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## **Editorial**

### **Dear authors, reviewers, and readers**

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to **THE VOL-7, ISSUE-11 of IJIER** which is scheduled to be published on **30<sup>th</sup> November 2019**.

International Journal for Innovation Education and Research (IJIER) is an open access, peer-reviewed and refereed multidisciplinary journal which is published by the International Educative Research Foundation and Publisher (IERFP). IJIER aims to promote academic interchange and attempts to sustain a closer cooperation among academics, researchers, policy makers and practitioners from a wide range of disciplines, which contribute to state of the art in science, education, and humanities. It provides a forum for the exchange of information in the fields mentioned above by welcoming original research papers, survey papers, and work-in-progress reports on promising developments, case studies, and best practice papers. The journal will continue to publish high-quality papers and will also ensure that the published papers achieve broad international credibility.

The Chief Editor, appointed by the Associate Editors and the Editorial Board, is in charge for every task for publication and other editorial issues related to the Journal. All submitted manuscripts are first screened by the editorial board. Those papers judged by the editors to be of insufficient general interest or otherwise inappropriate are rejected promptly without external review. Those papers that seem most likely to meet our editorial criteria are sent to experts for formal review, typically to one reviewer, but sometimes more if special advice is needed. The chief editor and the editors then make a decision based on the reviewers' advice.

We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

**Thanks,**

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## Transport Logistics Analysis of Amazon Application

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### Abstract

*The current marketing system faces one of the major challenges of finding strategies for safer logistics, both in quality and practicality to the competitive process that can be applied in the market. Transport infrastructure plays a significant role in the logistics process, as it impacts transport costs, bringing limits to the economic and social development of the region. In terms of transportation logistics in the Amazon, there are still obstacles where companies are constantly seeking to divert or solve such difficulties, since the state has geographical specificities, where its extensive rivers make the flow of production more difficult, so In this way, it is essential to understand how public waterway transportation policies contribute to the logistical bottlenecks of Amazonas. The state of Amazonas maintains about 600 km of state roads, however precariously, making traffic slow, and with the lack of BRs, the state is also penalized. Manaus has BR 174 and BR 210 that connects the municipality to Boa Vista, and BR 319 that connects Amazonas with the rest of the country is not completed and there is no concrete deadline for its completion, given the many difficulties and flaws. faced in that region. Regarding transport logistics in the most exclusive North Region in Amazonas, one particularity stands out: the lack of integrated planning for infrastructure that can bring positive results, both social and economic.*

**Keywords:** Transportation infrastructure; Economic and social development; Road transport.

### 1. Introduction

Logistics and transportation infrastructure are key factors in the socioeconomic performance of a region, and Amazonas, with a diversified conjuncture in terms of road transport, is deplorable that this is not in

accordance with the economic potential of the region and its vast range. importance. The scenario of Brazilian highways is precarious, especially in the Northern Region, paved highways are good indicators that show the limitations that the region faces, compromising the cargo transportation of companies operating in the State, especially in the rainy periods. It is precarious not only in the Amazon, but in the various states of the region, since we have the Transamazônica as a mirror, which should be the Brazilian miracle when in reality it is the nightmare of the various producers who depend on this road for their production flow. And in this extensive area of Amazonas, transport logistics faces major challenges and obstacles to be operationalized and to contribute to the achievement of the objectives of the organizations that operate in it. Transport Logistics in the Amazon are challenges and limitations for the development of the state, and, in the present times, it has assumed a vital role because it has emerged as a differential and strategies tool for companies and to guarantee advantages in their spawning and disposal. products.

Therefore, this paper aims to conduct a research on transport logistics of the Amazon, analyzing its contribution to the logistics process in the state. In this sense, we sought to analyze studies and publications in various forms and modes of transport of the Amazon. According to the results obtained, it can be verified that the concentration of investments in the road mode does not alleviate the problems of flow of the riverside production. The waterway infrastructure is still precarious and needs investments to meet the economic and social development of the region.

Given the reality, both national and state and local, it is evident the importance of having studies such as the one proposed here, in which the cargo transport infrastructure is analyzed. The results obtained seek a better understanding of the context in which the investments are applied, and contribute to overcome the inherent impasses to the economic and social development of the state of Amazonas.

## **2. Theoretical References**

Transport logistics is used by private and public organizations, such as manufacturing, transportation, food, Armed Forces, postal services, oil distribution and others. It is essential that the logistics planning activities are aligned with the manufacturing and marketing functions, so that the company can be effective in delivering and meeting the requirements established by the contractor. In addition, the main factor of logistics is to make goods and services available to the 20 consumers at the moment they are looking for them. (BRAZ, 2004; FERRAES NETO & KUEHNE JR, 2002).

Globalization has widened the distances between factories and consumer centers, as a company not only serves the local market, but also the national and international markets. Therefore, the management of institutional logistics systems uses different modes of transportation so that the distribution of their products reaches their final destination.

### ***2.1 The various forms of transport***

The ways in which products are distributed depend on a number of factors, especially in a region such as ours where roads are poor or nonexistent, enforcement on some stretches is not effective and transport is often neglected. The ways in which the various modes of transport relate, whether by force or idea, must be respected depending on the needs and characteristics of the Region, the services are used in a joint

action, which are:

### **2.1.1 Unimodal**

One of the simplest and most well-known forms of logistics is unimodal, i.e. when cargo is transported directly using only one vehicle and only one mode of transport. In this case, there is a transport contract;

### **2.1.2 Combined or Successive**

Uses another vehicle to transport its cargo on a given route, such as the carriage of a road semi-trailer by ship or barge. This type of transport contributes to the optimization in each step of the transport process, from the point of origin, with the collection, until the distribution of the products (BARAT, 2007);

### **2.1.3 Intermodal or Segmented**

Occurs through the transfer of cargo to another mode, without being responsible for the goods. This type of service is used when there are situations of routes that do not include the use of a single mode of transport (FRANCO; KITZBERGER & OLIVEIRA, 2008);

### **2.1.4 Multimodal**

Goods are transported by two or more modes; in which case it involves the integration of responsibilities of the multimodal transport operator from origin to final destination. In this type of service, it is clear to the shipper the entire path that his cargo has traveled (NOVAES, 2007).

## **2.3 Modalities of Transport**

Transport is a point of connection of a logistics chain, implying the search for efficiency of integration between two or more modes, and it must be coordinated and managed as a system in routes or corridors, implying the removal of any physical, operational obstacles. or institutional (BARAT, 2007). In addition, each mode of transport has its own peculiarities and specific mode of transportation: such as Road, Rail, Waterway, Air and Waterway. These modes can be used separately or combined with each other.

### **2.3.1 Road**

As its name implies, transport is usually by road and the cargo is packed in trucks, trailers, vans, medium vehicles, etc. The highway modal had its expansion with the end of World War II, mainly due to the flexibility achieved from the door-to-door delivery service, along with the intercity movement speed (CLOSS & BOWERSOX, 2007).

According to Novaes (2007), the advantage of the modal road is that it reaches almost the entire national territory, except very remote locations that do not have economic expression to demand this type of service.

For Goebel (1996), in addition to these advantages, he also mentions that this type of modal provides: higher travel speed; shorter loading time due to the vehicle's ability to allow its quick departure; ease of replacement of the vehicle with another due to the occurrence of incidents; and possibility of dispatch of cargo in installments. However, it has a higher operating cost compared to rail and river modes; impacts

road service level, especially during harvest periods when it causes major road congestion; and has lower load capacity.

### **2.3.2 Rail**

The cargo is transported by rail, i.e. by rail, packed in closed wagons and also often on platforms; The rail modal is the one used for ground transportation performed on railroads built for this purpose, that is, its space for transmission is not divided with other modes (RONÁ, 2002; KEEDI & MENDONÇA, 2000).

Rail transport is geared towards large volumes of cargo, making it attractive when transporting low value-added products takes a long distance. The aforementioned modal is used as a competitive advantage for the transportation of ores, steel products and bulk agricultural products (ANDRADE, 2007).

The rail modal is more efficient in relation to fuel consumption and other direct operating costs, to operate units that have higher load capacity, as well as low freight value compared to the road, suitable for transporting large and medium-sized vehicles. homogeneous shipments (NOVAES, 2007; GOEBEL, 1996).

However, the disadvantages of modal range from the need for longer travel time, high cost, when there is the need for transshipment, low flexibility and use subject to availability of rolling stock (GOEBEL, 1996).

### **2.3.3 Fluvial or Lacustrine Waterway**

In this mode, the cargo is transported by vessels that normally navigate in rivers, lakes and lagoons, using the largest natural resource available on the planet as the means for locomotion, water.

This mode has the advantage of being able to handle very large loads, and such transport uses two types of vessels: those offshore, designed for use in oceans and large lakes, and diesel-powered barges, operating in rivers and canals, having greater flexibility. This ability to transport large volumes / tonnages with a low variable cost contributes to this mode being required under conditions of low freight rates and when speed is not the primary point. In addition, it features high energy efficiency and high economies of scale for large long distance batches; has minimal maintenance and implementation cost; and is characterized by its low consumption of diesel oil, making it more economical and less polluting.

Compared to the building of road and rail modes, the construction of the waterway infrastructure requires low environmental impact, since the waterways use an existing road, that is, the river itself. (CLOSS & BOWESOX, 2007; ANDRADE, 2007; SILVA & DACOL, 2007; COSTA & PADULA, 2009).

However, the disadvantages are the limitation on speed and range of operation, and additional transport by rail or land is required when the origin and destination of the cargo are adjacent to the waterway. Another aspect considered disadvantageous concerns both the large number of handling, increased the likelihood of damage, and the need for ports with adequate infrastructure to meet the size of vessels. It is noteworthy that its effectiveness depends on the conditions of the infrastructure provided (CLOSS & BOWERSOX, 2007; ANDRADE, 2007).

The situation of the Brazilian ports is not satisfactory, because the low investments impact in their productivity regarding the cargo handling, because while in international standards forty containers are handled per hour, in Brazil the most efficient terminal cannot reach twenty seven containers. per hour.

Although the Brazilian coast has a number of sea and river ports, port operations occur with certain restrictions, such as congestion, excessive bureaucratic processes, arrival and departure delays, etc. (WANKE, 2010; SILVA, 2009).

According to Costa & Padula (2009), Brazil has a considerable waterway system, but it is underutilized due to the low usability of its roads, as the country has 43 thousand km of rivers, of which only 28 thousand km are navigable and only 10,000 37 km are used. However, navigable rivers require, due to their locality, dredging, terminal construction, damming, lock construction, winding river channels, improved road, rail and sea access. In addition to interventions in the rivers and construction of infrastructure in the waterways terminals in order to make it economically viable. Waterways also require investments in signaling, renewal and increased supply of equipment and fleet, as well as logistics capacity.

Among the Brazilian regions that most favor geographically the development of the waterway modal is the Northern Region, but its cargo transportation system is precarious, without conditions for efficient cargo transshipment. It is noteworthy that, because this part of the country has extensive waterways, transport by rivers plays a fundamental role in the development of the region. However, in some areas of floodplain the system used becomes the bi-modal, or better known as road-river. (Costa & Padula, 2009; Maciel, 2006).

2.3.4 Air - one of the most expensive modes, for transporting high value products with agility and safety. The air mode is the transport system that uses air for its displacement, having as its main characteristic to reach large distances in a short time. It occupies a very important space in the cargo transport sector, mainly internationally due to its greater safety and reliability, carrying high unitary value cargo such as consumer electronics, watch, high fashion etc., and perishables such as flowers, noble fruits, etc., (ANDRADE, 2007; NOVAES, 2007; RIBEIRO & FERREIRA, 2002).

With globalization, air transport has gained prominence, obtaining a growing demand from users despite the fact that freight is significantly higher compared to road transport, as markets have been expanded and consumers are demanding fast delivery of their goods. The supply chains have spread all over the world. However, the unreliability of shippers, to the detriment of the requirement of timely deliveries, induced the export and distribution of products through the air transport mode (NOVAES, 2007; RIBEIRO & FERREIRA, 2002).

This mode has the advantage of high speed, easy reach of distances, security against theft, damage and loss, as well as reduced inventory costs. However, when compared to other types of transport, the air is presented: more costly; higher fixed costs related to aircraft; handling and loading system; variable costs, spent on fuel, labor, maintenance, besides causing greater environmental impact (RIBEIRO & FERREIRA, 2002; SILVA & DACOL, 2007).

## ***2.2 Cargo Transport Infrastructure***

With regard to infrastructure, it has to imply access rights, both of vehicles and organizational units of transport that provide services for their own use as third parties, in the latter situation when the service charge is charged. Transport can also be conceptualized as a connection point of a logistic chain, this link implies the search for the efficiency of integration between two or more modes, and they must be

coordinated and managed as systems in routes or corridors, consisting in the removal of any physical, operational or institutional barriers (CLOSS & BOWERSOX, 2007; BARAT, 2007).

The economic and legal characteristics of modal or multimodal systems are determined by the nature of the infrastructure and may cover urban and freight transport. Freight transport infrastructure is considered as the main support for logistics, i.e. when transport infrastructure conditions present bottlenecks will impact the efficiency of the logistics process (CLOSS & BOWERSOX, 2007; BARAT, 2009).

The importance of transportation infrastructure is measured by financial indicators: cost, revenue and profit. Transportation contributes about 64% of logistics costs, 4.3% of revenues and can double the profit on certain occasions. Transportation costs are the main factor in the costs of the logistics process and, in some cases, their elevation is associated with the conditions of their infrastructure. In addition to the above mentioned indicators, there are others that measure the impact of infrastructure on the improvement of a given Region, such as the economic and social one (WANKE, 2010; CHOPA & MEINDL, 2003).

### ***2.2.1 Indicators for Analysis of Transport Infrastructure Investments***

The indicators are used to measure the level of development of a given region, especially those designed to ascertain the impact of freight transport infrastructure investments on economic, social and developmental aspects, using quantitative and qualitative data. In general, quantitative data are those based on numerical data and can be measurable and reliable; in turn, qualitative data are based on only perceptions of reality (BRAGA, 2008).

Regional development is driven by the transportation system: while the economic aspect links the production and consumption of goods; The social aspect is responsible for providing the conditions of comfort and well-being to society, also enabling the quick access of people, as well as their quality of life (TEIXEIRA, 2002).

Braga (2008) with another line of reasoning proposed a national transport model for Brazil composed of four modules:

- Transport Infrastructure Module;
- Regional Development Potential Characterization Module;
- Territorial and Space Module
- Impacts module.

Despite the changes suffered the need to invest in other modalities has emerged, the road mode remains the one that has the highest percentage of participation in the transport matrix.

Brazilian Air Modal This mode has been undergoing a restructuring, due to the new companies operating in the country and those older companies that went through a process of bankruptcy or financial crises, caused largely by the bad practices of corporate governance (MELO FILHO, 2008).

### ***2.3 Public Policies for Transport Infrastructure***

More succinctly, it can be said that the formulation of public policy constitutes programs and actions created from governmental purposes, which will produce, through their results, the necessary changes in

the country in which it was implemented. In this context, 38 have the policies focused on transport infrastructure that are formulated and implemented in each country, according to their needs and local reality (SOUZA, 2002). Brazil has as its main policies the National Logistics Plan - PNLT, the Multiyear Plan - PPA and the Growth Acceleration Program - PAC which will be described in the following topics.

### **2.3.1 National Logistics Plan**

PNLT The National Logistics and Transport Plan (PNLT) was created by the Ministry of Transport - MT together with the Ministry of Defense - MD through the Center of Excellence in Transport Engineering - CENTRAN, beginning to the elaboration work in February 2006 ending December 15, 2006 (PASSOS, 2007).

Conceptualized as a plan that covers the Federal, National and State spheres, having indicative character with operations in the medium and long term, it is associated with the process of socio-economic development, not being seen only as a list of projects and actions. Due to its involvement with the entire logistics chain associated with various types of transport, it is characterized as a multimodal plan (MT & MD, 2007).

In turn, the objective of the National Logistics and Transport Plan, as Perrupato (2006) is to develop, formalize and perpetuate a database and analysis tools, under the logistic perspective, to support the planning of public and private interventions in transport infrastructure and organization, so that the sector can contribute to the achievement of the country's economic, social and ecological goals, in the medium to long term horizons, towards sustainable development.

Abreu et al. (2008) also affirm that beyond these PNLT objectives in question is also the fact that the process of planning in the Transport Sector is resumed from the involvement of all modes used in transport, also containing the considerations regarding logistics costs and the need for a balance in Brazil's cargo matrix.

## **3. Materials and Methods**

The method used for this work had as approach the qualitative and deductive research, being the object of study the Transport Logistics in Amazonas, this method starts from the general through theories or laws to reach a conclusion and to understand the variables that generate or directly affect the problem. It was sought as steps of this method, the deepening about the knowledge of the problem, using data collections from various exploratory studies that were made through bibliographic research, by means of consulting articles, direct contacts, academic and technical papers relevant to the theme. . In the direct contacts were contacted people who provided possible and useful data or suggestions to the article, to compare the reality cited by the interviewees, we sought to have as a knowledge base the reading of works with the theme in question.

## **4. Analysis and Discussion of Results**

Representing the proposed model and its evaluations, the research studies (PLANOAMAZON) record five axes that would depart from Manaus as follows:



I- The North Axis, would make the road connection through BR-174, between Manaus (AM) and Boa Vista (RR), and could go to Venezuela, reaching the seaports of Caracas or Puerto La Cruz; or by diverting to Guyana, where it would also reach Georgetown Sea Port. In both cases it would be possible to reach the Caribbean, Central America and NAFTA countries.

II- The South Axis, would include the connection between Manaus and Cuiabá (Matogrosso) via Porto Velho (RO), and can be made by waterway through the Madeira River, connecting Manaus to Porto Velho and, from this point, to Cuiabá through BR-364 . Or by road, connecting Manaus to Porto Velho via the BR-319, in recovery, and from this point going to Cuiabá. One more consideration should be given to reaching Cuiabá via a road-to-river route from Manaus via Santarém via the Amazon River and from Santarém to Cuiabá via BR-163.

III- The East Axis presents a waterway linking Manaus to Macapá and the Santana Free Trade Zone in Amapá, establishing from this point a maritime corridor reaching North Atlantic (NAFTA, EU) and South Atlantic ports (Brazilian Coast, Uruguay and Argentina) and, finally, the East Atlantic, reaching the countries of Africa.

IV- The West Axis contemplates the fluvial transportation from the city of Manaus, through the Amazon and Marañon river to Puerto América in Peru. From there it would follow by road to the maritime ports of the Free Trade Zone of Paita, in Peru, accessing the sea routes to Chile, Alaska, the West Coast of the United States, Japan, and Pacific countries such as New Zealand and Australia.

V- The Radial Structure proposes the idea of integrated transport logistics in the State composed of a rod fluvial structure, where it is possible to establish a network capable of promoting not only interregional integration, provided by the axes, but also intraregional, linking the dynamic center to the main ones. inland municipalities. From a focused vision for the development of transportation in the Amazon, we intend to resemble the living standards of these regions, because with the distortions that occurs mainly in the interior of the Amazon, it is necessary to promote socioeconomic integration.

As a Transport evaluation, you cannot rule out any options, as alternatives often do not receive the necessary attention. Still talking about the product flow axes, the IIRSA Regional Integration Initiative for Regional Integration of South America has already distinguished the Amazon Axis as a multimodal transportation system that connects the ports of the Pacific region with the Brazilian ports of Manaus, Belém and Macapá. This interconnection of the Pacific Ocean with the Atlantic would occur through the Huallaga, Marañon, Ucayali and Amazonas rivers in Peru; Putumayo and Napo in Ecuador; Putumayo, Colombia; and Iça, Solimões and Amazonas, in Brazil.

## 5. Amazon Logistics

The creation of an integrated policy to overcome logistical challenges in the Amazon is identified as an essential strategy for the region's development. The Amazon suffers from an “Achilles Heel” that resides precisely in the absence of a long-term structural plan that keeps the state in geographical isolation with the rest of Brazil. The need for agile, safe and affordable transport mechanisms to acquire inputs and dispose of capital and state products.

Logistics is critical from any perspective of our region; it is the way cargo and people are transported as

we are far from the big markets. But the movement between cities and poles is precarious, because in the matter of waterways we do not have, for example, adequate ports are almost zero and the highway is totally unmanaged. The problem with logistics is strategic planning and infrastructure.

Due to its geographical location, in the Amazon, about 70% of all goods circulating in the region are transported by sea. Although there are long stretches of rivers with potential for navigation, only one waterway runs regularly formed by the Madeira and Amazon rivers. In addition, the sector faces major difficulties such as the constant lack of river dredging, signaling and river cargo theft.

“In the case of the Madeira River, which is the most navigated with cargo, it would need dredging and permanent signaling, since the beds are unstable. But overall, all the rivers in the region have these needs.”

## **6. Application of Research**

According to Gilvan Huosell Ramos - Logistics, until recently, existed to continue operations born in more developed regions, such as the South and Southeast of the country, essentially. The logistics centers acted in the northern region as simple regulatory warehouses which generated additional costs for the parties involved in the supply chain process. (April 2012)

And yet, with the great fiscal revolution in the country, the states of the northern region have had a certain industrialization, are now very competitive in distribution and are creating their own logistics that in the medium term will have nothing to envy the big centers.

According to Professor José Alberto Machado - to overcome the unique challenges of the Amazon it is necessary to create an integrated policy that will make logistics become an essential strategy for development in the region. “We are experiencing the same situations without major changes, with the aggravation of cargo theft. The great drama of our state is not having a plan for the next 20 years, it is nonexistent in the long run on a structural basis. Only one deal is made here and there, just for momentary measures.” August 2017.

And according to Machado - Without advances in logistics in recent years, Amazonas loses mainly in productivity and competitiveness. “For example, we could have a distribution center at our airport like Panama City, a reference in Central America. With that, we would have competitiveness mechanisms to get to other regions of the country and even international destinations fast. From this, there would be tourist flights that in our geographical point of view would be logical and affordable.”

Ballou (2008, p.42) says that the task of moving the product does not necessarily end when the goods reach the customer. Goods may be returned by the customer if, for example, the wrong product has been delivered, or the product is damaged. In any case, the logistics administrator should establish procedures and prepare for the storage of goods returned from the delivery sites. Similar arrangements should be made for products that have become obsolete while still in stock. They must be settled or returned to the factory for rework. ’

According to the Uniemp Institute (2007) ‘the development of logistics innovations is focused on the modernization of the ports, the handling of containers, the distribution logistics service of the interior of Amazonas. SOUZA et al Electronic Journal of Administration (Online), v. 10, n.2, edition 19, jul-dec

2011 5 storage yards, cargo traceability systems, integrated management software that monitor each stage of transportation, including fuel consumption. There are also vehicle innovations, such as trailers that adapt to both road and rail, as well as various types of technological implements. '

## 7. Conclusion

Analyzing all the problems faced in transport logistics in Amazonas, especially in road transport, an ideal solution seems distant, because it is up to those who experience logistics in essence, to look for possible ways of improvements and outputs to be able to perform this distribution of cargo. The great impact and influence that transport infrastructure has on the logistics and socioeconomic development of a region can be verified, and in order to improve these inadequate and inefficient points, a change of concepts and follow-up involving the public power is necessary. , since it has its share of responsibility, because it is necessary that governments, both federal and state, in addition to private initiative, engage in the search for new solutions and alternatives. Implementing measures to improve cargo outlets, adjust road infrastructure, establish a road plan, considering all development areas with a road and waterway network, create rest and guard points for trucks on the country's major highways, and thus a positive point, because with the conclusion of the paving of the BR 319 that connects Manaus to Porto Velho, it would be a favorable point in the flow of products from Manaus to other states, and thus the state's potential would be enriched through the adequacy in transport infrastructure and logistics.

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# **The Application of Logistics as Increase Income in Small Porte Company - Case Study in Salgados Mania**

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## **Abstract**

*Logistics challenges are present in any organization, including small businesses. If today it is indispensable in large industries, for smaller companies the reality is different, since, in general, they do not have enough structures or employees to face adversity and meet their goals. Thus, it is becoming increasingly relevant to invest in tools that can bring improvements and results. Logistics encompasses activities that deal with the flow of material, human and information resources, but micro and small entrepreneurs generally do not handle all these stages of the process, which ends up making production work, often with lower efficiency than its total capacity, generating costs and making the company less productive. Lack of planning causes damage most of the time. This involves everything from inventory control to small processes that need human monitoring to happen. Due to the tools logistics offers to implement in any industry, regardless of size, opportunities for management improvement are growing, making the small business owner eligible to plan and think bigger about their business.*

**Keywords:** Small business; Logistic process; Material flow;

## **1. Introduction**

In order to apply logistics tools to improve controls and processes, the small business Salgados Mania opened the door for a study based on how the company works, and how it currently manages its supplies and employees. .

Salgados Mania is a small company that works in the production of sweet and salty foods, small and large, fried and baked, for parties and buffet, and even for sale in grocery stores, convenience stores and snack bars in the city of Manaus. The organization, still small, has grown considerably in recent years, which has caused its demand to increase considerably, requiring greater attention from managers to reconcile the increase in demand with the need to adapt to what the market demands.

Founded in early 2010, the salty factory has sprung up unpretentiously. The beginning of the activities was marked by the willpower of the current owner to manually make the first salty produced by the company with high quality standard and reference in taste. This production was done in the house of the founder's own house, with the help of her husband and children. At that time, the company did not imagine the size that its products could take and being at the beginning of work, everything was done in a rudimentary way, from the purchase of materials, until the arrival of salty products to the final consumer. This work required a lot of everyone involved. There was no fixed person to purchase the materials needed for production, just as there was no fixed person for the deliveries of the product, and so on for the different processes required to reach the end of production. All family members performed all functions, with no organization that could optimize time and cost.

Over the years, the quality of the product began to become known in some regions and places of the city, which made the demand increase even more. Given the situation, the company needed to change the way it worked and decided to invest in machinery and human resources, increasing its internal costs to meet the requests of the various customers that the company had conquered. Currently the company has 7 employees, with a decrease in the artisanal workforce and the greater use of machines for the manufacture of savory foods. About 9 months opened its first physical store, fruit of the market change and increase the flow of production.

Given the above, the general objective of the case study in the company was to verify under what logistics conditions it was, using quality tools to identify problems and implementing logistics tools to correct what was identified as something to be improved. The specific objectives are to improve the company's inventory control, improve process controls and reduce idleness and nonconformities of the products that the company is subjected to on a daily basis.

## **2. Theoretical References**

### ***2.1. About logistics and its application in identifying problems***

Today's logistics challenges are inherent in any organization, whether large, medium or small. If in the former, adversities are present for execution, in small companies the obstacles are even greater, because the fierce competitiveness and complexity in management, lacking procedures and structuring flows between products and customers, Logistics arises to improve service levels in customer service, reducing financial costs and streamlining production, handling, transportation and distribution processes.

Logistics has a broad concept, covering various aspects of the organization, such as production, financial, economic, marketing, customer, among others, given its cross-cutting nature, emerging to foster the integration of functions, aiming at the best end result.

According to Razzolli Filho (2010, p.20):

"Logistics can be defined as part of the supply chain management process that aims to efficiently and effectively plan, implement and control the physical and information flow, as well as the storage of goods and services, from source to consumption, always keeping in mind the objectives of the company and the customers. "

In the words of Christopher (2011), logistics seeks to create a better flow of products and information through a unique plan that suits the company.

According to the Concil of Supply Chain Management (2019), logistics can be defined as the process of planning, implementing and controlling the efficient and cost-effective storage and flow of raw materials, process inventory, products and related information from the point of origin to the point of consumption for the purpose of meeting customer requirements.

In turn, Ballou (2006) defined business logistics as all handling and warehousing activities, which facilitate the flow of products from the point of purchase of raw materials to the point of final consumption, as well as information flows. that put products in motion for the purpose of providing adequate levels of customer service at a reasonable cost.

In this step, logistic development has as its starting point the integration of internal and external activities, connecting suppliers, customers, service providers, from the point of view of managing and coordinating variables, which will ensure quality performance, speed, flexibility, innovation, efficiency, economy, among others, adapting to the viable organization model.

## ***2.2. The use of process systems to solve business problems***

Given the complexity of the logistics system and the need for simultaneous management of multiple conflicting stakeholders, in-depth knowledge of both logistics (at all levels of their ecosystems) and external factors (at the corporate level whose ultimate object is customer satisfaction.

Considering that just the advancement in the processes is not enough to define the good performance of the organization, the application of the PDCA method as a tool for quality control and process improvements through four steps emerges to add value to the final product quality. to the client.

## ***2.3 - The PDCA Cycle***

The PDCA cycle is a cycle of continuous analysis and improvement, which was defined by Walter A. Shewhart, however was disseminated by Deming and is known as the Deming Cycle. The cycle consists of four basic control steps: Plan, Execute, Check and Act Correctly.

Quinquiolo (2002) defines the PDCA Cycle as a methodology that has the basic function of assisting in the diagnosis, analysis and prognosis of organizational problems, being extremely useful for problem solving. It is the method used to promote process improvements of any kind, resulting in the maintenance of results.

According to Moura (2006), the PDCA is a tool for the orientation of the sequence of activities that helps the management of a task, process or company and is based on the concepts of administration.

According to Mariani (2005) the PDCA method is used by organizations to manage their internal processes in order to ensure the achievement of established goals, taking information as a driving factor for decisions.

For Vieira (2010, p. 24) the PDCA is a method that manages decision making in order to improve the activities of an organization and is also widely explored in the pursuit of performance improvement. This makes PDCA very important and significantly contributes to better results.

The application of the PDCA cycle is an important instrument for achieving professional excellence, as it allows identifying the problem, managing risks, costs, business benefits through quality management and process control plans and guidelines, shaping the organizational culture. that seeks the best possible results.

#### **2.4 - Process management**

For the execution of the services, it is necessary that the companies follow procedures to sequence the activities and to guarantee the attendance of the external activities.

For Lopes et Bezerra (2008), process management can be used as a basis for continuous improvement of production processes, increasing efficiency levels and reducing losses and consequently maximizing profits. Thus, it is evident the need to constantly evaluate the organizational processes, as well as continuously improve or recreate them, due to changes in the organizational context in which the management is done.

For Slack, Chambers and Johnston (2015, p. 12), operations are processes that bring together a set of input, such as inputs of a service transforming something; and output, as output of services and products, following a general model inherent in their process.

For Maximiano (2015, p. 190) a process of an organization has three main meanings, namely: process organization of any set or resource; organization as a structure resulting from a process being organizational in any company or enterprise it has in an organization; and organization as a concrete entity, even if apparent to any large company or single enterprise. Still, according to the same author, organizing is the process that has any resource collection or set of parts in a given structure, order or classification. Being classified into an organized set or ordered parts, following any criteria or an assigning organization from any structured or ordered set.

### **3. Tools and Methods**

With the opportunity to experience the day to day life of the company, an analysis can be done with greater precision in the first visits to the factory. Everything was taken into consideration when considering the possible needs that the company demanded regarding improvements that could be applied.

Following a line of logical reasoning, according to the respective stages of the process, the main purpose of the analyzes was to gather relevant information that could determine and show where, in fact, the shortcomings of the procedures were evident. And for that, we used a quality tool that help identify operational failures so that the repair is done on multiple fronts. The tool in question was the PDCA, which facilitated the approach to the different stages of production of the company Salgados Mania, as it is focused on the control and continuous improvement of processes and products.



## 4. Study Application

### 4.1. Problem Identification and Tools Used

Firstly, the PDCA was used to gather information about the input of raw materials necessary for the beginning of salty manufacturing. In addition, this could also involve the way in which the company's inventory control was handled. The first signs that there were problems began to emerge.

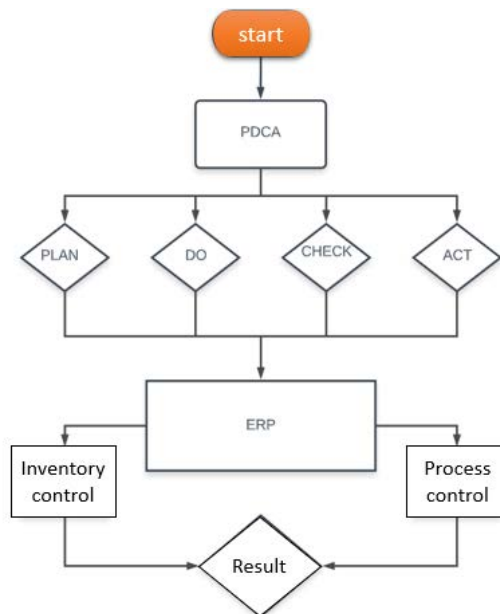


Figure 1. Initial flowchart for process analysis.

Source: Own Author

There was no ideal inventory control, purchases were made according to the absence of certain key products and thus created a large idle production due to lack of inventory. It was also found that the company had few fixed suppliers, which increased costs at some point when placing orders. Thus, the weekly spending on the purchase of groceries and waste was distributed as shown below, in reais:

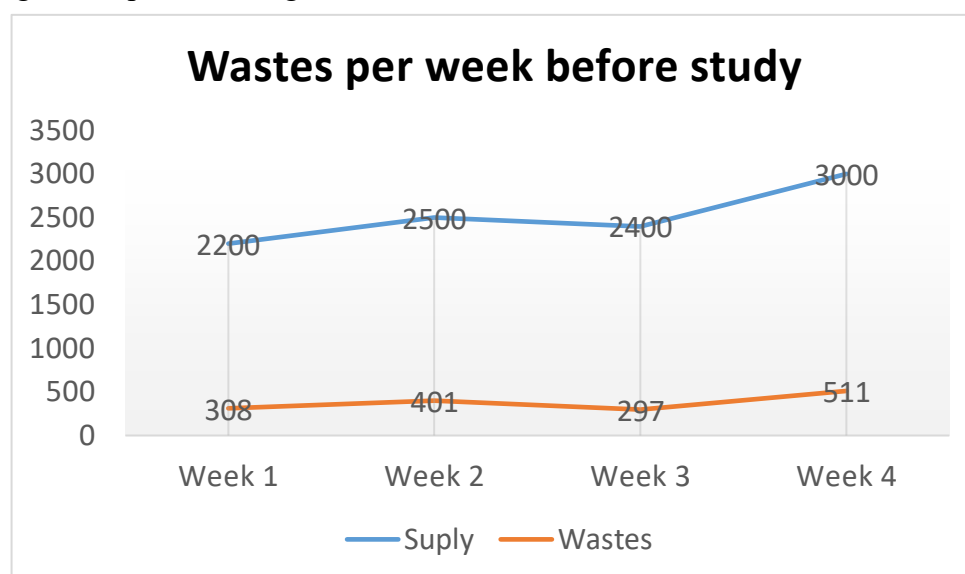


Figure 2. Expenses in R \$ with groceries and waste per week before the study.

Source: Own Author

From stock production began manually, since to start the process of production of small snacks in machines, there was the need to make the masses and fillings of various types and qualities of delicacies. With only three people taking care of both the manual and operational aspects of the machine, there was a lack of sufficient manpower to speed up the process, but the company said there was no availability for staff expansion at that time. It was then that the second problem was encountered, the existence of a production bottleneck that diminished the productive capacity in relation to the capacity that the factory could present if it were operated correctly. Another point that was noteworthy was that all the production of large salted foods did not have the aid of machinery, that is, it was done entirely by hand and by hand, by the same people who worked in the process of the smaller salted foods, which showed that it did not. There was an organization of different types of procedures, which resulted in wasted time and increased costs.

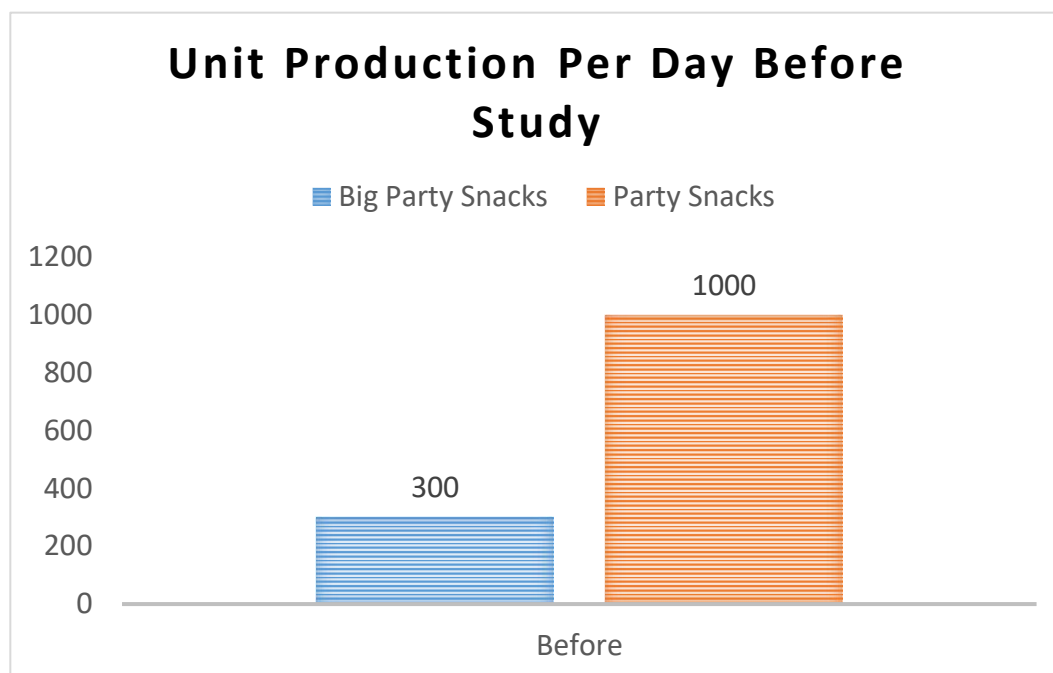


Figure 3. Production of large and small salty foods in units per day before the study.

Source: Own Author

Given the analyzes carried out in the process part, finally the last verification step was the storage and disposal of ready-to-eat products and products ready for freezing and subsequent sale. Applying the inventory controls tool and logistics tools, it can be seen that in both activities the company was in need of greater control and monitoring, which caused delays in delivery.

#### ***4.2. Proposed measures to be taken to improve processes.***

From the moment the company's improvement needs were identified, the opportunity arose to apply actions that could turn into results, and for this, as proposed, the logistics tools that could have some positive effect were put into practice. within the current scenario of the company.

Based on the inventory control tool, the first part of the company to be worked on was the purchase and storage of the raw materials necessary for the development of the processes to be performed from the

production sequence required on the factory's production line. If previously there was no effective control over purchases, then the FIFO system - "First in first out" was applied. The inventory control method adopted allows companies to use raw materials with longer usage times first, and also allows the possibility of creating a stock without shortages in any unforeseen order needs, and it also allows The company is in the food business, lower losses with expired or damaged products, since the probability of this happening is great if there is not a correct storage procedure for each type of food.

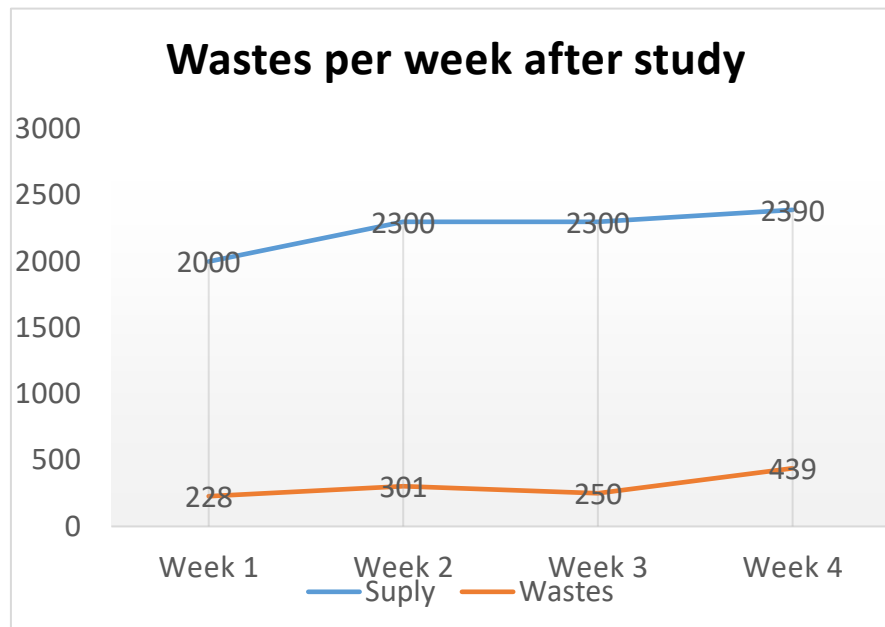


Figure 4. Expenses in R \$ with groceries and waste per week after the study.

Source: Own Author

Following the line of inventory control, the company was proposed to be loyal to certain suppliers. The practice implied in purchases with volume established according to the weekly need of the company, this consequently allowed a bigger gain in relation to the discounts applied in the purchase of the goods, since in purchases of large volumes one can buy with the wholesale price.

Going against the processes adopted by the company, the application of tools to improve process controls was also started. Prior to any change initiative or proposal, it was evident that there was a need to increase the number of employees who take care of this area, so it was proposed to improve the hiring of at least one more person who could manage the machines and processes involving the production of savory foods. Still regarding the process controls, it was suggested the creation of a production schedule, establishing guidelines and goals to be fulfilled according to the seasonality of the orders that the company has, although, in certain periods of the year, have a lower production need. There was no hiring another person, but there was a relocation and assignment of tasks exclusive to certain employees. Thus, the daily production capacity has evolved significantly.

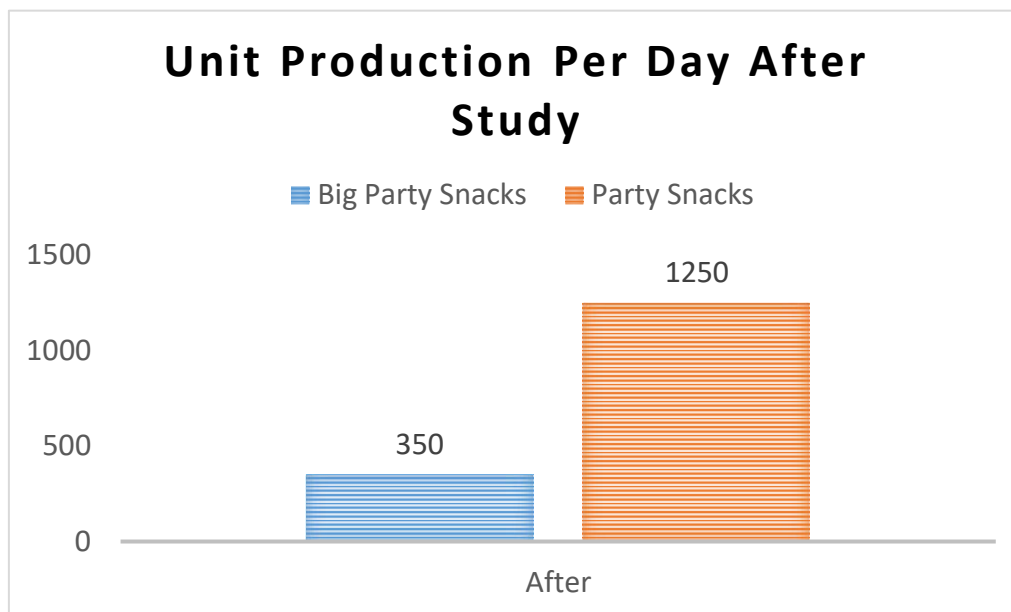


Figure 5. Production of large and small salty foods in units per day after the study.

Source: Own Author

The implementation of process control is also due to the company's ability to manage its organizational deficiencies. Due to this, a higher quality was proposed in the follow-up of the decision making in the motivational scope of the company, regarding the quality of the workforce and satisfaction in doing the best for those who make up the staff of the organization. This causes the company to have to have a favorable organizational climate that enables such conditions. Thus, it was indicated the use of the famous 5S method, which provides process improvements when working the five fundamental pillars to create a fundamental work environment for good results.

## 5. Results and Discussions

With the completion of data collection and the implementation of the proposed resources to improve the processes executed within the salty factory, new ways of managing the business can be put into practice, so the various positive results began to appear shortly after the changes made in the way of production of the organization.

From this, the company's initial objective of improving financial results was achieved by implementing changes in the behavior and way of running the company and adding approximately 10% higher profit compared to before the study. Where there is a decrease in spending in all sectors of the company, especially by the organization that was exercised to put into practice all that was proposed.

Despite not being able to reach the total effective production capacity, the percentage of its delivery to large salted products rose considerably, about 14.9% higher than the previous month's production. For small savory foods, the improvement was even better, 25% above the previous average. The stock now includes frozen products set for sale with a shorter time than previously had, this reduces the cost of energy, since it stopped using one of the refrigerators, and the product is no longer waiting for more orders, translating into better product quality.

The use of an ERP system has been ruled out. As much as it was known the gain that the tool could drive in sales and management of the company, the high cost for a small business weighed at the time of decision.

## **6. Final Considerations**

The applied study aimed to improve financial results in a small company by applying logistics tools capable of creating improvements in various sectors of production, from the input of raw materials to the flow and storage of production. Thus, a study was proposed in the process that could identify the main points of the production line in need of changes, which caused the process as a whole, idle production and relevant losses due to inefficient management. As a result, this also led to inefficiency in the production line, making the process less standardized and considerably reducing the company's effective production capacity.

After the changes were made, the analysis of process improvements began. Using the PDCA, the "CHECK" was put in place to check if the results obtained were in accordance with the main expectations established in the planning and execution stages of the changes.

It was evident that it was possible to reach an acceptable evolution to the previous molds and results that the company had been presenting. Initially decreased inventory costs. With the way of working centrally and with fixed suppliers, losses with overdue foods were nil at certain times, which resulted in an 11.9% reduction in the amounts spent on obtaining the raw material. There was no need for hiring employees, the study was conducted with the same number of people working, however, with the assignment of functions and pre-established activities, it was noticed a decrease in machine setups, when there was the need to diversify salty types. What allowed the perception of improvements was greater control in the process, in addition to the importance of the organization established from the 5S.

For future studies, I suggest the possibility of implementing an ERP system, which would allow the whole company an integrated management follow-up, which can bring even more benefits to the company, which was not possible to study it due to the lack of resources for investment. in the tool by the company.

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## **A Solar Powered Electronic Device Charging Station**

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### **Abstract**

*This paper proposes the development of a mobile device charging station with solar energy as a source of energy to meet the population's need in a sustainable way. To validate the concept of the article, a prototype was built using photovoltaic solar panels, charge controller and battery and tests were done at different times of the day so that it was possible to verify different quantities, such as voltage and electric current and with this data calculate the power supplied and the battery charging time. As a result, it was observed that the best performance was at noon, with two photovoltaic solar panels, but energy was generated throughout the daytime.*

**Keywords:** solar energy; mobile devices; batteries; sustainability.

### **1. Introduction**

Great is the concern of many countries to make better use of natural resources. Initiatives such as the Kyoto Protocol [1], Rio +10 and Agenda 21 have been showing this.

Brazil, for having the largest tropical forest, prioritizes projects that develop clean technologies or allow resources to be used, but that are compensated in some way, either by reforestation, by species preservation projects or by alternative power generation.

Brazil is one of the countries aimed at developing more responsible products and systems through renewable sources and cleaner manufacturing processes that are consistent with environmental policies. In this sense, it maintains the most renewable energy matrix in the world, with 45.4% of its consumption directed to the use of water resources, biomass and ethanol, in addition to the contribution of wind and solar energy, and hydroelectric plants account for over 75% of electricity consumption by the Brazilian population [2].

Among the main alternative sources, it can be highlighted photovoltaic solar energy, as it is characterized as one of the least polluting primary sources, still quoted as silent, needs low maintenance and maintains short installation and operation times. Thereby, it has no high environmental impact, which is almost zero and can easily be integrated into the construction processes [3].

On the other hand, according to the Brazilian Institute of Geography and Statistics– IBGE [4], 93.2% of the Brazilian population had mobile communication devices such as mobile phones or tablets and these, where over 90% spend more than eight hours a day away from home, whether working or studying and the battery charges of their mobile devices lasts around seven hours if heavily used so, most of the time it is necessary to recharge your mobile device battery throughout the day.

Besides the need to recharge the batteries, this work prioritizes the research bias that seeks to use renewable energies, such as wind and solar, since they do not emit greenhouse gases like those generated in thermoelectric plants and neither devastate areas of forests such as those generated by hydroelectric dams.

With a view to producing clean energy in the use of numerous other activities that fit this same condition, we have seen in the creation of solar powered stations for charging electronic devices battery, an alternative to decrease environmental and energy impacts and also the opportunity to bring electricity to remote places, like the many that exist in the Amazon.

This paper is organized as follows: Section 2 presents the theoretical framework, Section 3 presents the methodology and tools used, Section 4 presents the tests and discussion of the results, followed by Section 5, which is the conclusion.

## **2.Theoretical Framework**

### **2.1. Photovoltaic Solar Energy**

There are two types of photovoltaic systems, differing in their application forms: the systems connected to the electric grid and the autonomous. A typical home solar system consists of “PV modules, charge controller, batteries, inverter for converting DC to AC voltage and other auxiliary equipment, building materials and mounting of modules, wiring, meters, supervision software and assembly service” [5].

In systems connected to the electricity grid, the use of photovoltaic generators is necessary; panel protection equipment to prevent reverse currents; inverter, which acts in the transformation of the energy in direct and alternating current, maintaining the compatibility with the electric network, as shown in the Figure1 [6].



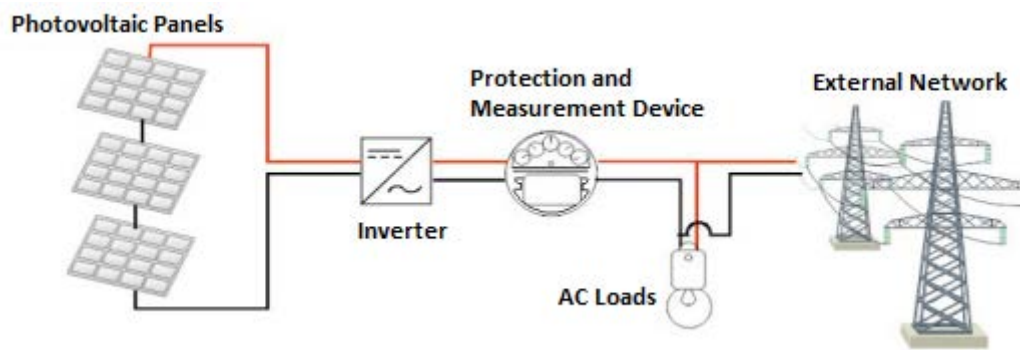


Figure 1: Photovoltaic system connected to the electric grid

Source: [6]

Autonomous systems, in its turn, consist of an energy storage system whose action is performed by batteries, which also need protection equipment against overvoltage and excessive discharges, such as a charge controller. It is essential that the connected loads be compatible with the battery voltage and be transformed into alternating current using a converter or inverter [6], based on the Figure 2.

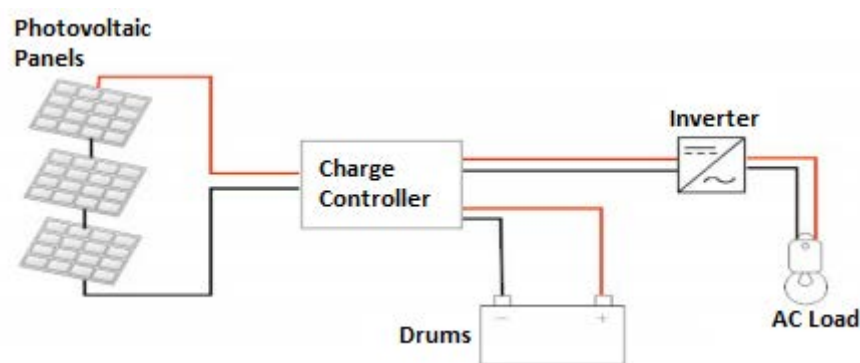


Figure 2: Autonomous Photovoltaic System

Source: [6]

By converting solar energy into electrical energy, photovoltaic cells utilize the properties of semiconductor materials, mostly silicon, which when combined with chemical elements such as boron and phosphorus, give rise to the PN function, concentrating on the one hand the positive charges and the another, negative charges. This permanent electric field prevents the passage of electrons from side to side. When a photon has enough energy to excite an electron, there is the circulation of electric current, and then the generation of continuous energy, obtaining the photovoltaic effect [6].

Figure 3 presents a symbology commonly used in the representation of photovoltaic cells and panels, as well as the constitution of an electrical circuit facing the solar cell:

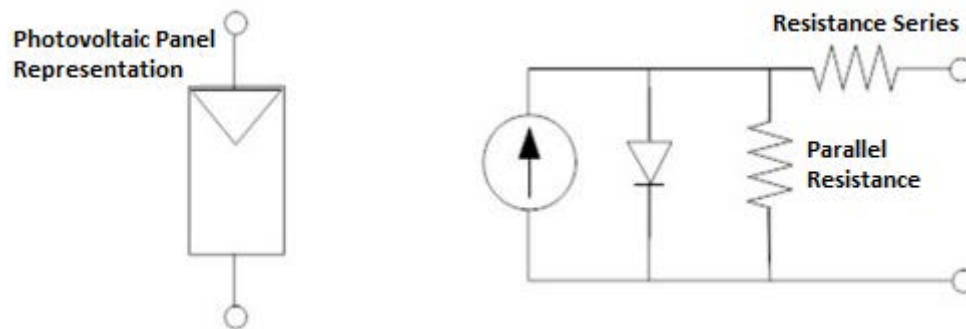


Figure 3: Representation of a photovoltaic cell

Source: [6].

Photovoltaic solar panels are designed and produced to be exposed outdoors, subject to sun, rain and other weather agents, operating with satisfactory results for at least 30 years. They can be housed in building wraps, maintaining the dual function of generating electricity and serving as an architectural element in covering roofs, walls, facades and windows [7].

In the field of civil construction and electrical installations, the implantation of photovoltaic solar panels is already supported by well-established technologies and projects that make this practice increasingly common in buildings [7]. The electrical connection to the network and the peripheral devices that act as interconnectors can be easily found in the market, meeting any type of configuration or size.

Most photovoltaic systems are connected to the conventional grid and nowadays have become more accessible [3]. Although Brazil is located in a high insolation area, photovoltaic energy is little explored. This is due to the fact that Brazil is rich in water resources, encouraging the generation of electricity from the most accessible large hydroelectric plants. On the other hand, centralized power generation presents its needs, being normally located far from the consumer centers, requiring the installation of large transmission lines, leaving in some cases to serve isolated communities. Thus, it is understood that besides offering economic and environmental advantages to consumers, it is able to serve these communities.

With the use of solar energy and consequently the reduction of conventional electricity consumption there are economic and environmental advantages, as well as ensuring the construction of environmental and socio-cultural awareness through the application of clean and free energy [8].

## 2.2. Solar Power for Mobile Phone Chargers

There are few studies on the development of solar powered mobile phone charger prototypes. According to [9], Charge Controllers are referred to as “electronic circuits that manage the energy in and out of batteries to protect them from the effects of overcharging and deep discharge by adjusting the actuation points of the circuits of load and consumption”. They can be developed from two types of physical configuration: in series, when the photovoltaic panel of the charging circuit is disconnected as soon as the

battery reaches almost its full potential; and in parallel, when there is a short circuit during power generation, both of which are able to decrease the charge current offered to the battery.

In the study by [9], it was stated that "because it depends on the intensity of radiation, the generation of electric energy from solar sources presents great variability, thus requiring the use of batteries for storage". The author also points out that this does not affect the efficiency of the system, since the use of batteries enables the proper functioning of the proposed system. However, the biggest difficulty of the project was to find the availability of photovoltaic cells to build its own panel.

[10] presented a prototype of a solar cell battery charger, demonstrating that the auxiliary battery is fundamental for the system to operate at night and in unfavorable locations for photovoltaic panels. The charger under study adopts photovoltaic cells as a sustainable source of energy, and also consists of the auxiliary battery that provides greater charging efficiency, accumulating energy and providing greater benefits to the user.



Figure 4: Prototype of photovoltaic cell phone charger

Source: [10]

The charger architecture developed by [11] was made up of a photovoltaic panel, responsible for transforming solar energy into electrical energy, which remains connected to a charge controller and the cell phone. You can also connect it to a rechargeable battery whose purpose is to ensure energy use at times when solar incidence cannot be obtained, illustrated in the Figure 5.

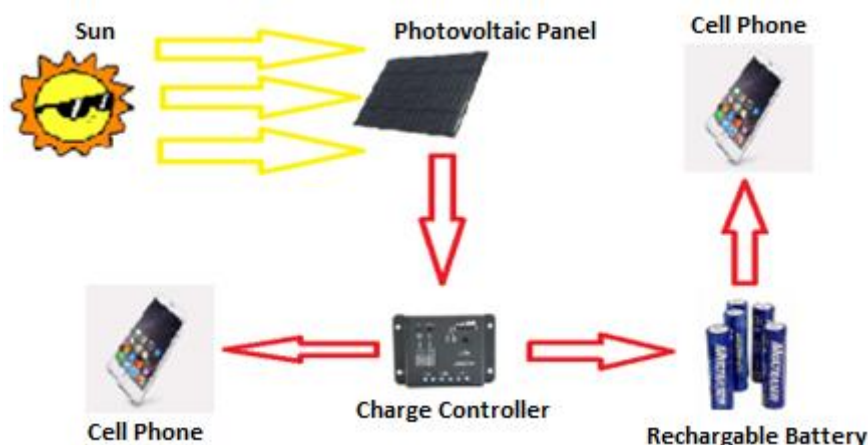


Figure 5: Design Architecture of a Photovoltaic Cell Charger

Source: [11]

### 3. Applied Methodology

After the bibliographic research, the steps towards the execution of the project began. As illustrated in figure 6, the methodology followed three steps which are: Component survey, prototype assembly and testing and are described below.

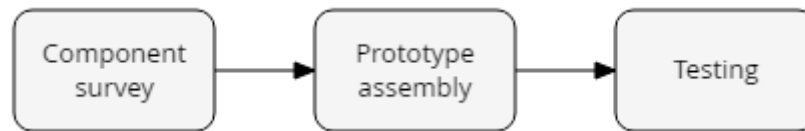


Figure 6: Development Steps

First the components were selected. The main element is the 2 W and 5 V photovoltaic solar plate, there is also i) the charge controller, which uses the HT4936S integrated circuit and has two outputs with limited voltages of 3.6V and 5V, making it possible to connect directly to a battery and the connection of an electronic device and ii) 3.7V and 2000 mAh lithium polymer battery and iii) the connecting peripherals such as cables and USB sockets.

Next, the electronic charging station architecture was designed and executed. This architecture followed the model proposed by [11], presented in Figure 5, in which the positive and negative poles of the solar panel were connected to the charge controller input and its 3.7 V output was connected to the battery. In this way, the battery is protected against very high electrical charges and very fast discharges, which extends battery life and optimizes battery operation, preventing accidents such as explosion caused by overcharging. USB ports for direct charging of devices have been connected to the controller's 5 V outputs, as this is the voltage that devices work to recharge their internal batteries.

Finally, tests were performed to validate whether the station was turning solar power into electrical power, if the controller was limiting the charge, if the USB port output was reaching the expected voltage, and if the battery was charging as planned.

The tests were divided into two parts: one with one photovoltaic plate and other with two 5 V photovoltaic plates in parallel. The tests were repeated at different times of the day, so that the incidence of sunlight was different in each test.

### 4. Analysis and Discussion of Results

#### 4.1. Test using one photovoltaic solar plate

The first tests, with a single photovoltaic solar plate, were done at 06 a.m., 10 a.m., 12 p.m., 03 p.m., 04 p.m. and 05 p.m. The voltages and currents at each time were measured and it was calculated the power provided by the plate and how long it would take the battery to fully charge at that power, as shown in Table 1.

Table 1 - Results of the experiments using a single photovoltaic plate

Time (h)	Power (watt)	Current (mA)	Voltage (V)	Charging Time (h)
06 a.m.	0.53	173	3.07	11.56
10 a.m.	1.15	254	4.52	7.87
12 p.m.	1.60	300	5.32	6.67
03 p.m.	1.38	279	4.96	7.17
04 p.m.	1.06	244	4.34	8.20
05 p.m.	0.70	199	3.54	10.05

The Figure 7 illustrates the relationship between the time of day, represented on the abscissa axis, and the power supplied by the photovoltaic plate, represented on the coordinate axis. It is possible to observe that as the hours of the day go by, the intensity of solar radiation changes, peaking at noon and, consequently, has the highest power provided by the solar plate.

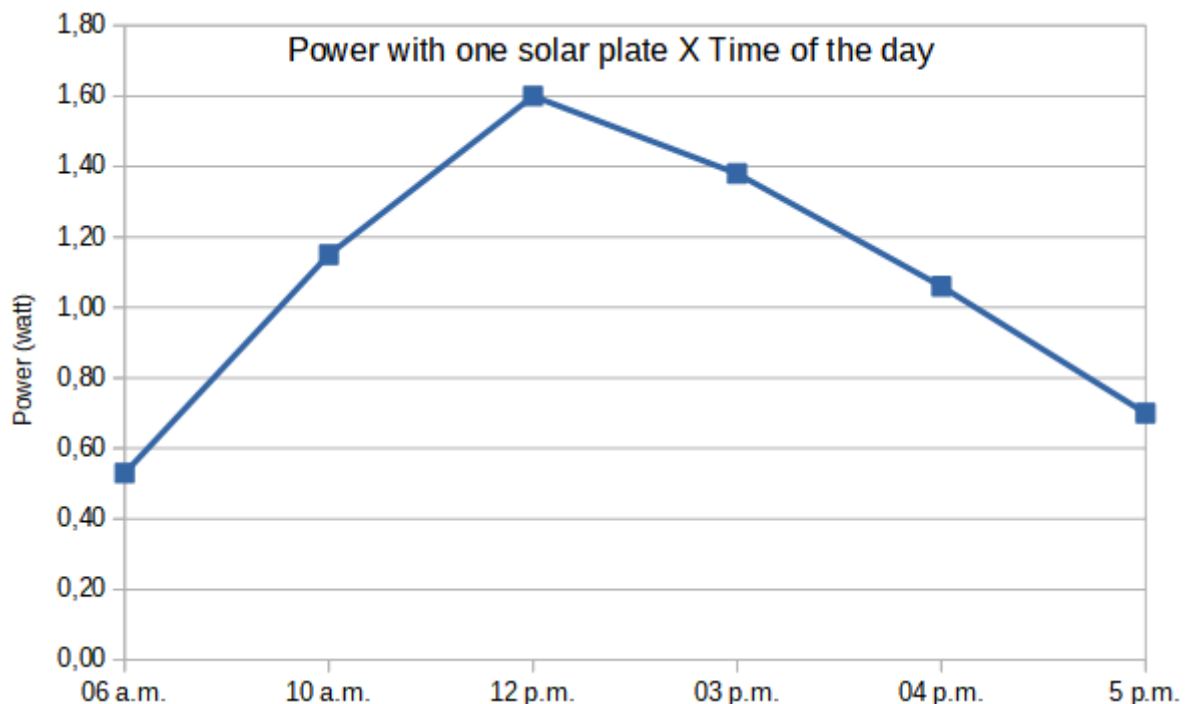


Figure 7: Information on the power supplied by the board versus the time of day.

By analyzing in Table 1 the time when the solar plate provides the most power (at 12 p.m.), it can be seen that the battery would take 6 hours and 40 minutes to fully charge. However, despite being a source of clean energy that justifies the proposal, it was observed that the recharge time is longer than the market offers. Given this, tests were performed by adding another photovoltaic plate in parallel to the existing one, which is being described in the following section.

#### 4.2. Test using two solar photovoltaic plates

The second stage of the tests followed the same times as the first, which are: 06 a.m., 10 a.m., 12 p.m., 03 p.m., 04 p.m. and 05 p.m. The parameters of voltage, electric current was measured and the power and

time required for full battery charging were also calculated. With the addition of the second photovoltaic plate, it was possible to reduce the charging time by half, causing the electric current to double in value and the voltage to remain at the same level. These results can be better seen in the Table2.

Table 2 - Results of the experiments using two photovoltaic plates in parallel.

Time (h)	Power (watt)	Current (mA)	Voltage (V)	Charging Time (h)
06 a.m.	1.06	346	3.05	5.78
10 a.m.	2.28	508	4.48	3.94
12 p.m.	3.15	600	5.25	3.33
03 p.m.	2.78	558	4.99	3.58
04 p.m.	2.15	488	4.4	4.10
05 p.m.	1.42	395	3.6	5.06

When the new solar plate was added in parallel, the electric current doubled and the charging time decreased since they are inversely proportional quantities, so at the time of maximum solar incidence, which previously took 6.67 hours for a full battery charge, after coupling the new solar plate, it only takes 3 hours and 19 minutes.

Figure 8 shows the relationship between time of day and power provided by two photovoltaic plates connected in parallel with each other. The curve of this graph is very similar to the graph in Figure 7, but through the power values shows that they present an increase of about two times the value of when using only one plate.

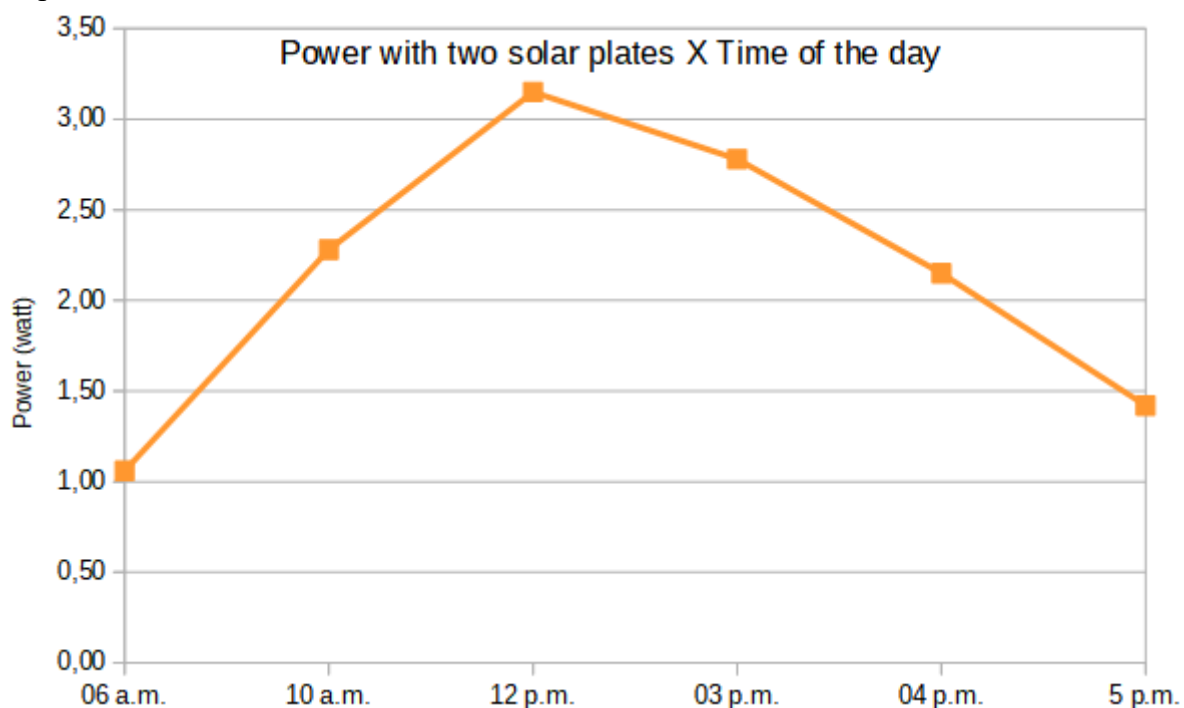


Figure 8: Two Solar Plates Power vs. Time of Day Information

## 5. Conclusion

This work presents an alternative and sustainable proposal to solve the problem of discharged batteries, with the implantation of a mobile device battery charging stations, which can be used in urban or rural areas, only with sunlight. To validate this concept a smaller scale prototype was built using photovoltaic solar panels, a charge controller and a battery.

After the construction of this prototype, several tests were made and the results showed that, to a smaller scale, there is a much higher efficiency if two 5-volt, 2-watt solar photovoltaic plates are used in parallel, thus, the total charging time of the battery drops by half from 6.67 hours to 3.33 hours, almost equaling conventional high-efficiency chargers that require a traditional power source.

The importance of accurate project sizing can be noted at the moment when it was necessary to add another solar plate, since without one of them the project would achieve its goal, but would take twice as long.

Future work may include: (i) the study, for the purpose of charging mobile device batteries, of the use of larger solar photovoltaic plates and therefore more power, so that more devices can be charged simultaneously; ii ) the implementation of the charging station in an area with difficult access to electricity, to verify its impact on the life of the local population and even to diversify the use of this station.

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# **A proposal for an Atmospheric Discharge Protection System (ADPS) for a Public School in the City of Manaus-AM**

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## **Abstract**

*The present study sought to highlight the importance of protection against electric discharges to a school in the public school of the city of Manaus-AM, based on the basic recommendations and guidelines for making decisions presented in the elaboration of a ADPS proposal. The methodology of the work was based on the collection of information on the subject from the theoretical-bibliographic research, as well as the accomplishment of the field research in the school through the technical visits for data collection. The results of the research were presented in the technical verification report of the ADPS need at school, so the study carried out a detailed study on the protection risk management, the analysis of the risk components to the atmospheric discharges, general risk assessment, evaluation the design of the protection system. Based on the report, the research presented the appropriate recommendations to assist school management in decision making, considering the importance of protecting the public heritage from the damages caused by the atmospheric discharges.*

**Keywords:** atmospheric discharge protection system; electrical discharge; public property

## **1. Introduction**

Electricity is vital in modern life and it is unnecessary to emphasize its importance, either providing comfort to our homes or acting as an input in the various segments of the economy. On the other hand, the use of electricity requires from the consumer the application of certain precautions in view of the risk

posed by electricity, many don't know, you do not know or do not understand this risk.

Accidents with electricity, at home and at work, are the most frequent and proven to have the most severe consequences. Safety rules provide that persons should be informed of the risks to which they are exposed, as well as their effects and applicable safety measures.

## 2. Theoretical Referential

### 2.1 Atmospheric Discharge

Is NBR 5419 - Protection of structures against lightning - defines lightning as a phenomenon that occurs from the atmospheric origin between a cloud and the earth or between clouds, which generates electrical impulses. The National Integrated Discharge Detection Network (RINDAT) says that electrical discharges (Figure 1) are linked to phenomena of lightning and thunder, which are quite phenomena recurring in large urban areas.



Figure 1. Electric discharges

Source: National Lightning Detection Network - RINDAT (2009)

The concentration of negative charges in the lower portion of the cloud causes immersion of the positive charge migration to the area corresponding to what is called the “shadow”, so this cloud, with the help of the wind, approaches the urban space [1].

#### 2.1.1 Basic Concepts

Some brief basic concepts can be analyzed regarding the phenomenon of atmospheric discharge. The concepts that make up the basic formation of atmospheric discharge, such as: the lightning, the thunder, The Ceraúnico Index (CI), the Isoceraúnicas and Lightning Density (RD) [2].

The Earth has excess negative charges, being one of the planets with the highest degree of reference in negative charges between the planets. It is also understood that the air currents carry a large amount of moisture, which, when found at lower temperatures in higher regions, leads to condensation and formation of water droplets suspended in the atmosphere [3].

### **2.1.2 Discharge**

The electric discharge in the earth in view of the so-called descending pilot (precursors), that is, an ionized conductive channel whose path is made by successive "leaps" towards the earth from the breakdown of the dielectric formed by air at a time when the earth exceeds a certain value with the charged cloud [3].

It is noted that the damage with electric discharge varies according to the current present, which can reach from muscle contraction from the reaction in the body to death, depending on the severity. Lightning strikes or currents are responsible for neutralizing the crowded charges in the clouds, so some studies reveal that each lightning strike can last a few milliseconds, as in multiple and sequential lightning strikes.

### **2.2 Protection System Against Atmospheric Discharge (ADPS)**

Studies conducted on the Protection system against Atmospheric discharge (ADPS) add to an understanding of transmission line protection and performance improvement methodologies against lightning strikes that occur daily. ADPS can be considered one of the main methods used to make this optimization possible, especially with the installation of lightning rods as an efficient protection system. It is widely used in homes, small and large buildings, commercial area, public area, etc.

#### **2.2.1 ADPS Function Definitions**

The ADPS is used to protect the most different types of structures from lightning, aiming to minimize the effects and impacts generated by these discharges, in order to ensure the safety of equipment and electrical structures [4]. The main functions of the ADPS can be highlighted as: external protection system; internal protection system; neutralization with the flow of electrical charges from the environment to the earth from its system; reducing the risk of lightning striking structures.

#### **2.2.2 ADPS Types**

ADPSs are basically divided into three types: Franklin type, Faraday Cage and advance to Ignition. The Franklin Type is made up of a metal rod having its pointed end at its tip so that it accumulates more load. It is considerably cheaper compared to other types, but is less efficient [3].

Faraday Cage is a type of system that is more complex, it has several receivers that are provided at the top of the structure to wrap the entire structure. It has a much higher efficiency compared the Franklin Type, but its cost is much higher and not feasible to implement in some structures [4]. Ignition advance is the ability of the arrester to anticipate lightning and modify the lightning path. It is widely used in a medium-sized building, as it has high efficiency and low cost, but its use over longer distances compromises the receptor uptake [3] [4].

## **3. Methodology**

The methodology of the work was based on the gathering of information on the subject from the theoretical-bibliographic research, as well as the accomplishment of the field research in the school

through the technical visits for data collection.

The field research was conducted at a state public school located in the eastern zone of the city of Manaus. The choice of the institution was based on the need to conduct the research in a space that did not have an ADPS, in order to present to the managers, based on the study results, a proposal to implement an ADPS. In the field analysis process carried out at school, there was also the descriptive process of the research, whose purpose was to observe and describe the area of study, as well as identifying which critical points observed by the absence of an ADPS project and thus collect enough data for the application of the technical study in the space.

#### 4. Analysis and Discussion of Results

The verification report consists of the feasibility presentation of the proposed implementation of an ADPS system in the school. It is observed that this school does not have any pre-installed structure for the implementation of an ADPS, with its structure completely unprotected (Figure 2):

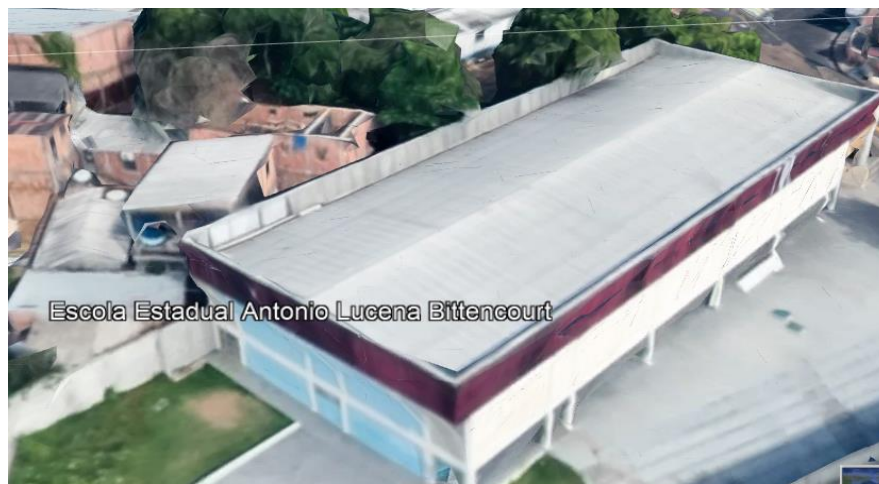


Figure 2 - Top view of the area [5]

##### 4.1 Building Parameters

Height: 9 m( $H$ )

Width: 20 m( $W$ )

Length: 48 m( $L$ )

##### 4.2 Protection Risk Assessment

The equivalent exposure area ( $Ad$ ) corresponds to the plan area of extended structure in all directions, to take into account your height. The equivalent exposure area boundaries are spaced from the perimeter of the structure by a distance of three times the height of the structure at the point considered.

$$Ad = L \cdot W + 2 \cdot (3 \cdot H) \cdot (L + W) + \pi \cdot (3 \cdot H)^2$$

$$Ad = 48 \cdot 20 + 2 \cdot (3 \cdot 9) \cdot (48 + 20) + \pi \cdot (3 \cdot 9)^2$$

$$Ad = 6922,22 \text{ m}^2$$

The density of lightning strikes to earth ( $N_g$ ) is the number of lightning strikes to earth per  $\text{km}^2/\text{year}$ . INPE (National Institute for Space Research), through the atmospheric electricity group, provided  $N_g$  data as shown in the figure below (Figure 3):



Figure 3 - Number of rays per year per  $\text{km}^2$  [6].

$$N_g = 14,8 \text{ Discharges per km}^2/\text{year}$$

Dangerous event numbers  $N_d$  for structure is:

$$\begin{aligned} N_d &= N_g \cdot A_d \cdot C_d \cdot 10^{-6} \\ N_d &= 14,8 \cdot 6922,22 \cdot 0,5 \cdot 10^{-6} \\ N_d &= \frac{5,12 \cdot 10^{-2}}{\text{ano}} \end{aligned}$$

It is recommended that loss amount values be evaluated and set by the ADPS designer (or the structure owner).

$$\begin{aligned} LA &= r_t \cdot L_T \cdot n_Z / n_t \cdot t_z / 8760 \\ LA &= 10^{-3} \cdot 10^{-2} \cdot 450 / 450 \cdot 8760 / 8760 \\ LA &= LU = 10^{-5} \\ LB &= r_p \cdot r_f \cdot h_z \cdot L_F \cdot n_Z / n_t \cdot t_z / 8760 \\ LB &= 0,5 \cdot 10^{-3} \cdot 5 \cdot 10^{-1} \cdot 450 / 450 \cdot 8760 / 8760 \\ LB &= LV = 2,5 \cdot 10^{-4} \end{aligned}$$

Where,

$L_T$  - It is the typical average relative number of victims injured by electric shock due to a dangerous event;

$L_F$  - It is a typical average relative number of victims of physical injury due to a dangerous event;

$L_O$  - It is the typical average relative number of victims of internal system failure due to a dangerous event;

$r_t$  - It is a factor in reducing the loss of human life, depending on the type of soil or floor;

$r_p$  - It is a factor in reducing the loss due to physical damage depending on the steps taken to reduce the consequences of the fire;

$r_f$  - It is a factor in reducing the loss due to physical damage that may affect the risk of fire or the risk of structure explosion;

*hz* - It is a factor of increased loss due to physical damage when a special hazard is present;

*nz* - It is the number of people in the zone;

*nt* - It is the total number of people in the structure;

*tz* - It is the time during which people are present in the area, expressed in hours per year.

#### 4.3 Analysis of Risk Components Due to Lightning in the Structure

The risk components to consider for this structure can be summarized schematically in table 1:

Table 1 - Risk components considered.

Damage Sources	S1: Discharge in the structure			S2: Discharge near structure	S3: Discharge on a line connected to the frame		S4: Discharge near a line connected to the frame
Risk Components	Ra	Rb	Rc	Rm	Ru	RvRw	Rz
R1: loss of human life	X				X	X	
R2: Loss of service to the public							
R3: loss of cultural heritage							
R4: loss of economic value							

Source: NBR 5419-2: 2015, 2015.

For the assessment of risk components due to lightning strikes in the structure, the following equations apply:

a) component related to injury to living beings by electric shock (D1)

$$\begin{aligned}
 RA &= ND \cdot PA \cdot LA \\
 RA &= 5,12 \cdot 10^{-12} \cdot 1 \cdot 10^{-5} \\
 RA &= 5,12 \cdot 10^{-7}
 \end{aligned}$$

b) component related to physical damage (D2)

$$\begin{aligned}
 RB &= ND \cdot PB \cdot LB \\
 RB &= 5,12 \cdot 10^{-2} \cdot 1 \cdot 2,5 \cdot 10^{-4} \\
 RB &= 1,28 \cdot 10^{-5}
 \end{aligned}$$

##### 4.3.1 Hazardous Component Analysis Due to Lightning Strikes on a Line Connected to the Structure

For the assessment of risk components due to lightning strikes on a line connected to the structure, the following equations [7] apply:

a) Component related to injury to living beings by electric shock (D1)

$$\begin{aligned}
 RU &= (NL + NDJ) \cdot PU \cdot LU \\
 RU &= (5,92 \cdot 10^{-2} + 0) \cdot 1 \cdot 10^{-5} \\
 RU &= 5,92 \cdot 10^{-5}
 \end{aligned}$$

b) Component related to physical damage (D2)

$$RV = (NL + NDJ) \cdot PV \cdot LV$$

$$RV = (5,92 \cdot 10^{-2} + 0) \cdot 1,25 \cdot 10^{-4}$$

$$RV = 1,48 \cdot 10^{-5}$$

#### 4.3.2 Overall Risk Assessment

The R1 risk to be considered in this structure of the Antonio Lucena Bittencourt State School includes the following definition and formula [2] [6]:

a) R1: risk of loss of human life:

$$R1 = RA + RB + RU + RV$$

$$R1 = 5,12 \cdot 10^{-7} + 1,28 \cdot 10^{-5} + 5,92 \cdot 10^{-7} + 1,48 \cdot 10^{-5}$$

$$R1 = 2,87 \cdot 10^{-5}$$

#### 4.3.3 Protection Level Assessment

It is concluded that the level of protection is II due to the classification of the structure, ie school, whose failure in the lightning arrester system can cause the loss valuable assets or cause panic to those present.

#### 4.3.4 Choice of Method

Faraday method was chosen because it is a structure with a large horizontal area, that consists of to engage the top of the building with a bare electric conductor capture mesh, whose distance between them is a function of the desired level of protection and given by the standard NBR 5410-3 / 2015, which establishes the width of the protective mesh module, the length of the module cannot be more than twice its width.

### 4.4 Sizing of Atmospheric Discharges Protection System

#### 4.4.1 Dimensions Mesh Capture

According to the data presented in the survey of NBR 5410-3 / 2015, the width and length of the protective mesh module are a maximum of  $10 \times 10$  m, because the protection class is level II, for this project was chosen  $10 \times 8$  m, width and length that fits the design respectively [2] [7].

## 5. Conclusion

Given the relevance of the topic addressed in the research it was observed that there are several studies on the importance of designing, effectively and planned, a protection system to avoid the problems caused by electrical discharges, common in large urban areas. The bibliographic survey conducted in the research allowed the subject to be widely studied and that through the observation of other case studies it was possible to understand the efficiency of an ADPS project.

The study aimed to contribute, in a practical and academic way, to the proposal of an ADPS project for the state public school, with the objective of assisting in decision making regarding the protection of its public patrimony. Necessary recommendations were presented to avoid atmospheric accidents, as well as to make the school management aware about the preservation of its patrimony from the implementation

of an ADPS.

The ADPS Needs Verification Report provided all the technical information collected from the on-site survey and detailed protection risk management. The risk assessment, the analysis of the normative parameters, the assessment of the protection level and the design of the ADPS were performed. The elaboration of the report helped in the definition of the recommendations and observations about the preservation of the patrimony, which were presented to the school management after the study.

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## **Study and Simulation of Voltage Profile Recovery on a 200 km Transmission Line Using Shunt Static Var Compensator (SVC)**

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### **Abstract**

*This article aims to clarify how Flexible Alternating Current Transmission Systems (FACTS) technology, for static operating devices, conditioned on application to long-distance transmission lines can solve problems related to voltage drop on paths known as “weak zones” of the power transmission system. Some technical aspects of the construction of the SVC Static Reactive Compensator in conjunction with thyristor switching devices such as TCR and TSC are described. The proposed scenario is similar to the Brazilian interconnected system, where much of the generator park is hundreds of miles from the country's major consumer centers, leading to the structure of this system longer transmission lines and consequently greater losses in the transmission paths. For the proposed simulations the MATLAB Simulink<sup>®</sup> environment was used considering different voltage unbalance operating ranges caused by three-phase faults in the transmission lines. The conclusions show that the distance from the lines to the load has a great influence on the oscillatory effects of voltage, and the fact that the “loading” transmission lines can compensate for much of the path by generating waves through the circuit's natural capacitance. The allocation of capacitor and shunt reactor banks is a reliable option for the transmission system and can act as a support mechanism for voltage control maneuvers to circumvent abrupt changes in reactive demand. From the simulations output comparison, the transient effects showed greater stability in the voltage signal recovery in the stretches where the compensation blocks were located near the lowering substation bus, thus demonstrating the capacity of the applied technology.*

**Key words:** voltage regulation; facts; transmission lines; reactive power;

## 1. Introduction

Demand loads in electrical power systems are mostly nonlinear, meaning that much of the time demand characteristics change as different types of loads are driven by consumers. This natural behavior of the grid often implies close control by the system operator, because the operational safety of the system coupled with the guarantee of continuous supply of electricity. It is legally guarded by the government that failure to comply with the specifications established for the operation of the guidelines within the minimum grid frequency and system stability standards can cause significant harm to consumers of all voltage levels it meets.

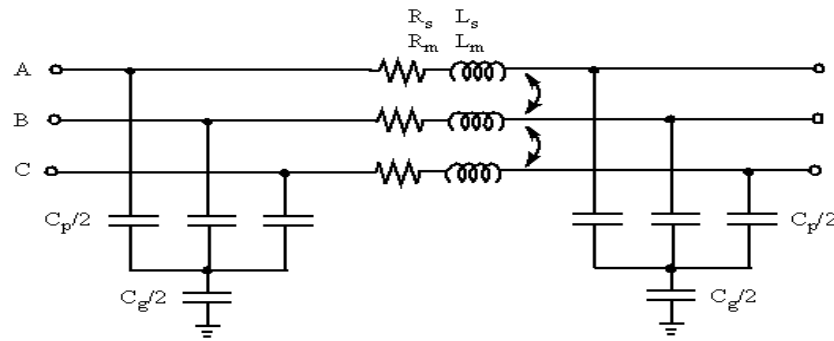
This study addresses the three layers, with greater emphasis on the primary (generation plants) and secondary (transmission lines) spheres. The Brazilian scenario is home to great geographical diversity and has what is considered one of the largest interconnected energy supply systems in the world. The challenges of expansion are constant because the geography of each region of the country is different and requires large studies for the implementation of transmission network infrastructure for the transportation of energy to the major consumer centers of the country. But while the country has an essentially diverse energy matrix, taking advantage of the intermittence of each power source in its territory, this system faces a problem attributed to the extension of this transmission grid network. Since most generation plants are built far from large urban centers, the high cost of installing new power systems and the fact that the farther these power plants are located, the greater the electrical losses, there is a growing problem of financial and economic magnitude. Flexible Alternating Current Transmission Systems (FACTS) technology, which has been devised for more than two decades and has been increasingly highlighted by the advanced technology capability in the electrical systems segment, reflects its revolutionary potential in a scenario where electricity has become an increasingly scarce good to all humanity.

## 2. Theoretical Reference

### 2.1 Electric Power Transmission Overhead Lines

Used to transmit electricity from generation sites to consumer centers by means of conductive cables, overhead power transmission lines are constructed so that an interconnected sine-wave operation system is achieved. [1]. Throughout the consolidation cycle of technologies for more efficient and quality transmission of electricity, there is an increasing demand for flexible systems based on power electronics in which they are used for the control of electrical losses and voltage stability on transmission lines. Its implementation is mainly due to the scenario of the current power generation plants, which concentrated in most of the urban centers, implies longer routes for the transport of energy, which consequently substantially increases the electrical losses linked to the extension of the lines. of transmission [2] [9].

Transmission lines have four important characteristics to consider: series resistance, parallel conductance, series inductance, and parallel capacitance. And for the study of this paper we use the model  $\pi$  for transmission lines with medium extension (80 to 240 Km) in which the parallel admittance in two equal parts is considered [1].

Figure 1: Pi ( $\pi$ ) model for transmission lines.

## 2.2 Equation for Load Flow in Transmission Lines Model $\pi$

The representations of the  $\pi$  model used follow three fixed parameters:  $r_{km}$  series resistance; the  $X_{km}$  series reactance; and the shunt  $b_{km}^{sh}$  susceptance, so that we have between bus  $k$  and  $m$  the impedance  $Z_{km}$  which according to [2] is described by:

$$Z_{km} = r_{km} + jX_{km} \quad (2.1)$$

The transmission line given to the inductive component, makes the elements conductance and susceptance positive. Since the shunt element is capacitive then,  $b_{km}^{sh}$  is positive. The terminal and parameter voltages of the model  $\pi$  used have the current  $I_{km}$  and  $I_{mk}$  formed by a series component and a shunt component that are calculated from them. Therefore,  $E_k$  and  $E_m$  are the tensions in bars  $k$  and  $m$  as below:

$$I_{km} = y_{km}(E_k - E_m) + jb_{km}^{sh}E_k \quad (2.2)$$

$$I_{mk} = y_{km}(E_m + E_k) + jb_{km}^{sh}E_m \quad (2.3)$$

$$E_k = V_k e^{j\theta_k}; E_m = V_m e^{j\theta_m} \quad (2.4)$$

## 2.3 Voltage Profile Recovery in Electricity Transmission Networks

The distortion effects of the voltage profile are mainly caused by the inductive and capacitive elements inherent to the equipment that make up the Electric Power System (EPS). Inductive reactive loads are very common in these systems and have as their main consumer destination industrial motor groups that are naturally large consumers of inductive reactive power. The electromagnetic fields of these motors require the circulation of inductive reactive elements to maintain their operation (when designed in the EPS model), which disables part of the capacity of the transmission lines and generate losses in active power transport due to the inability to generate effective work. by the reactive power [3].

## 2.4 Flexible Alternating Current Transmission Systems - FACTS

Flexible Alternating Current Transmission Systems (FACTS) belong to the family of power electronics-based controlled devices developed for the purpose of increasing control and power transmission

capability, unlike the family of switched and advanced FACTS. Reactive power control in so-called SEP “Weak Zones” increases the degree of voltage stability resulting in lower losses along power transmission paths and greater control flexibility of electrical systems. [4] [8].

### **2.5 Static Var Compensator (SVC)**

Static Compensation (SVC) devices use reactive elements (capacitors and / or inductors) which, depending on the need for implementation, are adjusted to achieve the desired compensation. Another important feature of these devices is that their Shunt connections give them the ability to generate or absorb reactive power where they are connected and are perfect elements for varying and controlling certain quantities such as voltage [5] [10].

### **2.6 Thyristor Switched Capacitor – (TSC)**

It consists of a capacitor bank assembly in which thyristors form a switch whose circuit is used to connect or disconnect from the power system. In this way reactive power is injected into the system discontinuously through the keyed seat. Resonance effects associated with switching transients are mitigated with the inductor connection which also provides safe damping of the magnetization currents of the circuit. Since the switching performed is low frequency, there are no problems related to harmonic disturbances and are therefore irrelevant to the system [3] [6].

### **2.7 Thyristor Controlled Reactor - (TCR)**

The basic building block of the TCR is an inductor connected in series to a switch consisting of two bidirectionally connected thyristors. The tripping angle  $\alpha$  determines at each half cycle of the fundamental frequency its conduction alternately when the voltage level crosses its zero value, the zero of the voltage. Through its bidirectional switching capability, you have control of the thyristor firing angle where it becomes possible to control the current as well as the driving time for each half cycle of the fundamental wave. Within the limits of the device's trigger angle control, continuous current adjustment is obtained which gives greater variability in terms of absorption control or reactive power injection within the nominal TCR values [6] [7].

## **3. Applied Methodology**

For this study was used the MATLAB Software version R2017b that offers parameters for problem solving and analysis for different conditions and scenarios to the academic and professional. From the Simulink ® environment, whose space is intended for the simulation of scientific problems based on the configuration of mathematical base parameters, it also has a vast collection of complementary libraries for which one was used in this work called *Simscape Power Systems*, this library. allows you to set parameters of electrical systems and electrical and electronic devices for linear or nonlinear optimization, with time domain and frequency domain modeling. The models shown (Figures 2 and 3) represent the bases used for the construction of simulations that start from values where it is expected to achieve a high level of performance of capacitor banks, considering that their allocation is in

derivation with transmission line and thus establish capacitive gain conditions in the critical sections between the transmission lines.

In this scenario of simulations, it was considered to represent the various disturbances and failures in the transmission network through the illustrative block called Three Phase Fault, which represents, among other situations, the occurrence of voltage dips or dips along the transmission paths transmission of electricity over long distances.

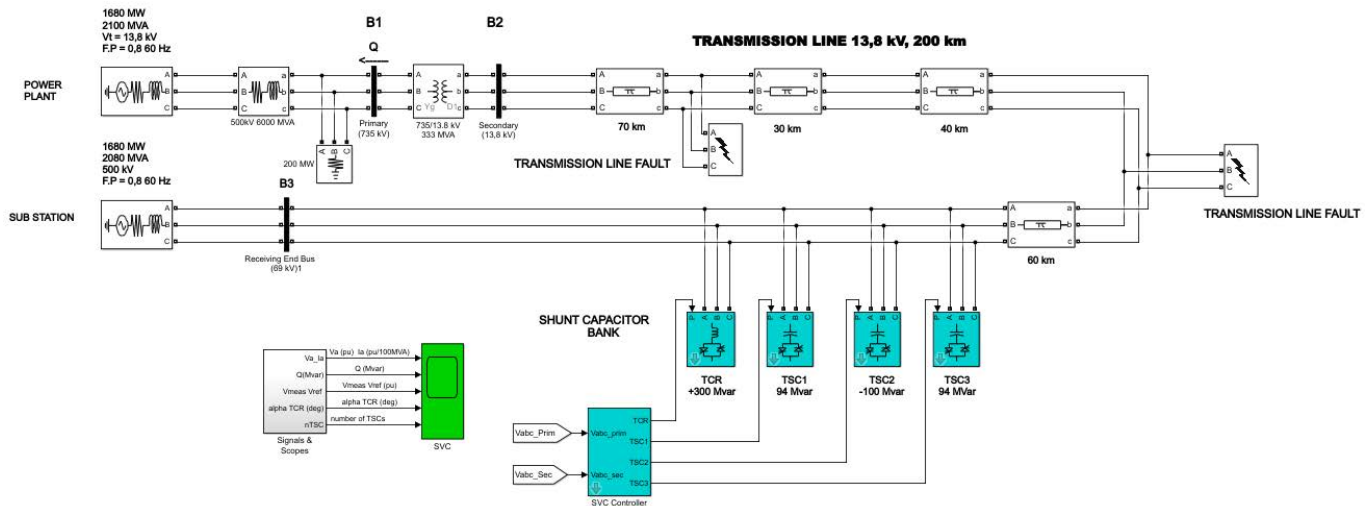


Figure 2: HVAC Receiving Bus Shunt Compensation.

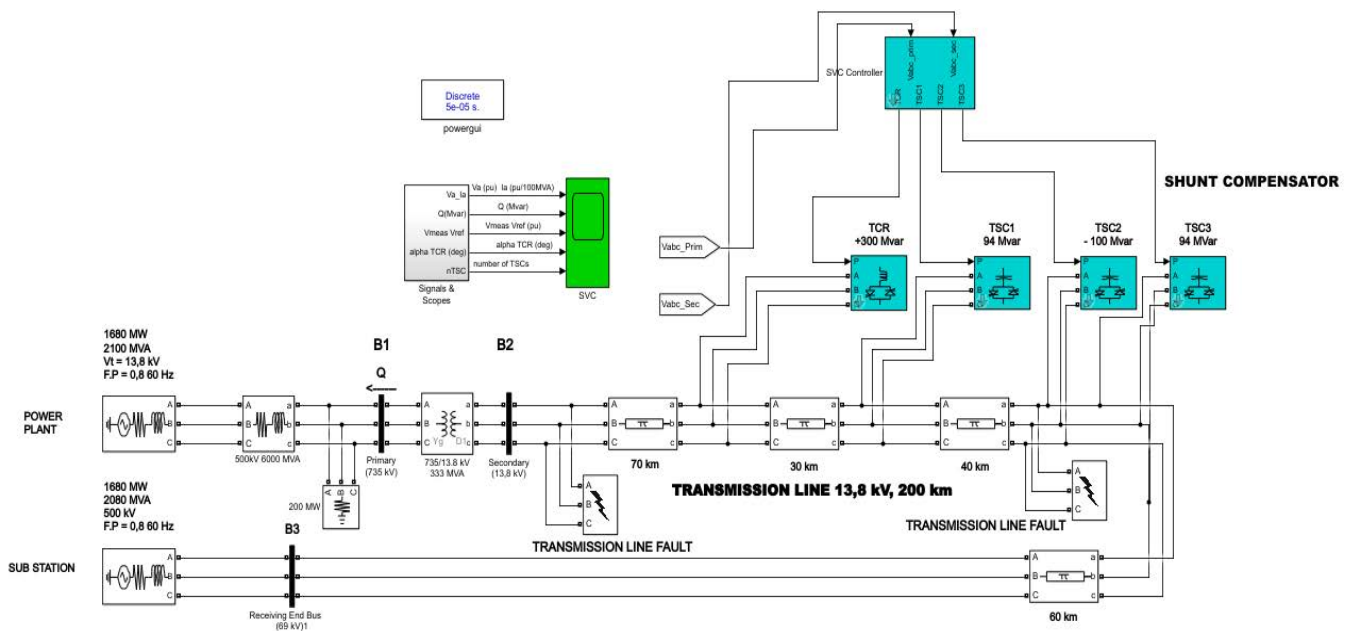


Figure 3: Shunt Compensation at Intervals in an HVAC System.

The proposed modeling uses equal values for the two reactive zone compensation scenarios that are prone to voltage drops. The data resulting from the voltage and power values (inductive reactive and capacitive reactive) were obtained from the Matpower library together with the same Simulink interface. Thus, some samples of the voltage profile during the energy transport path of the generation plant to the load

feeding substation. It was necessary to note in this article the voltage transmission pattern of the large energy blocks, like the Brazilian context, values that vary according to the location of the generation plants and the availability conditions of the transmission circuits. Between the regions connected by the Brazilian Interconnected Electrical System - BIES. Thus, the values 500 kV, 735 kV and 13.8 kV are the most common values of electric current transmission in the country. The highest value (13.8 kV) determined the condition of voltage rise from the isolating bus B2 (secondary of the transformer elevator) from the generating plant.

The representation model for the transmission lines used (model  $\pi$ ) emerged as the least expensive option for the mathematical simplifications related to the division of parallel susceptibilities and capacitive and inductive line reactance. The transformer used is a delta three-phase three-winding model whose rated operating frequency in the grid is  $336\text{ e}^6$  at 60 Hz. For transformer bars B1 and B2, the substation in B3 was of the magnitude measurements of phase-to-ground faults in B1 on the primary bus, while in B2 (secondary) the occurrence of phase-to-phase faults was measured. Under “normal” conditions of full-load operation this transmission system would be able to establish self-charging line conditions compared to a capacitor that charges slowly over time.

Therefore, the objective behind the high values of capacitive reactive power and inductive reactive power used in devices comprising capacitor banks sought to reach the maximum operating range of the transmission line circuits. The more critical the demand for supply line reactive supply or substation load supply became, the more these instruments were required to intervene so that the voltage values would not sink or increase uncontrollably. For the initial load conditions, 1680 MW of active power to be transmitted by the grid was established, with an ideal power factor  $FP = 0.8$  at 60 Hz. Reactive compensation is required by the grid to regulate and maintain the voltage profile. So that the transmission pattern does not show too much loss or abrupt voltage drops. Rapid maneuvering of the system to maintain this balance requires continuous monitoring as demand does not follow a standard curve throughout the system. Values of + 300 / -100 Mvar are used in shunt capacitor bank controllers for power factor conditions closer to optimal operation for voltage stability over much of the transmission path.

The Thyristor-TCR Controlled Reactor (Figure 4) provides inductive characteristics to the voltage waveforms. Given this fact, in the proposed power system we tried to establish load parameters in which the values of the angle  $\alpha$  most closely approximated the value. Optimal for power factor FP in power per unit p.u.

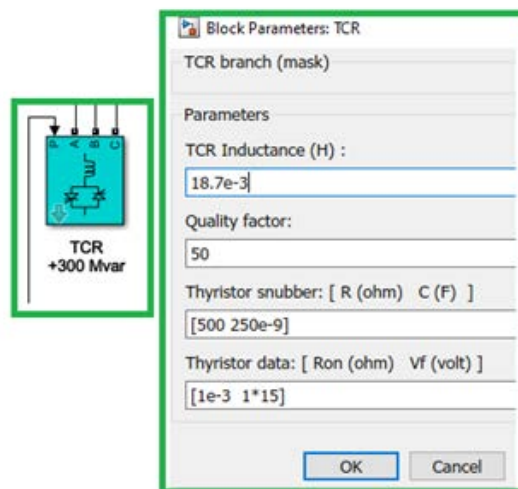


Figure 4: TCR Controller Parameterization.

The parameterization of the TSC 1 Thyristor Switched Capacitor Arrangement (Figure 5) operates in conjunction with the reactive static compensator. The pre-set parameters had values above 30 Mvar for the "shortening" of the transmission line and increased the gains upon application. These devices were associated in a group of 3 subdivided into 94 MVar value for absorption or shunt compensation in conservative controlled operating mode.

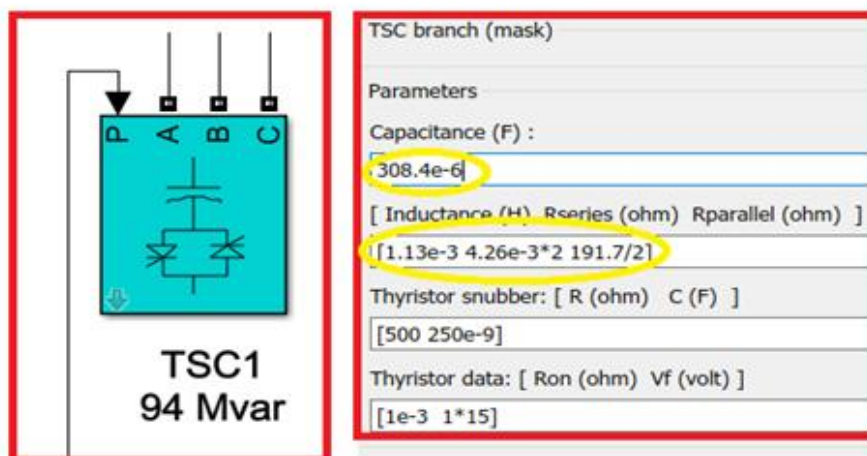


Figure 5: Thyristor Switched Capacitor.

According to the operating characteristic of the thyristor switches, the number 3 TCS will operate with a 3% cut-off factor when the previous ones are triggered, so it must be placed in a ready response condition for line reactance compensation transmission (Figure 6):

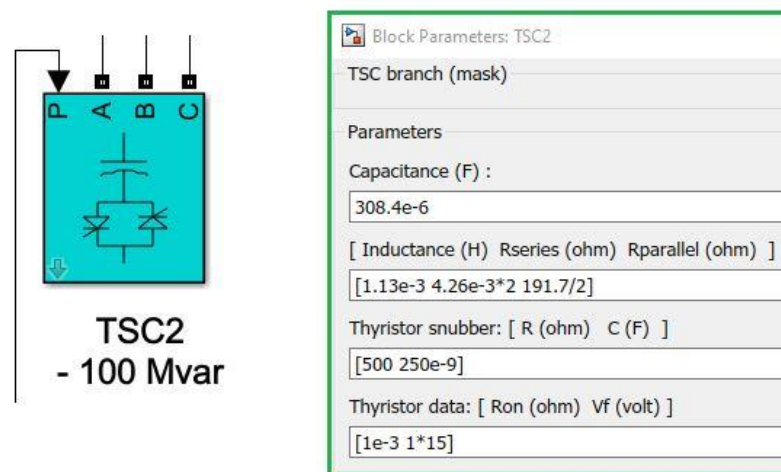


Figure 6: Thyristor Switching Capacitor 2

For the set three of thyristor keys the same values were established as in the previous figure:

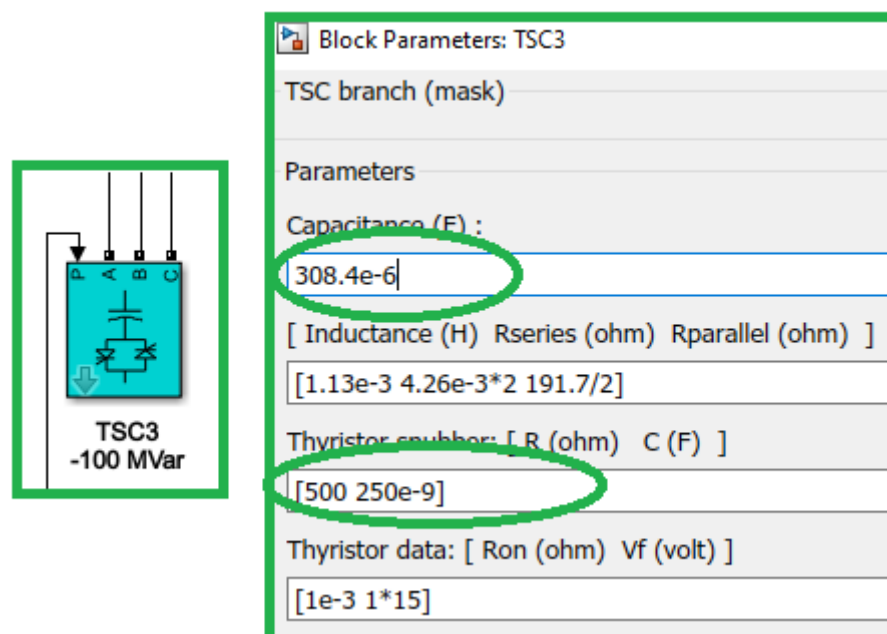


Figure 7: Parameterization of the Thyristor Switched Capacitor

The arrangement parameters of this device (Figure 7) aimed to retain the maximum reactive power consumption in the final feeder bus (B3) aiming to establish higher quality and stability in the wave signal received at the substation.

#### 4. Analysis and Discussion of Results

As the system requires periodic injection of reactive power to bus B1 it is noted that the voltage profile is distorted in the switching interval between 0.5 s and 1 s of tripping of the controller switches, being characteristic of the capacitors connected in bypass to delay the effects of currents on bidirectional circuit switching.



### Simulation 1

For case 1 it was observed that the voltage signals especially in the execution of control techniques 2 and 3 with the switches in the on / off mode (Figure 8) made the same high distortion rates with the experiment on the transmission bar B1.

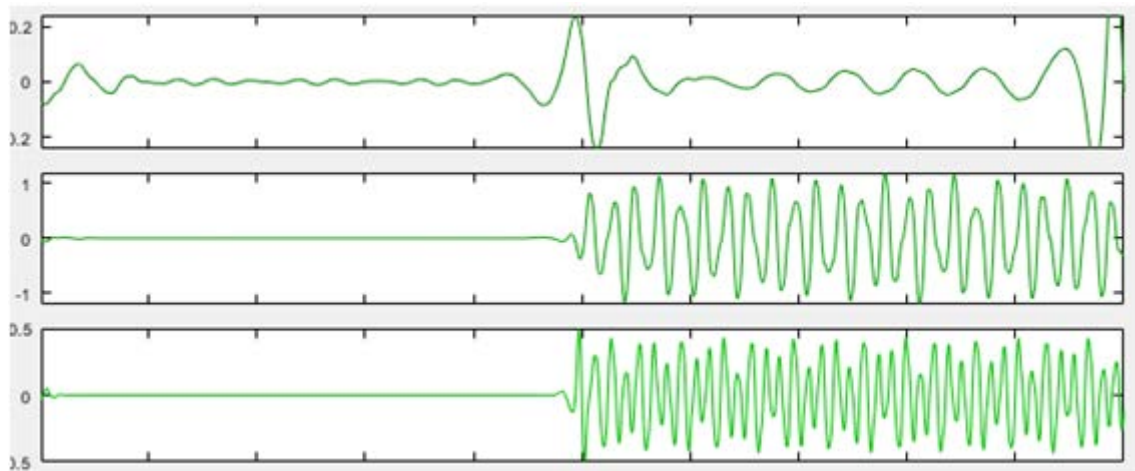


Figure. 8: Effect of Static Control on Bus 1 and Bus 2

The histogram of the switched circuit bus frequency B1 of the transfer circuit exemplifies that under conditions of continuous reactive power supply in the system, the estimated time between the TSC and TCR switch keys is respectively 1,025 for switching over the analyzed frequency range, which is 60 Hz. The need to transmit large blocks of energy has caused the transmission networks to work very close to their thermal capacity, which often places extra stress on the transmission tower structures and cables that wear out faster due to the Joule effect and suffer from it. Consequent losses even if they mean little at first, causes such as: corona effect, ambient temperature wear and air ionization, the Ferranti effect between the lines are some of the many problems that may be inserted in this same context.

### Simulation 2

For case 2 it was installed in the same parameters of the first example with the change of control time of the switches in the period  $T = 0.1$  according to the system requests for reactive power injection in bars B2 and B3, which meant in this case high levels of voltage signal disturbance in simulations for B1 and B3 (Figure 9). Case 3 showed some stability but with large fluctuations in the interspersed pathways.

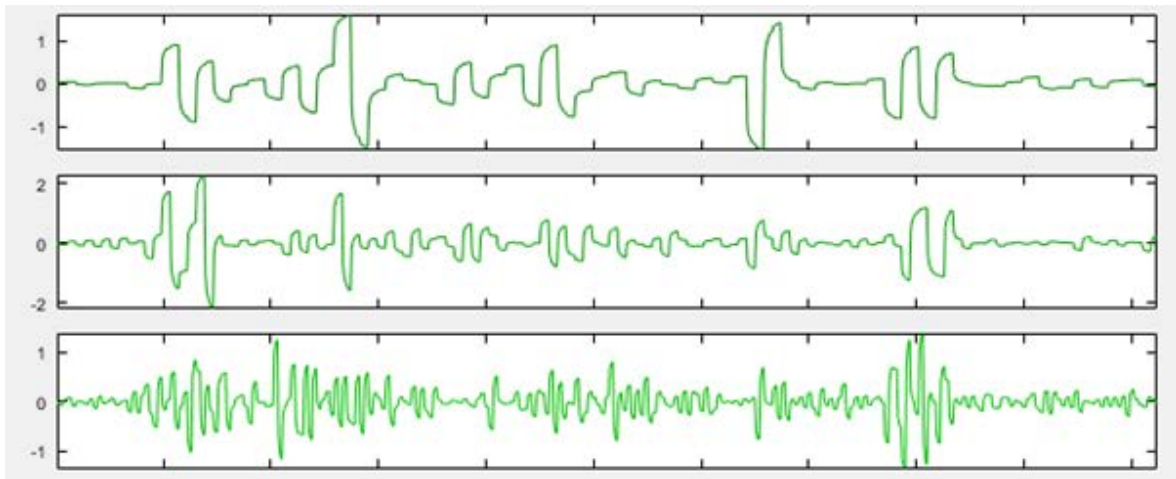


Figure 9: Controllers Acting on Bus B1 and B2

Similarly, case three represented gains in signal quality, unlike case one and two, the transmitted frequency signal showed higher positive fractions, which means greater control capacity at bus B2 terminals resulting in fast recovery capability (Figure10).

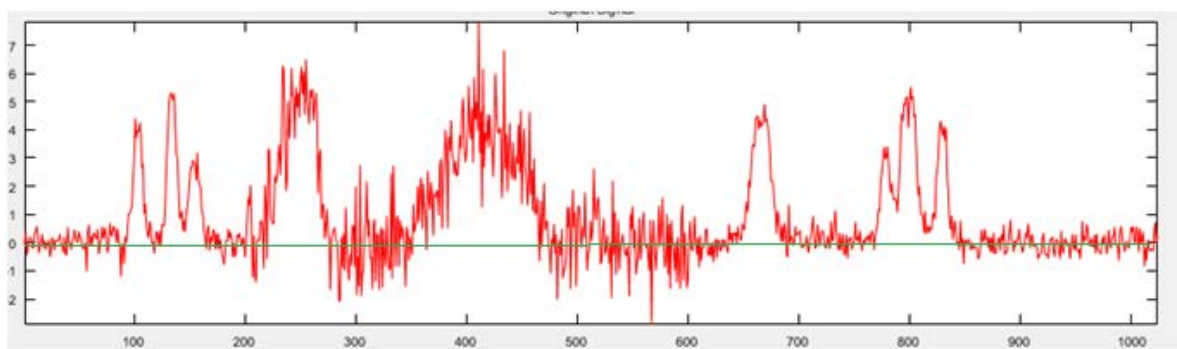


Figure 10: Positive Sequence of Capacitor Bank Operating Range

As the substation buses achieve a good level of inductive reactive power continuously throughout full load operation, this is because the power factor generated satisfactory gains on the real side of the power triangle.

### Simulation 3

Case 3 was with the compensation device operating in linear regime, without control interventions for the analyzed section, in this case the bus B4 (substation), the receiving bus meant among the previous cases the best response in time since the inductive reactive power parameters to be injected / absorbed on transmission bus B2 allowed the system greater absolute gain capacities in power per unit p.u.

The voltage signal showed strong variations in the stretch, but from the moment when bus B2 received reactive power compensation via bus B3, the line quickly drained its inductive reactive state to more capacitive reactive, thus contributing to the input voltage stability. Without much impact on substation control devices. The signal behavior and its stability trend are gradually recovered at the end of each controller trip (Figure 11).

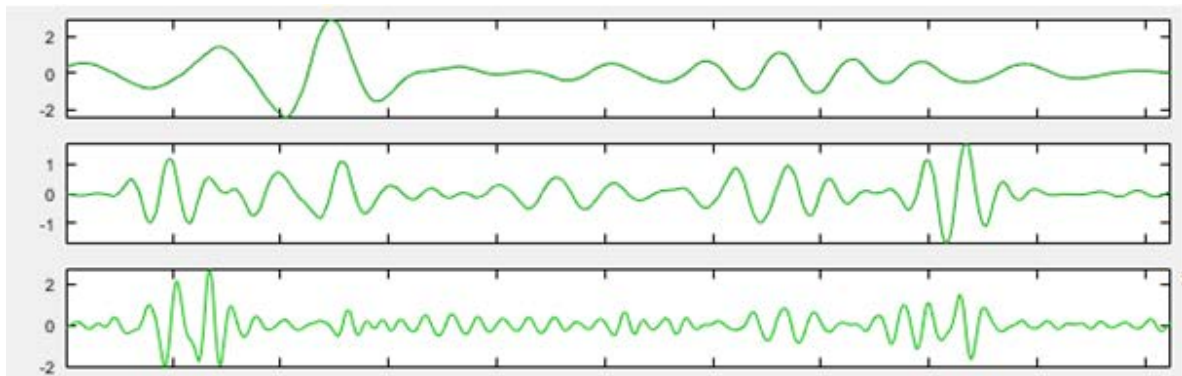


Figure 11: Recovery of transient voltage stability in B3

The switched frequency signal on bus B3 denotes greater stability of the voltage signal absorbed by the substation bars (Figure 11). It was noticeable that, being farther from the inductive reactive power absorption site in this case of the B1 bus, there was a slight decrease of the grid frequencies, which eventually also contributes to the reduction of the power factor for that moment at  $T = 0.10$  s. This effect on bus B3, which can be considered the final stage of successive control strategies and / or recovery of voltage rises on critical transmission line paths (Figure 12).

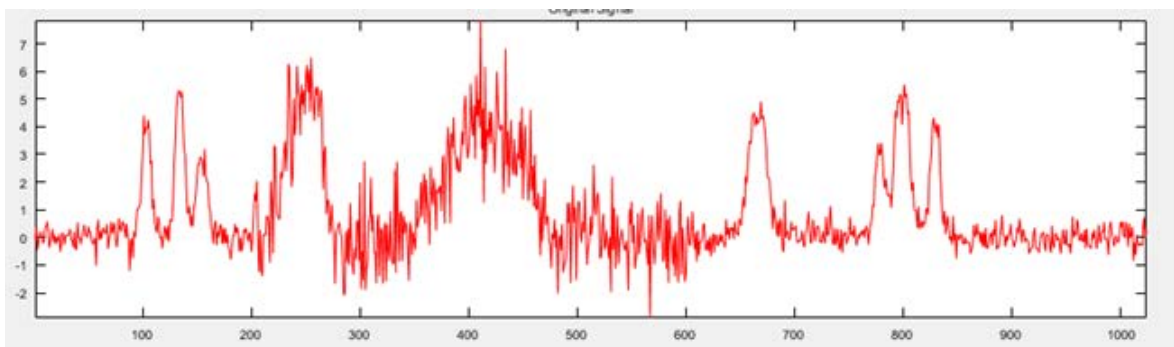


Figure 12: Voltage profile recovery at the end of the path B3 - positive range of the receiving bus (substation).

The values obtained in the final bus (substation) suggest that the positive sequence of the voltage signal after the capacitor banks actuation is effective. Signals observed on the secondary bus of the generating plant do not require shunt maneuvers.

Generation		Load		Losses	
MW	Mvar	MW	Mvar	MW	Mvar
273.9	113	259	73.5	14.9	39.5

Figure 13: Load balance and loss due to control delays.

Source: Adapted Matpower

As the load flow values suggest, losses tend to accumulate as the transmission lines reach their maximum transport capacity, this is due to the gain tendency that the disconnecting buses which in this case boils down to B3 maximum reactive values for voltage stabilization.

Flow			Losses	
MW	Mvar	MVA	MW	Mvar
159.1	-21	153.6	4.55	8.21
74.8	16.3	73.2	2.94	7.12
-154.6	29.2	152.7	4.55	8.21

Figure 14: Accumulated power flow and losses in the transmission bus of the plant.

Source: Adapted Matpower

## 5. Conclusion

Simulation results demonstrate the effectiveness of using reactive compensation in transmission lines. Stability margins require close control by the electrical system operator, and this is the exercise of continuous control of the balanced operating ranges of the electrical system. Especially when one can identify the behavior of demand throughout the day at times of higher energy consumption, the control technique enabled by FACTS device technology is an excellent long-term investment proposition.

The problem discussed in this paper can be distinguished mathematically as a midsize nonlinear programming problem, and there may be several variables and constraints. Having observed that the scenario modeling makes the criteria restricted to the study of this article itself. It is also evident that, in the Brazilian context of large urban centers, there is much to develop for the implementation of advanced technologies in the large Brazilian territory. Transmission system integration requires complex regional operators that operate with minimal electrical noise in the regional interconnection sections, the operation of the circuit routes behind the loss maximization and this study can serve as a basis for future developments to be applied in this context.

## 6. Acknowledgment

To the Engineering Coordination of the FAMETRO University Center and Professor M.Sc. Livia da Silva Oliveira, for their support in the development of this work.

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## Longitudinal Analysis of Patents on Colorectal Cancer

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### Abstract

*colorectal cancer is epidemiologically relevant worldwide because it is the fourth leading cause of death from cancer. This study aims to present the mapping of technologies related to colorectal cancer. The search took place during the months of May and June 2019. The Leans database was used, which collects global patent information. The search occurred through the term "colorectal cancer", inserted in the title or abstract fields. Patents with publication date between January 1, 2000 and June 1, 2019 were selected. Only the patents granted and those filed were filtered (patent application; granted patent). A total of 6,850 patents were identified, of which 5,445 (79.48%) correspond to patents filed and 1,405 (20.51%) are patents granted in the period from 2000 to 2019. In 2000, 47 patents on colorectal cancer were published. The quantitative growth of technologies filed and granted was constant. In 2017 there was a total of 911 applications, indicating a growth of 1938.29% in relation to the year 2000. The first patent of the period was on the APC gene mutation, associated with colorectal cancer in families of Ashkenazi Jews, developed by Laken and collaborators (2000), and belongs to Johns Hopkins University, Baltimore, Maryland, in the United States. It can be concluded that the mapping of patents is important to trace a panorama of the world technological advance, as well as it can also be used as an instrument to identify scientific articles that cite patents developed in a given time space.*

**Keywords:** patents; colorectal cancer; technological advances.

### 1. Introduction

Currently, one of the main public health problems worldwide is cancer, which is a chronic degenerative disease that affects several dimensions of human life, causing economic impact on society, because it requires specialized treatment prolonged and costly. It is also considered responsible for reducing the potential of human labor and the loss of many lives, which can have an impact on the financial aspect of

organizations (INCA, 2018).

The National Cancer Institute José Alencar Gomes da Silva (INCA) and the Ministry of Health (MS) estimate the occurrence of about 600 thousand new cases of cancer in Brazil in 2018. The precise number of the estimate is 582,590 new cases of cancer: 282,450 in women and 300,140 in men. The study covers the 2018-2019 biennium and the estimates for 2019 are the same as for 2018. In a projection, more than 15 million new cases of cancer are expected worldwide for the year 2020 (INCA, 2018).

Cancer of the colon and rectum has epidemiological relevance worldwide, since it is the third most commonly diagnosed malignant neoplasm and the fourth leading cause of death from cancer (FERLAY et al., 2013). A large geographical variation has been observed, with high rates in more developed countries compared to those less developed (CENTER; JEMAL; WARD, 2009; FERLAY et al., 2013).

Geographic patterns are very similar between men and women, but rectal cancer is about 20% to 50% higher in men in most populations. The number of new cases of colon and rectum cancer (more commonly called bowel cancer) estimated for Brazil for each year of the 2018-2019 biennium is 36,360 in both sexes, 17,380 new cases in men and 18,980 in women. These values correspond to an estimated risk of 16.83 new cases per 100,000 men and 17.90 per 100,000 women. It is the third most frequent type of cancer in men and the second among women (INCA, 2018).

Colon and rectal cancer in men is the second most frequent in the Southeastern Region (23.29/100,000) and the third in the Southern (22.17/100,000) and Midwestern (16.95/100,000) Regions. In the Northeast (7.98/100,000) and North (4.97/100,000) regions, it occupies the fourth position. For women, it is the second most frequent in the Southeast (23.86/100 thousand) and South (22.92/100 thousand) regions. In the Midwestern (17.98/100,000), Northeastern (9.52/100,000) and Northern (7.38/100,000) regions, it is the third most frequent, not considering non-melanoma skin tumors (INCA, 2018).

Incidence and mortality rates from colon and rectal cancer vary widely around the world according to the Human Development Index (HDI), with three patterns of disease distribution being identified: (1) increase in both rates in recent decades in countries that underwent a rapid economic transition, including Brazil; (2) increase in incidence and decrease in mortality in countries with high HDI, including Canada, United Kingdom, Singapore and Denmark; and (3) decrease in both rates in countries with very high HDI, such as the United States, Japan and France (ARNOLD et al., 2016; GASPARINI et al., 2018). So the research question is: what is the current panorama of technologies related to colorectal cancer? The overall objective is to map patents on colorectal cancer.

## **2. Theoretical Framework**

### **2.1 Colorectal cancer**

CRC is a multifactorial disease influenced by genetic, environmental and lifestyle factors (SANDLER, 1996; BOYLE; LEON, 2002; CAMPOS et al. (2017). Hereditary factors, such as family history of CRC and inflammatory bowel diseases, represent only a small proportion of the variation observed in the overall burden of disease. In this sense, the geographical differences observed in incidence possibly reflect the adoption of western lifestyle habits (ARNOLD et al., 2016). It is evident that a nutritional transition is occurring around the world, mainly affecting developing countries. Thus, lifestyle risk

factors are modifiable and include: alcohol consumption, low fruit and vegetable intake, high consumption of red meat and processed foods, obesity, smoking and physical inactivity (HARRISS et al., 2009; FEDIRKO et al., 2011; WALTER, 2014; BOUVARD et al., 2015). CRC is one of the most malignant tumors in both sexes, among all types of tumors worldwide (HUANG et al., 2016).

### **2.1.1 Risk factors**

Risk factors are conceptualized as any action that increases the risk of an individual developing a certain disease or suffering a certain disease (BRASIL, 2003).

Risk factors for the development of CRC can be considered: age over 50 years; first degree relatives with intestinal cancer; genetic syndromes (family adenomatous polyposis and nonpolyphoid hereditary colorectal cancer); inflammatory bowel disease (ulcerative colitis, Crohn's disease); excessive consumption of alcoholic beverages and animal fat; smoking and obesity (BRASIL, 2003).

### **2.2 Technology Mapping**

Patentometry is a tool used for quantitative and qualitative analysis, i.e., the technological mapping of patents (ANDRADE, 2014; ANTUNES et al., 2018).

Abbas, Zhang and Khan (2014) conducted a review of the patent literature and concluded that patent analysis is a tool that can be used to forecast technological trends. Patentometry is one of the instruments capable of evaluating and monitoring the transformations and technological growth is the analysis of patents (PANTANO et al, 2017).

## **3. Methodology**

In this study, a mapping of the technologies related to colorectal cancer was performed (ARNOLD et al, 2016; ANTUNES et al., 2018). The search took place during the months of May and June 2019. It was used the Leans database, which captures global information on patents and academic research, available through the link: <https://www.lens.org>.

The search for information occurred through the term "colorectal cancer", inserted in the title or abstract fields of the base. Patents with publication date between January 1, 2000 and June 1, 2019 were selected. Only patents granted and patents deposited (patent application and granted patent) were filtered for analysis.

Lens allows the analysis of patent and scientific information (articles, dissertations, theses, among others) of a certain area. Thus, it enables a more effective and comprehensive analysis of the context of a technology. Thus, in the first stage of the research, we proceeded with the analysis of patent information: year of publication, countries, inventors, holders and International Classification of Patents (IPC). Then the information of the academic works cited in the patents were mapped: authors, institutions, journals, countries and subjects of the works.



The search expression and the number of records identified are shown in Table 1:

Table 1 - Search expression used in the study.

Search expression *	Number of records	
	Patent	School work
title:("colorectal cancer") OR abstract:("colorectal cancer")	6.850	14.083

\*Filters: Publication Date = (Jan 1, 2000 - Jun 1, 2019 ) types = ( Patent Application , Granted Patent )

Source: research data (2019).

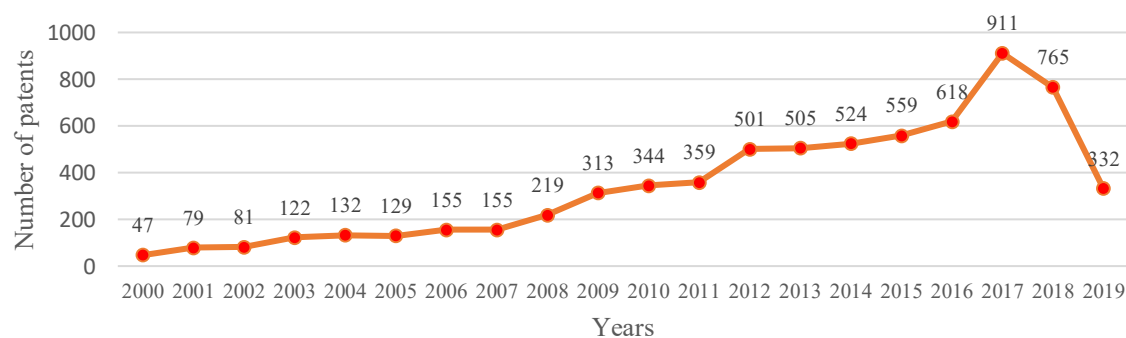
## 4. Results

In the following items are presented the results regarding the mapping of patents on colorectal cancer and the mapping of academic works cited in these technologies.

### 4.1 Patent Mapping Related to Colorectal Cancer

6,850 patents related to colon and rectal cancer were identified. 5,445 (79.48%) correspond to patents filed and 1,405 (20.51%) are patents granted in the period from 2000 to 2019. The evolution of the publication of these patents occurred as shown in Figure 1.

Figure 1 - Patents on colorectal cancer by years (2000-2019).



Source: research data (2019).

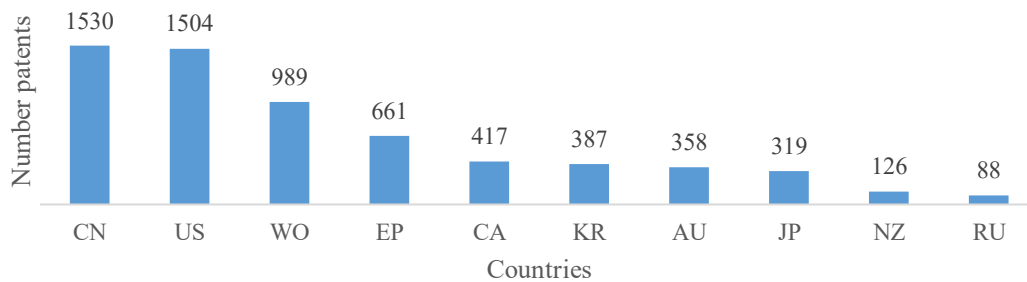
In 2000, the first year of the historical series, 47 patents on colorectal cancer were published. The growth in the number of technologies deposited and granted was constant. In 2017 there were a total of 911 deposits, indicating a growth of 1938.29% in relation to the year 2000. The first identified patent of the period was "Apc Mutation Associated With Familial Colorectal Cancer In Ashkenazi Jews" - APC gene mutation associated with colorectal cancer in families of Ashkenazi Jews (LAKEN et al., 2000), developed by Steve Laken, Stephen Gruber, Gloria Petersen, Kenneth Kinzler and Bert Vogelstein. This patent belongs to Johns Hopkins University, located in Baltimore, Maryland, USA.

The patent is described as follows:

During routine screening of a patient with a family history of colorectal cancer for truncation of APC mutations, a new missense mutation was identified. After further evaluation, it was found that 6% of ashkenazi Jews carry this mutation, and that it was present in the DIFFERENCE 20% of ashkenazis with a family history of CRC. Probes, methods and kits are provided to identify individuals affected by this missense mutation (LAKEN et al., 2000).

The Figure 2 shows the distribution of patents analyzed by country.

Figure 2 - Patents on colorectal cancer by country (2000-2019).



Note: CN - China; US - United States of America; WO - World Intellectual Property Organization; EP - European Patent

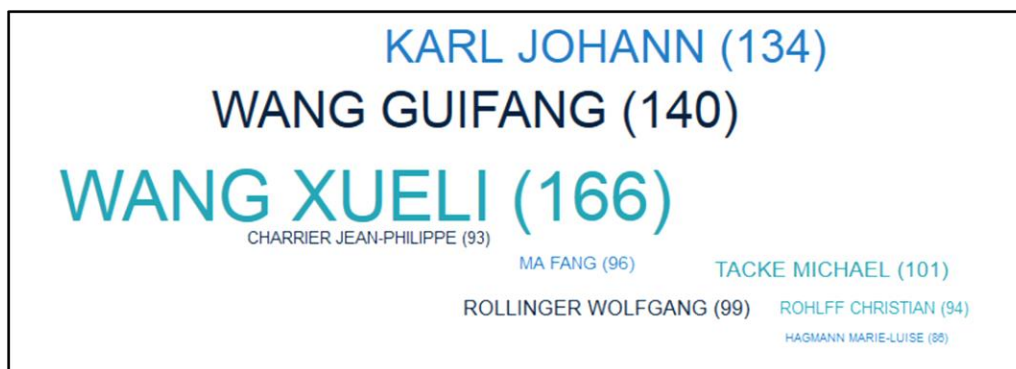
Organization; CA - Canada; KR - Republic of Korea; AU - Australia; JP - Japan; NZ - New Zealand; RU - Russian Federation.

Source: research data (2019).

Among the countries that have developed the most technologies related to colorectal cancer is China, with 1530 patents and the United States, with 1504 documents. This result is related to the large amount of research that both countries have developed on color and rectal cancer, especially the United States. Other countries that have stood out in the technological production of the area are Canada, Korea, Australia, Japan, New Zealand and Russia.

The figure 3 shows a cloud of the inventors of the patents analyzed in this work.

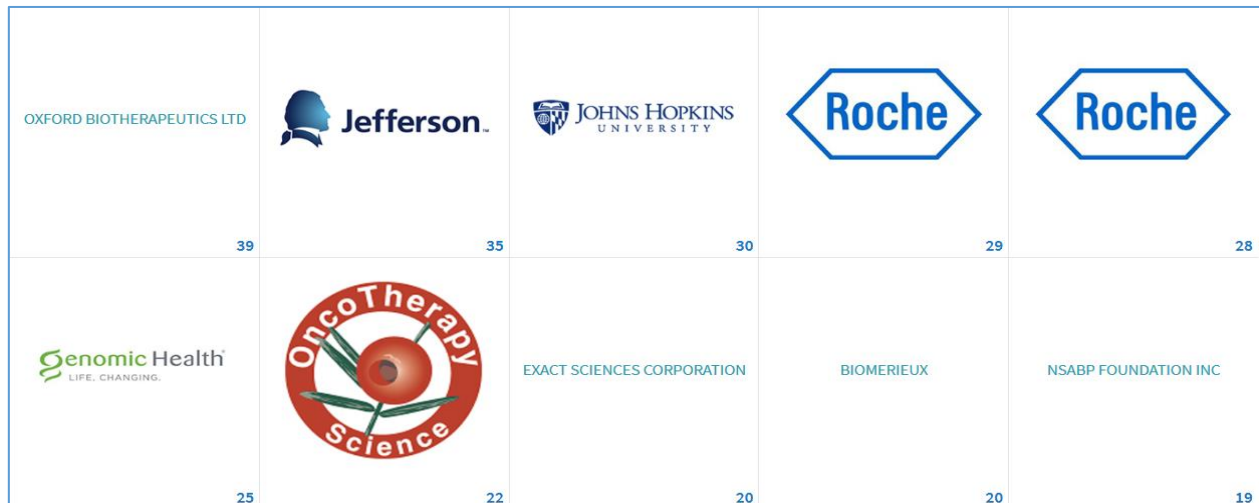
Figure 3 - Patents on colorectal cancer by inventors (2000-2019).



Source: research data (2019).

Wang Xueli was the most outstanding inventor in this ranking, with 166 patents identified. His patents were applied for by Yinchuan Shanghetu New Tech Dev Co Ltd, being initially applied for in China. Other outstanding inventors are Wang Guifang, also from China, with 140 patent documents, and Karl Johann, with 134. He has patents predominantly filed in Canada and the United States, and there are also deposits in other countries. Figure 4 shows the holders of patents on colorectal cancer.

Figure 4 - Patents on colorectal cancer by holders (2000-2019).



Note - The map shows the logos of the following institutions: Oxford Biotherapeutics Ltd, Thomas Jefferson University, The Johns Hopkins University, Roche Diagnostics Operations Inc, Roche Diagnostics GmbH, Genomic Health Inc, Oncotherapy Science Inc, Biomerieux, Exact Sciences Corporation, Biomerieux e Nsabp Foundation Inc.

Source: research data (2019).

With regard to the holders of patents on colorectal cancer, it appears that the universities of Oxford, Thomas Jefferson and The Johns Hopkins are the ones that stand out the most. It is noteworthy that the three institutions are located in the United States, which is related to the supremacy of the country in technological production in this area. Table 2 presents the International Classifications that most have patent documents on colorectal cancer.

Table 2 - Patents on colorectal cancer by international classification (2000-2019).

Classification IPC	Description	N° of patents
A61P35/00	Human needs section, referring to medical or veterinary science/hygiene, related to the specific therapeutic activity of chemical compounds or medicinal preparations from antineoplastic agents;	2140
C12Q1/68	Section of chemicals or metallurgy, referring to biochemistry, beer, alcohol, wine, vinegar, microbiology, enzyme, genetic engineering or mutation, related to measurement or testing processes involving enzymes, nucleic acids or microorganisms (g01n 33/53 immunoassays), their compositions or their test papers, processes for preparing these compositions, responsive control to environmental conditions in microbiological or enzymatic processes, specifically in measuring or testing processes involving enzymes, nucleic acids or micro-organisms (measuring or testing apparatus or means of measuring or detecting environmental conditions, p. e.g. colony counters, c12m 1/34), compositions for this purpose or preparation processes of such compositions involving nucleic acids.	1989
G01N33/574	Section referring to Physics for measurement or testing, specifically for investigation or analysis of materials by determining their chemical or physical properties (measurement or test processes, other than immunological assays, involving enzymes or microorganisms c12m, c12q), for investigation or analysis of materials by specific methods not covered by groups g01n 1/00-g01n 31/00, for cancer.	1731

A61K39/395	Human needs section, focused on medical or veterinary science and/or hygiene, specifically related to preparations for medical, dental or hygienic purposes (devices or methods specially adapted to give pharmaceutical products determined physical forms or for their administration A61J 3/00; chemical aspects of, or use of, bandaging materials, dressings, absorbent pads or A61L surgical articles; C11D soaps), within the scope of medicinal preparations containing antigens or antibodies (G01N 33/53 immunoassay materials) with antibodies (A61K 38/36 agglutinins), immunoglobulins, immunosorum, p. e.g. antilymphocytic serum.	516
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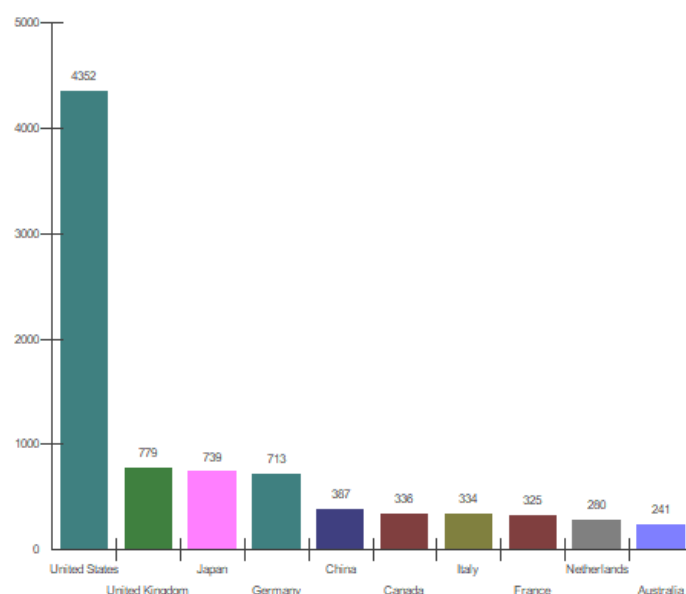
In general, patents in this area are classified in the human needs, chemical or physical sections. This is related to the nature of the technologies developed to combat the problem, which generally include machines or equipment to diagnose the problem or even to treat it. In addition, it is related to the remedies used throughout the treatment process.

#### 4.2 Patent mapping related to colorectal cancer

The analysis of academic papers cited in patent documents is important for understanding the evolutionary context of a given technology. In this sense, this section shows some information regarding the mapping of the scientific papers cited in the patents analyzed in the research.

The figure 5 shows the academic works cited by patents related to colorectal cancer by country (2000-2019).

Figure 5 - Academic papers cited by patents related to colorectal cancer by country (2000-2019).



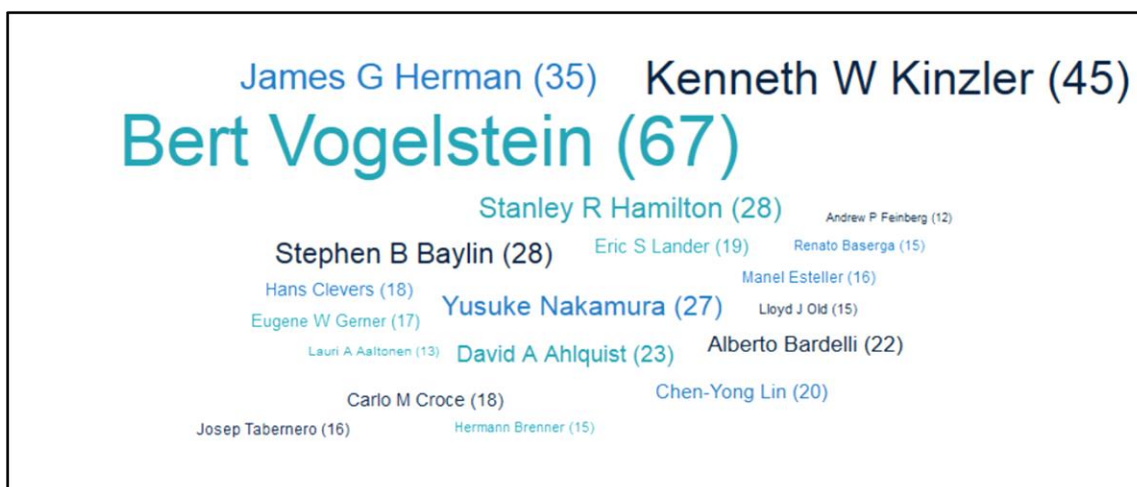
Source: research data (2019).

The United States stands out as an isolated country producing academic works on colorectal cancer, with 4,532 articles identified. This aspect is closely related to the prominence of the country in technological production (patents), as previously presented.

Other countries that have presented considerable scientific production are the United Kingdom, Japan and Germany. China is not one of the countries with the greatest prominence in the ranking, but has important scientific production in the area, which also has a relationship with the country's technological

production. Figure 6 shows the map of authors of these works.

Figure 6 - Academic studies cited by patents related to colorectal cancer by authors (2000-2019).

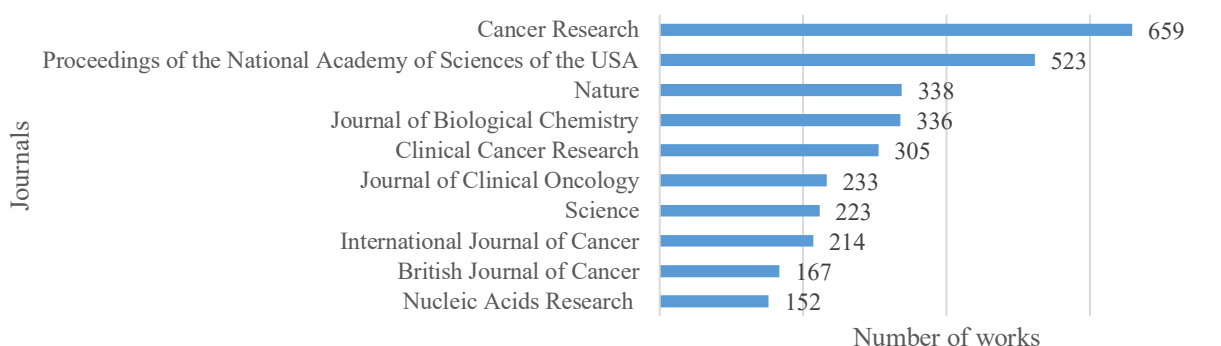


Source: research data (2019).

Doctor Bert Vogelstein is the researcher with the highest volume of work on the subject, with 67 documents identified. Kenneth Kinzler and James G. Herman also have a large amount of research on the subject, with 45 and 35 papers, respectively.

The three researchers are North Americans. Two of them have already established some link with Johns Hopkins University (one of the institutions with the highest number of patents on colorectal cancer in the world). The figure 7 shows the journals in which the studies under analysis have been published (2000-2019).

Figure 7 - Academic works cited by patents related to colorectal cancer by periodicals (2000-2019).



Source: research data (2019).

Cancer Research has 659 of the publications cited by patents on colorectal cancer. It is a journal published by the American Association for Cancer Research and was created in 1941. It has an impact factor of 9.13 and ranks 17th in the ranking of journals on oncology in the world, among 222 journals. The figure 8 shows the map of the institutions originating from these academic works.

Figure 8 - Academic studies cited by patents related to colorectal cancer by institutions (2000-2019).

Figure 8 - Academic studies cited by patents related to colorectal cancer by institutions (2000-2019).



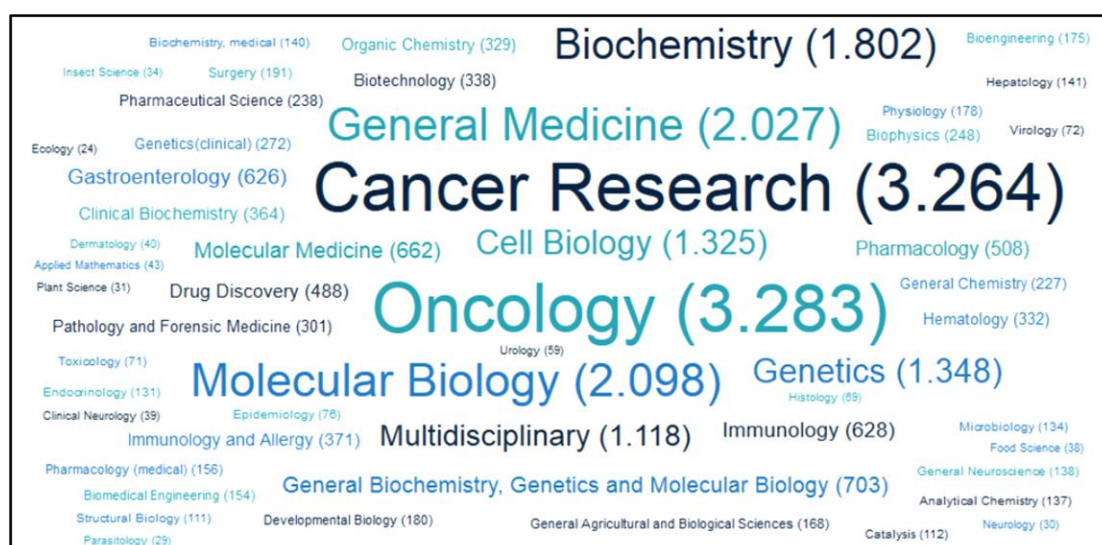
Note - The map shows the logos of the following institutions, respectively: Harvard University, National Institutes of Health, Johns Hopkins University, University of Texas MD Anderson Cancer Center, Memorial Sloan Kettering Cancer Center, Mayo Clinic, University of Michigan, University of California, San Francisco, French Institute of Health and Medical Research e Max Planck Society.

Source: research data (2019).

Among the universities that have produced the most research cited in the patents on colorectal cancer are Harvard University, the National Institutes of Health and Johns Hopkins University. The three institutions are located in the United States, which contributes to the country's numbers in technological production in the area.

In addition, it is also observed that Johns Hopkins has great know-how in the subject, both in scientific production and in technological production (patents). Figure 9 shows the cloud of the main issues identified in the researches.

Figure 9 - Subjects addressed in academic works cited by patents related to colorectal cancer (2000-2019).



Source: research data (2019).



Among the main expressions are "cancer research", "oncology", "molecular biology", "general medicine" and "biochemistry". In general, these are terms aimed at medicine and oncology, specifically involving studies on cancer and on possible alternatives to the problem.

## 5. The Final Considerations

From the mapping of patents carried out in this study, in the period from 2000 to 2019, it was found that in 2017 there was a total of 911 applications, indicating a growth of 1938.29% in relation to the year 2000. The first patent identified in the period was "Apc Mutation Associated With Familial Colorectal Cancer In Ashkenazi Jews" - APC gene mutation associated with colorectal cancer in families of Ashkenazi Jews. Among the countries that have developed the most technologies related to colorectal cancer is China, with 1530 patents and the United States, with 1504 documents. Wang Xueli was the most outstanding inventor in this ranking, with 166 patents identified. His patents were applied for by Yinchuan Shanghetu New Tech Dev Co Ltd, being initially applied for in China.

As for the academic papers cited by patents related to colorectal cancer by countries (2000-2019), the United States stands out as an isolated country producing academic papers on colorectal cancer, with 4,532 articles identified.

Doctor Bert Vogelstein is the researcher with the highest volume of work on the subject, with 67 documents identified. The journal Cancer Research has 659 of the publications cited by patents on colorectal cancer.

It is important to note that the universities that have produced the most research cited in the patents on colorectal cancer are Harvard University, the National Institutes of Health and Johns Hopkins University. Given the high prevalence of this disease, there is a need for a greater incentive in scientific and technological research to reduce it and improve the quality of life of patients affected by this type of cancer.

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# **PH Analysis of an Wastewater Treatment Plants (WWTP) in a Paper Recycling Industry**

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## **Abstract**

*The paper industry in its production process consumes a large amount of water, and the flow of effluent is very variable, being related to the manufacturing process used in production capacity. Effluents are formed by complex mixtures of chemical compounds. The wide composition variability among the effluents from the most diverse origins, added to the market entry of numerous chemical substances every year, which will become part of the effluents, makes the complete characterization of its composition very difficult. To characterize the effluent, some parameters are analyzed, which may be physical, chemical or bacteriological. The pH, which is directly related to the coagulation efficiency, as it influences the chemistry of the coagulants, their reactions in the aqueous environment, the predominant hydrolysed species and the variation in surface charge of colloids present in the effluent, where in the aqueous system it is typically measured by use of a pH meter. Therefore, the objective of this study was to perform an effluent treatment plant (ETE) analysis of a paper recycling industry, the inlet and outlet flow values of the WWTP, using the pH parameter, comparing the dry periods, flood and transition from August 2018 to July 2019. Initially, a survey of technical documents related to the effluent treatment process and the verification of the standard norms, in use in the Industry WWTP was carried out. The collections were performed bimonthly, observed at times that did not interfere in the results and identified according to CONAMA Resolution, nº 430/2011. The pH values obtained at the WWTP revealed an improvement in the quality of the effluent treated in accordance with current legislation. However, although the effluent was adequate for the release pattern, the high toxicity found in the inlet and outlet pH of the WWTP, evidences the need to define new treatment and / or control strategies to*

*comply with the legislation regarding this parameter.*

**Keywords:** Wastewater Treatment Plants; Paper industry.

## 1. Introduction

From the economic point of view, the relevance of industries for the different production processes is unquestionable, however they are often sourcing responsible for major pollution, including water, caused by environmental contamination, generated by improper disposal of waste, where they do not have a system. efficient and applicable management.

The paper industry in its production process consumes a large amount of water, and the flow of effluent is very variable, being related to the manufacturing process used in production capacity. Considering the characteristics of the pulp and paper industries, with regard to water consumption, the generation of liquid effluents and the current crisis in water resources, highlights the need for efficient treatment of their wastewater and simple release into receiving bodies.

According to [1], water pollution occurs when its nature is altered or its legitimate uses are impaired due to the addition of substances or forms of energy. This pollution can cause various effects on water bodies, such as oxygen consumption problems, waterborne diseases, different odors, among many others.

Among the different forms of dumping, one of the most serious is industrial wastewater that contains a considerable amount and variety of chemicals that affect public health and the environment if released to untreated water bodies [2].

Effluents are formed by complex mixtures of chemical compounds. The large composition variability among the effluents from the most diverse origins, added to the entry into the market of numerous chemical substances every year, which will become part of the effluents, makes the complete characterization of its composition very difficult [3].

Proper wastewater treatment requires strict control of the system used, in addition to understanding the influence of toxic compounds on the purification process and how efficient the toxic load removal system is, which is often measured by COD reduction ( Chemical Oxygen Demand), BOD5 (Biological Oxygen Demand), toxicity, or other compound whose removal is indispensable for final disposal [4].

To characterize the effluent, some parameters are analyzed, which may be physical, chemical or bacteriological. One example is turbidity, due to the presence of suspended matter in water, which decreases its transparency. Turbidity is a parameter used to identify the interference that light suffers when passing through the liquid [5].

Another parameter to be analyzed is Oxygen Demand, which according to [5], are linked to organic compounds, chemicals that contain carbon, hydrogen, oxygen, nitrogen, sulfur and / or phosphorus, which may be present in the effluent and biologically and chemically oxidized, demanding oxygen.

Biochemical Oxygen Demand (BOD) is the measure of oxygen required for bacteria to destroy organic matter, indicating the amount of oxygen needed for microorganisms to oxidize organic compounds. It can also be used to size equipment, measure process efficiency and ultimately assist as an indicator within the process of environmental standards [6].

As the COD is recognized as an indicator of effluent treatment, it can be used to evaluate the pollution

load in relation to the amount of oxygen required for its total oxidation in CO<sub>2</sub> and H<sub>2</sub>O. Therefore, the lower the BOD and COD values, the lower the organic load and effluent pollution capacity [5].

[7] points out that the analysis of COD values in effluents is one of the most expressive analyzes to determine its degree of pollution. Performed COD analyzes, the value obtained indicates an estimate of the oxygen consumption that an effluent discharged directly into a water body would require. If the amount of organic matter present in this effluent could be mineralized, the higher value of this parameter indicates a higher effluent pollution content [8].

Another parameter is achieved by turbidity, measured by the property of light transmission through water, related to the colloidal and suspended residual material, which is based on the comparison of the scattered light intensity in the sample with the amount of water dispersed in a solution. under the same conditions and correlated with the suspended solids concentration [9].

Another important indicator is hydrogen potential, better known as pH, which is determined at various stages of water treatment as it can affect numerous processes. An acidic pH (below 7) indicates that water or effluent is corrosive and can damage pipes; a basic pH (above 7) indicates that they are foul, which can also damage appliances [5].

The pH is directly related to the coagulation efficiency, as it influences the chemistry of these coagulants, their reactions in the aqueous environment, the predominant hydrolyzed species and the variation in the surface charge of colloids present in the effluent, where in the aqueous system is typically measured by the use of a pH meter [10].

Large industries, whose production process requires high water consumption, are potential generators of large volumes of liquid effluents, such as pulp and paper industries, which demand water at all production stages and can generate life-effluent effluents. water and the environment. Thus, it becomes the sixth largest environmental polluter, given all its contribution of environmental losses, in the most different areas [11].

Therefore, the objective of this study was to perform an analysis at a Wastewater Treatment Plant (WWTP) of a paper recycling industry, evaluating the inlet and outlet flow values of the WWTP, using the pH parameter, comparing the periods. from drought, flood and transition from August 2018 to July 2019.

## 2. Materials and Method

Initially, a survey of technical documents related to the effluent treatment process and the verification of the standard norms in use in the ETE of a paper recycling industry was carried out.

The collections were performed bimonthly, observed at times that did not interfere in the results and identified according to CONAMA Resolution [12], during the established period (Table 1).

Table 1 - Collection Period by Season

Period	Season
August to October - 2018	Dry Season
November to January - 2019	Transition Station
February to April - 2019	Rainy season

Source: Own authorship (2019).

Samples were collected from 1000 ml polyethylene bottles and taken directly to the laboratory. Since this condition is given in less than an hour, there is no need for refrigeration according to NBR [13].

The samples of the collected effluents were sent to the industry service laboratory, Analytical Center, registered with the Amazonas Environmental Protection Institute (IPAAM), for the analysis of the Ph, by the Electrometric Method (4500-H + B) SMEWW. [14]

The variation of the pH during the seasons was verified, being identified which ones generate the largest amount of effluent, describing the reasons for the increase of the effluent flow.

### 3. Results and Discussion

Industrial and domestic effluents should be treated by mixing with water from aquatic environments that are seriously contaminated with heavy metals and organic matter, reducing or extinguishing many types of aquatic life and also generating an environment conducive to other non-aquatic species. desirable. In addition to rivers and lakes, groundwater has been contaminated through seepage, septic tanks, sinks or industrial wastewater reservoirs [15].

In Brazil, the discharge of industrial effluents is regulated at the federal level by Resolution [12]. This Resolution, dated May 13, 2011 in its wording provides on conditions, parameters, standards and guidelines for the management of effluent discharge into receiving water bodies.

Eco-toxicity tests allow the assessment of environmental contamination by various polluting sources, such as: agricultural, industrial and domestic effluents, sediments, medicines and chemicals in general, as well as to evaluate the resultant of their synergistic and antagonistic effects [16].

Strategies for reducing effluent toxicity primarily involve knowledge of the production processes, associating the raw materials and inputs used, as well as the effluent treatment process [17].

Toxicity testing has been employed to monitor industrial effluents in order to minimize environmental impact, evaluate the efficiency of treatment plants and comply with legal requirements. The analyzes carried out in an effluent as required by the environmental agency are insufficient to relate to toxicity and sometimes the limits set for effluent release patterns present toxicity to at least one of the trophic levels analyzed. Based on this information, strategies and targets for reducing effluent toxicity on solution characteristics can be defined [17].

The characteristics of a solution depend largely on the solute contained in it. There are substances that do not react with the medium and do not interfere with its balance, while acids and bases, when dissolved, ionize or dissociate and alter the amount of  $H^+$  and  $OH^-$  of the medium, making it acid or alkaline [18 ].

The pH values obtained in the paper industry's TEE were represented in the table and graph, showing larger oscillations in the dry-rain season with Input 8.14 and Output 7.21; and smaller oscillations during the Dry-Rain season with Input 5.21 and Output 5.18, proving that they are in accordance with Resolution [12] which determines a pH range between 5.0 and 9.0 (Table 2). .

Table 2 - Industrial ETE Stations Period

<b>Industrial (WWTP)</b>		
Station	pH Input	pH Output
Rain	6,1	6,52
Dry Rain	8,14	7,21
Rain Dry	5,21	5,18
Rain	6,82	6,85
Average	6,568	6,440
Standard deviation	1,238	0,886
95% CI	1,213	0,868

Source: Own authorship (2019).

The pH or hydrogenic potential is a parameter that indicates the acidity, neutrality or alkalinity of an aqueous solution, determined by the concentration of hydronium ions. The values vary on a scale from 0 to 14, being acidic - pH below 7, basic - pH above 7 and neutral - pH 7, which can be measured using the pH meter [18].

The pH condition of the effluents results from the contamination caused by the various industrial manufacturing processes. The contact of water with substances such as caustic soda, caustic potash, lime, among others, releases a highly harmful alkaline final effluent to water sources, requiring a corrective solution to reduce pH to tolerable levels. Inorganic, sulfuric and hydrochloric acids are generally used for industrial effluents. The damage caused by these aggressive acids and the high risks arising from their use and problems during transport can seriously compromise the environment [19].

Often the pH measurements obtained using equipment without proper calibration and control may be indicating values allowing the discharge of effluent at pH within the established environmental standard; However, in reality, non-compliance may be occurring due to lack of knowledge of the uncertainty of these values. And uncertainty can only be established when the traceability of measurements is known [20].

PH is the measure of the acid balance of a solution, defined as the negative logarithm of hydrogen ion concentration. The pH values are related to natural factors, such as rock dissolution, atmospheric gas absorption, organic matter oxidation and photosynthesis, and to anthropogenic factors due to the disposal of domestic and industrial sewage, due to the oxidation of organic matter and acid washing. tanks respectively [1].

The data show the average pH range for 6.56 at Input and 6.44 at Output with standard deviation of 1.23 and 0.88 respectively (Figure 1).

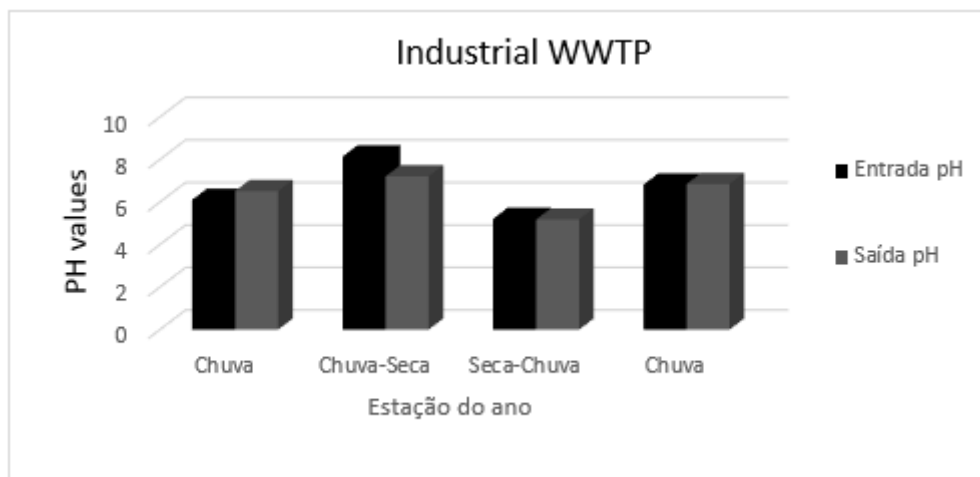


Figure 1. Input and output values in an effluent at different seasons of an industrial WWTP.

Source: Own authorship (2019).

[21] concludes that the pH should remain close to neutrality, and assigns a range of 6.5 to 7.5 as the ideal pH for anaerobic digestion to occur; aiming at higher methane production in the system the pH should be between 6.8 and 7.2.

From the value obtained it can be said, based on [21], that the system was within neutral limits, not making possible problems to the treatment system in this regard. A possible alternative to be indicated for the TEE of the analyzed industry is the feasibility of its exploration for the methane gas formed in the process, due to its pH in the range of higher production of this gas during the dry-rain transition season.

The composition of the effluent and its respective concentrations in the sample is due to several factors, such as: time of collection, rainfall or drought, industrial sewage network clandestinely connected to the collection system and presence of various constituents. Another relevant factor that may change the system is the presence of toxic compounds and the upward flow velocity and inadequate tributary pH, as well as possible mechanical failures may influence the efficiency of the biological treatment process. These requirements directly affect the treatment process and are a fundamental cause of fluctuations in the values of the physicochemical standards of analysis [1].

#### 4. Final Considerations

The analysis of the obtained results reveals an improvement in the treated effluent quality, in compliance with the current legislation regarding the physical and chemical parameters. However, although the effluent was adequate to the release pattern, the high toxicity found in the input and output pH of the wastewater treatment plant evidences the need to define new treatment and / or control strategies to comply with the legislation regarding to this parameter.

It can be observed that the final pH result with the associated uncertainty indicated values confirming that there are control conditions for discharge purposes, when considering the allowable limits of pH 6.0 to 9.0 for the region where the treatment station is located.

Importantly, care should also be taken with the electrodes used for pH measurement. Inadequate maintenance can lead to poor measurement quality. Using meters and electrodes not suitable for use

would invalidate all results. Estimating the uncertainty of the measurements thus obtained would be meaningless.

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# **Energy Efficiency and Lumino technique Analysis in a Higher Education Unit in Manaus - Amazonas**

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## **Abstract**

*This paper presents an energy efficiency analysis at a unit of a private higher education institution in the city of Manaus. In this case study, we sought to analyze the lighting system of the educational institution, promoting a simple and effective way to contribute to the improvement of energy efficiency in the institution that is the replacement of fluorescent lamps with LED lamps (Ligth Emitting Diode). In addition to increasing efficiency, LEDs bring significant benefits to the power grid, such as improved installation power factor and power quality, and reduced maintenance due to their longer service life. This case study presents a case study to be implemented in a higher education institution. The benefits that the use of LED brings in various aspects will be analyzed in detail.*

**Keywords:** *Energy efficiency; Lighting system; Ligth Emitting Diode.*

## **1. Introduction**

Much of the electricity produced in Brazil comes from hydroelectric plants, even if considered as renewable energy sources, hydroelectric plants have a large environmental impact in the region where they are installed [20]. After years of uncontrolled energy consumption, disregard for environmental

problems, the scarcity of natural resources, the overconsumption of consumerism by a large portion of society, humanity faces a major hindrance: saving, recycling, sustainability and using it wisely. efficiency of natural resources [22].

Humanity today faces several problems when it comes to conscious use of energy, since to produce more energy is necessary to extract it from some source of energy and thus it is necessary to build generating sources. Energy production through hydroelectric dams does not pollute the air, but causes huge environmental impacts due to the large amount of water that will be dammed. The generation of thermoelectric energy emits gases that can contribute to the aggravation of the greenhouse effect. Solar energy needs large areas for the installation of photovoltaic panels. Wind energy from the displacement of air masses generates many noises and can interfere with the migratory behavior of birds [15].

In 2001, Brazil experienced several frequent outages or outages, such as long-term blackouts due to low levels of hydroelectric reservoirs due to the long drought and a lack of planning in the sector and lack of investment in power generation and distribution [5].

The search for greater efficiency in consuming energy is not only due to environmental factors, such concern is also due to the current economic situation in Brazil, which has been formally in recession since the second quarter of 2014, Brazilian per capita output fell by 9%. % between 2014 and 2016, with the economy recovering and inflation rising, the price of energy rose almost exponentially [10].

One way to have more energy for consumption without increasing electricity production or expanding the energy matrix would be to invest in energy efficiency, i.e. to develop equipment that consumes less and less energy in the execution of electricity. a particular process [21].

With the increasing difficulty of many countries in meeting the growing demand for energy, it also provides energy resources to meet their economic growth. It is the responsibility of the public authorities to know the behavior of its population that demands energy so that mechanisms can be developed that promote the rational use of energy in the most diverse sectors [3].

In Brazil, several public policy programs were adopted to encourage energy efficiency, which began since 1981 with CONSERVE, where the purpose of this program was to promote energy conservation in industry, the development of efficient products and the substitution of imported energy sources by national sources. . The following year the Energy Mobilization Program (SME) was launched in which its main features consisted of a set of actions aimed at encouraging the use of energy conservation measures and especially replacing petroleum products with renewable energy sources [ 17].

In 1985 the National Program for the Conservation of Electric Energy (PROCEL) was created, its main mission was to promote the rational use of electricity throughout the country and among its initiatives is the creation of the Brazilian Labeling Program [18]. The National Program for the Rationalization of the Use of Oil and Natural Gas Derivatives (CONPET) was established, whose purpose was to stimulate the rational use of energy resources in the country, but focused on renewable energy sources [17].

The National Energy Policy (PEN) program was created by Law No. 9,478, and the principles of the PEN in relation to the rational use of energy sources were determined, aiming at energy conservation and environmental preservation [3].

At the beginning of the 21st century, in the 2000s, the main legal framework in the area of energy efficiency in the country was published, Law No. 10.295 / 2001, which launched the National Policy for

Conservation and Rational Use of Energy, with the purpose of to establish that the executive branch be responsible for developing mechanisms that promote efficiency in machines and equipment produced and sold, and in buildings built in the country [3].

About 5% of world electricity consumption could be saved annually by implementing more efficient lighting, reflecting an annual savings of more than US \$ 110 billion, where Brazil, when adopting this strategy saves more than US \$ 3 billion / year. and would reduce more than 5% of its consumption [15].

With all measures and incentives made to increase equipment efficiency, between 2001 and 2010 the first results of this investment were obtained where the efficiency of the installed lighting system increased from 45 to 58 lm / W, a significant increase of 28.8%. due to the replacement of the incandescent lamp for the compact fluorescent lamp [20].

Incandescent lamps until mid 2007 were common in many locations due to the low initial cost. Its simple operation produces light by raising the temperature of a filament, commonly tungsten, when subjected to electric current. Several factors contributed to the replacement of this technology, among them the short life span of about 1,000 h and its energy loss by Joule effect where about 90% of the energy is lost and only 10% is transformed into light [13]. ].

Low-pressure discharge fluorescent lamps [2] were created by Nikola Tesla, introduced in the market in 1938. Their operation consists of discharging mercury vapors composed of a filament, a cylindrical glass tube filled with a noble gas ( argon is usually used) and the inner part covered with fluorescent powder which is phosphorus [9]. There are several advantages to its use, given its low energy consumption, of approximately 80% less compared to ordinary incandescent lamps, high performance in turning electric energy into light than in heat and its durability is far superior to incandescent ones. Fluorescent lamps have an average lifespan of 6,000 to 9,000 h [11].

Contrary to what is thought of light emitting diode (LED) lamps, it is not such a recent discovery. LED has been around since 1962 and was initially used only for signaling because of its low luminous flux (light emission), narrow color gamut and low wattage. In 1990, with investments in technology, Dr. Shuji Nakamura of Nichia Chemical Corporation invented the high luminous blue LED, which together with a Phosphorus layer emits white light [6].

The LED lamp has superiority to other lamps in the market because it has higher luminous efficiency, that is, it uses less energy to generate the same illumination [12]. By definition LED is a semiconductor electronic component, with technology similar to that used in computer chips, which has the function of turning electricity into light. No metal filaments are used, do not emit ultraviolet radiation or gas discharge. All electricity consumed is transformed into light, without considerable loss [19].

It is remarkable the superiority of LED lamps over the others, with a service life ranging from 15,000 to 50,000 h, their disposal is also a factor that proves their sustainability as it has no heavy metals in its composition and disposal in the environment. it does not need any special treatment before recycling [14].

The human being is influenced by visual stimuli and has optical information for most of his daily actions. The luminotechnical study is of utmost importance so that the lighting efficiency is as high as possible without affecting the human health [8].

In an environment it is essential that lighting values are in accordance with the standard, as poor sizing

can influence worker performance or a student's ability to learn and discomfort can cause visual fatigue [7]. For each task to be performed there is an adequate luminance level and for the present study the luminance levels for classrooms will be used. It is established for classrooms with a minimum luminance of 500 lux [4].

The present study seeks to analyze the luminotechnical and economic benefits of led lamps, compared to conventional ones, with the aid of luxmeter aiming to verify the lighting levels in the higher education unit in Manaus-AM. In case of non-compliance with NBR-8995, carry out a new lighting project to comply with the standard if necessary, simulate the impact on electricity consumption with possible substitution, assess what capital needs to be invested.

## 2. Material and Method

The study was conducted in a unit of a private Higher Education Institution (HEI), located in the Chapada neighborhood, Manaus / AM.

The analysis of energy and lighting efficiency was due to the large amount of luminaires containing fluorescent lamps and four types of rooms that will be named as: STANDARD 1, STANDARD 2, STANDARD 3, STANDARD 4, such separation of room types occurred. by Layout having different dimensions, with patterns that repeat on all six floors, with nine classrooms (Figure 1).

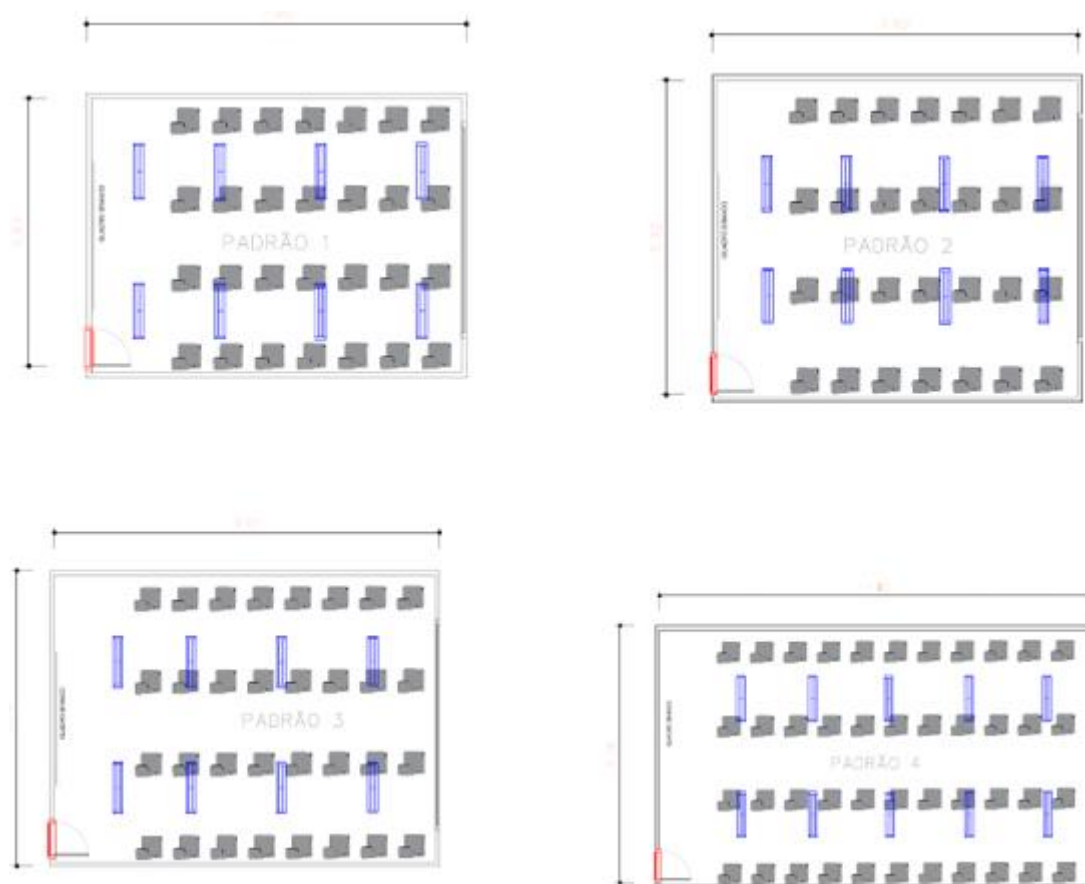


Figure 1. Layout of the four room patterns in a teaching unit.

Source: Own authorship, 2019.

## a) Survey of characteristic site data

The unit has 54 rooms, with four different standards, considering size (area - m<sup>2</sup>): STANDARD 1 - 46.4 m<sup>2</sup>; STANDARD 2 - 54.80 m<sup>2</sup>; STANDARD 3 - 61.1 m<sup>2</sup>; STANDARD 4 - 77.3 m<sup>2</sup>. The rooms have a ceiling height of 2.55 m. The distribution of luminaires for each room pattern was as follows: eight luminaires for standard 1, 2 and 3 and 10 luminaires in rooms with standard 4. Adding the number of luminaires from all rooms gives an amount of 444 luminaires, each luminaire with two 36W fluorescent lamps. Each floor has two rooms similar to Standard 1, two rooms similar to Standard 2, four rooms similar to Standard 3, and only one room has Standard 4.

## b) Standardization of Project Items

Given the variation in the brand of lamp manufacturers, a standard was adopted for each one, using the largest quantity present in the rooms. Thus, the manufacturer used will be Philips Lighting, model TL - D 36W / 54-765 1SL / 25, with characteristics: luminous flux 2500lm; service life 13000h; lumen maintenance 10000h - 75%; lumen maintenance 2000h - 90%; lumen maintenance 5000h - 80%; color temperature - 6200 K; color rendering index - 72%; power 36W; power consumption kWh / 1000h - 43kWh; length - 120cm [16]. The luminaire to be adopted is made by Abalux, model - A 60; yield - 86%; length - 123 cm; ip - 20 [1].

For the new project, the Philips Lighting TMS022 2xTL-D18W HFS + GMS022 R LED luminaire will be adopted, with total luminous flux of 2400lm, with the power of each 18W LED bulb. The equipment to be adopted has the following technical information: base - G13; luminous flux - 2100 lm; useful life - 25000 h; color temperature - 6200 K; color rendering index - 82; power - 18 W; power consumption kWh / 1000h - 19.5kWh; length 120 cm [16]. To obtain parameters of the lighting design the Dialuxevo 8.2 software was used.

## c) Current demand for lighting in the analyzed rooms.

The demand for an electrical installation is the amount of power required by all equipment to be energized demonstrated by equation 1.

$$D = P_n * QE \quad (\text{Eq. 1})$$

Where:

D - demand

P<sub>n</sub> - nominal wattage of the lamps;

QE - amount of existing equipment;

For the survey of the consumption of IES, it was established characteristics of the equipment, while: the full use of its useful life, 100% luminous flux and no system failure. For monthly consumption for calculation purposes we have:

$$C = \frac{(P_n * N_h * QE)}{1000} \quad (\text{Eq. 2})$$

Where:

P<sub>n</sub> - nominal wattage of the lamps;

Nh - number of hours the lamps are on;

QE - amount of existing equipment;

The unit has six floors, with nine rooms per floor reaching 444 lamps and 888 lamps in general. The academic calendar is available for the annual consumption calculation (Table 1).

Table 1- Average data of current lighting system

Academic Calendar			
School days	1st semester	2st semester	Horas
	127	104	2772
Total			2772

Source: Own authorship, 2019.

#### d) Initial Luminotechnical Diagnosis

The on-site collection, used to reach the luminotechnical data due to the lack of electrical and luminous design of the IES, used the base project to perform the energy efficiency study considering all the characteristics present in the current layout, where to perform the analysis all steps in NBR - 8995, to better portray a study environment (Table 2).

Table 2- Average data of current lighting system.

Environment	Medium Brightness	Lowest brightness value	Uniformity Factor
Pattern 1	492 lux	243 lux	0,49
Pattern 2	430 lux	177 lux	0,41
Pattern 3	240 lux	97 lux	0,40
Pattern 4	306 lux	136 lux	0,44

Source: Own authorship, 2019.

The definition of the use plan considered for all rooms was 0.73m, with a ceiling height of 2.55m. For classrooms using NBR-9995 500 lux illuminance and uniformity factor of  $\geq 0.70$ .

#### e) New project: Retrofit

The new project aimed to adjust the illuminance values (NBR-8995), where table 3 shows the values of average illuminance and uniformity factor.

Table 3- Average data of the new lighting system.

Environment	Medium Brightness	Lowest brightness value	Uniformity Factor
Pattern 1	516 lux	349 lux	0,67
Pattern 2	666 lux	460 lux	0,69
Pattern 3	609 lux	438 lux	0,71
Pattern 4	631 lux	430 lux	0,68

Source: Own Authorship, 2019.

#### Isometric lines

In a lighting system the isometric lines show how the entire luminous flux in a room is distributed, indicating which area needs more lighting. Thus, it is possible to obtain through simulations how the new project will behave in the real environment.

### 3. Results and Discussion

The teaching unit where the study was carried out has 100% of its illumination composed by fluorescent tube lamps, where summed up the demands of each classroom it was possible to obtain for the lighting system the total demand of 31,968 kW, which corresponds to approximately 4% of the contracted demand of the teaching unit. Considering the teaching days of the teaching unit and the demand obtained, the annual consumption value is 92.06784kWh / year.

Evaluating the current situation of the lighting system, it was observed that the standards of the rooms do not meet the minimum illuminance requirements of 500lux, being 26.6% below the ideal required by the standard. It was found that the average uniformity factor is 62.14% below the ideal, which may lead students to visual fatigue [8] and decreased academic performance, thus justifying the elaboration of a new lighting project for the institution. .

The elaboration of the new project with the aid of Dialux software kept the same right foot and the same height of the work plan, below it is possible to verify the isometric lines of the new project (Figure 2).

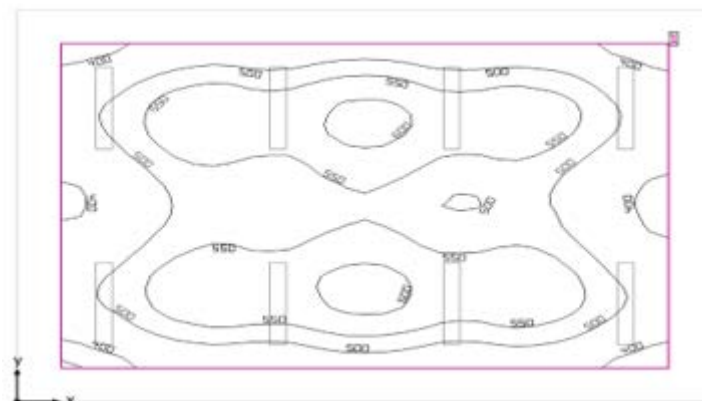


Figure 2. Isometric Lines Retrofit Pattern 1.

Source: Own authorship, 2019.

Light has a measurable neuroendocrine and neurobehavioral effect on the human body. By investigating the effects of light on human health, [8] indicates that the evidence shows direct relationships between light exposure and health and productivity, further complements that light ensures a healthy sleep / wake cycle and acts to maintain the health. activity / rest cycle.

Retrofit fits NBR - 89951, maintaining average illuminance of 516lux. The adequacy of the rooms with standard 1 kept the same amount of light fixtures and lamps present, with a reduction of 50% of the demand due to the replacement of fluorescent lamps with LED lamps (Figure 3).

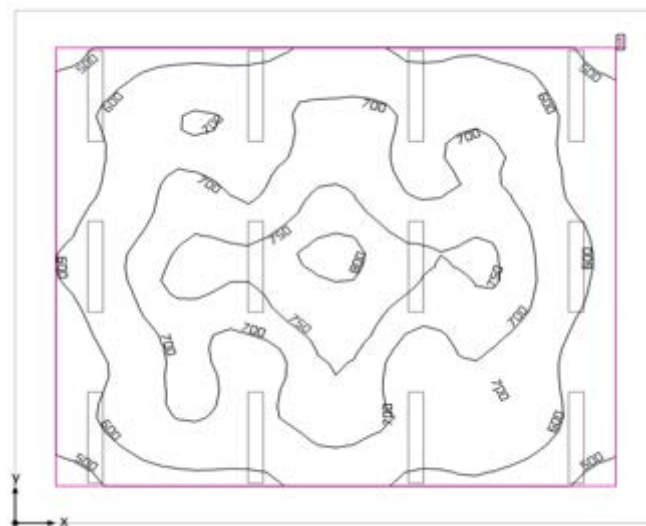


Figure 3. Isometric Lines Standard Retrofit 2

Source: Own Authorship, 2019.

The retrofit of the standard 2 rooms met the illuminance standards established by the standard, and the illuminance obtained was 666 lux. There was an increase of four new luminaires because the room area is larger than standard 1. The new demand is 25% less than the old design and the uniformity factor meets the minimum parameters (Figure 4).

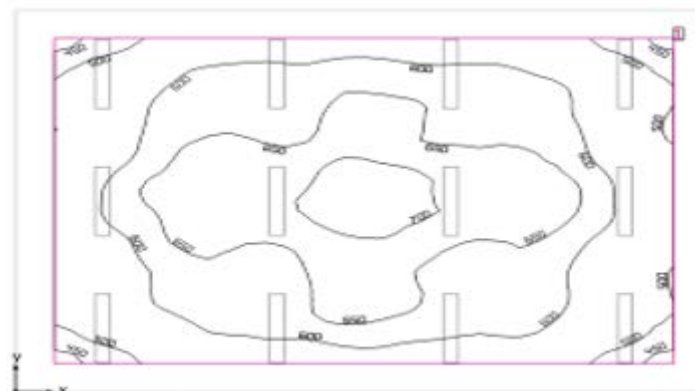


Figure 4. Isometric Lines Retrofit Pattern 3

Source: Own Authorship, 2019.

According to [20] the lamps purchased are based on characteristics such as their power consumption (in Watts), without considering the illumination level (lux), considering lumens information, as measured by the amount of light. or total number of lines of light flux emitted from the light source; efficiency, measured by how many lumens are emitted for a given input power (lumens per Watt -  $\text{lm.W}^{-1}$ ); and illumination, measured in a given area of the brightness level.

Standard 3 showed an increase of four luminaires compared to the old design and savings of 25% compared to the system already installed in the teaching unit. The project met the norm, in which the retrofit had an average illuminance of 609 lux (Figure 5).



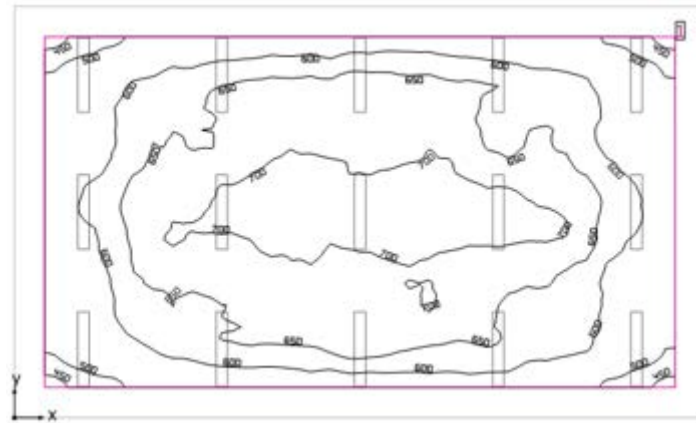


Figure 5. Isometric Lines Standard Retrofit 4

Source: Own Authorship, 2019.

For an autonomous potential for energy efficiency (range between 4.4% and 8.7%), [3] effective planning is required for the rational use of energy inputs by different economic sectors and also by the population. It is indicated that they are autonomous potentials, that is, those expected in the evolution of the market, and that the technical potential is much higher and usable if implemented by strong incentive policies for energy conservation.

The retrofit of the rooms with standard 4 simulated average illumination of 631 lux, which is the standard with the largest area (77.3 m<sup>2</sup>), with an increase of five new luminaires compared to the original installation, with the change of lamps. fluorescent lamps for led lamps an increase in savings of 25% over the previous system. The retrofit of pattern 4 observed in isometric lines presents better luminous flux distribution and fits NBR8995-1.

The new project called retrofit has 457 luminaires and 914 18W led lamps, where applying equation 1 it is possible to obtain the demand of 16.452 kW which represents 48.53% savings compared to the current lighting system. Using equation 2 it is observed that the annual energy consumption is 47.38kWh / year.

## 4. Conclusion

After the data collection stage, concomitantly with the elaboration of the project and analysis of the obtained results, it is verified that the lighting system of the teaching unit's rooms when compared to the energy efficiency actions described in this work can be considered inefficient. .

With the new project, the room lighting system will represent approximately 1.79% of the total contracted demand, which is 920 kW. The saved energy can be redirected to other tasks. It is known that the trend is to adopt LED lamps in lighting systems, where it has been proven in simulation a decrease of 48.5% of the concomitant demand with consumption.

Energy savings may be greater as the impact of harmonic distortions caused by fluorescent lamp reactors is not being analyzed. The design becomes viable due to the suggested lamp life for use in the new design and the low lamp maintenance and replacement factor.

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# **Energy Efficiency and Sustainability and a Productive Industry in Manaus**

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## **Abstract**

*O presente trabalho apresenta um estudo de caso em uma indústria de Manaus, localizada no Polo Industrial, com vistas a uma economia energética. Um potencial dessa eficiência no setor industrial é bastante significativo, tendo em vista o alto consumo de energia dentro de diferentes setores. O objetivo do presente estudo foi proporcional à melhoria da reeducação do consumo de energia elétrica de uma indústria de Manaus / AM, a partir de palestras e empresas de sensibilização e conscientização sobre a necessidade de uso adequado da energia elétrica e dos recursos ambientais de forma sustentável, além de descrever como mudanças ocorridas para esse novo processo. Os procedimentos metodológicos consideraram os aspectos da pesquisa com abordagem qualitativa do caráter bibliográfico, seguindo a construção do referencial teórico e o delineamento do objeto de estudo a partir de referências relacionadas ao assunto em questão. Foi realizada a implementação de palestras ministradas aos funcionários que disponibilizaram a participação de forma espontânea do projeto, relatados como resultados que tiveram a sensibilização de funcionários e corpo gestor para o processo inicial de mudanças enquanto as despesas gastas, tendo como suporte a minimização do uso do recurso, promoção da conscientização sobre a necessidade de fazer uso eficiente da energia.*

**Keywords:** Manaus Industrial Pole; Sustainability; Industry.

## **1. Introduction**

In the city of Manaus, the socioeconomic development vector is based on the Industrial Pole - PIM, where industries aim to increase their competitiveness, as well as improving their production process, based on the reduction of energy losses and costs, taking into account the relationship between energy efficiency, sustainability and production base.

Among current concepts, the Ministry of Environment [1] defines energy efficiency as a ratio between the amount of energy employed in an activity and that available for its performance.

The promotion of energy efficiency encompasses the optimization of transformations, transportation and use of energy resources, from their primary sources to their utilization, in which they adopt, as basic assumptions, the maintenance of comfort, safety and productivity conditions of users. , contributing in addition to improving the quality of energy services and mitigating environmental impacts [1].

For this purpose, energy efficiency became part of the world agenda, since the increase of oil prices in 1970, when it became evident that the use of fossil resources reserves would have increasing costs, given the equipment. and consumption habits would be analyzed at the expense of energy conservation [2].

Moreover, when the increase in energy consumption was proved, new arguments emerged through [3] that justify highlighting energy efficiency from the perspective of supply and consumption.

According to [2] the author argues that one of the alternatives for obtaining energy is energy efficiency, and not only the expansion of production supply. In this line of thought, [4] also recommends the implementation of policies to encourage energy efficiency, as well as for renewable generation, as well as allowing the reduction of energy consumption to perform the same service.

Investing in energy efficiency should be seen as a strategic option, as it can be an alternative in meeting the evolution of energy demand, promoting energy efficiency, which can be considered the most economical and safest way for sustainability [3].

Given the above, it is important to highlight that electric energy is essential for human survival given the technological conditions, where quality of life is increasingly linked to energy availability. Thus, electricity becomes indispensable not only for human development, but also for the economic development of any region, where today, from construction to industries, they are looking for savings in the consumption of electricity.

Many companies eventually develop appliances that achieve better energy efficiency with low consumption, in addition to the technological benefits, along with programs implemented by the government, requiring the management of environments that promote improvements and increase energy efficiency [5].

Thus, it is perceived in the current scenario, a great concern about the excessive consumption of electricity, or even an emphatic problematization about this condition, by the industrial systems that provide the heating, cooling or operation process necessary for the conversion of electricity. raw material and manufacture of final products, causing serious damage to the environment, given by the use of resources, against sustainability [6].

Not only does the waste of electricity imply the needs of the entire population, but it can also incur crises related to the shortage of these sources that correspond to most of the country's energy supply.

It is a fact, the importance of saving electricity, in which the creation of initiatives to ensure environmental awareness is essential. According to [5] the current social concern, also describes the need for new models for this production, triggered by the substantial increase in consumption, promoted by the population increase, besides the lack of public policies focused on the energy matrix in Brazil.

The Brazilian government has been pursuing a policy of conserving energy in industrial, commercial and public lighting areas in order to reduce waste in order to obtain a better use of the energy consumed.

In order to promote the conscious use of energy rationing, the National Program for the Conservation of Electric Energy, PROCEL, was created through Eletrobrás, aiming at combating waste and having as its main symbol the PROCEL Seal. According to [7] in Brazil, electricity is mostly generated from river water, so in order to preserve natural resources and save our energy bill, we must consciously use electricity.

To this end, a bill was presented the following year, which aimed to compensate the electric utilities, based on the commitment to invest in energy conservation and to propose minimum energy efficiency limits in appliances sold in Brazil. From a study by [8] he stated that “this project was only approved after the severe electricity supply crisis of 2001, leading to [9] on energy efficiency.

However, [10] indicate that energy efficiency reduces waste and energy loss, without reducing the compromise of its supply, and can state that energy efficiency activities represent benefits for an institution, in addition to reducing the monthly bill, being strategies for meeting global warming emission reduction targets, enabling energy efficiency to be achieved using energy without compromising daily comfort.

Energy conservation by maintaining or improving the standard of services and quality of life, with lower cost of energy consumption. With the reduction or elimination of waste or from behavioral changes (education) administrative improvement, corrective actions and introduction of new technologies, it is possible to achieve competitive differentials [10].

If the company presents actions aimed at energy efficiency, it can also balance the comfort of the company, environmental awareness, cost reduction, and provide the growth of production with new investments, coupled with its technological development.

According to [11] analyze the waste potential of the different types of installed loads and also implement actions that seek the rationalization of energy use, consequently, there is a saving in the monthly electricity bill, where such actions should and can be practiced in various consumer segments.

Given the context it is clear that there are several ways to apply the energy efficiency actions that can be performed: in lighting, using the appropriate lamp for each type of environment, as well as making use of translucent tiles, presence sensors cells photoelectric or time devices in external illumination.

In recent years, according to [12] a greater concern for sustainable development has been triggered, through the changes that man has caused to the environment, corroborating the increased efforts to save energy in industries, and analyzes of the financial return of medium and long term. It soon appears that, through behavioral changes, minor renovations and equipment changes, a significant financial gain is possible, in addition to the environmental gain.

Also, according to [12] sustainable development is defined as development that seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own needs in accordance with the available (ecological) means of the planet. Thus, the issue of sustainability assumes in this new century a central role in the reflection on the dimensions of development and the alternatives that are configured.

The socioenvironmental framework that characterizes contemporary societies reveals that the impact of man on the environment has had increasingly complex consequences, both in quantitative and qualitative terms, especially in the energy context. The notion of sustainable development based on energy efficiency therefore implies a break with the current pattern of development of industrial tracking [13].

For the author cited energy efficiency can be applied in various segments of the industrial sector, in various ways, from power generation to the consumer source. An energy efficiency industry should invest in its maintenance through modern technology that is adequate to the structure, since a large part of energy losses and wastes can be reduced through appropriate maintenance actions, not only corrective, but above all preventive, thus avoiding the high waste of electricity.

Given this reflection, it is important to highlight that there are several strategies to make the use of energy efficient, especially in the industrial sector. [14] tells us that "one of them is, through an energy management program that includes energy auditing, staff awareness and training."

It is notorious that besides this format there are also others, one of them being the adoption of technologies, in view of the great advance of industrial production, and may also count on the help of government policies, since several strategies have been adopted to encourage the use of these technologies. resources effectively, such as: agreements with industries with energy efficiency targets; standards with minimum indices; tax incentives, from credit to financing; energy audit programs and industry guidance for best practice adoption.

However, decision makers must watch over companies so that they do not fall into traps. As an argument in a water reuse system and yet as a major investment keep a productive process full of waste. Given this perspective, it is necessary to bring the necessary information into the industries, so that everyone is socialized about consumption.

[15] clarifies that the decision depends on the decision maker's level of information and hierarchical position in the organizational structure. It is therefore essential that the process of awareness and information on energy efficiency occurs at all hierarchical levels of the organization.

Therefore, it is necessary that the good performance of this system is associated with the care to be taken from the beginning of the electrical project, seeking methods that involve important information about luminaires and usage profile, so that it can ensure a less harmful system.

According to the Ministry of Mines and Energy [16], Brazil has shown a great evolution in recent years, both in legislation, as well as in the knowledge acquired in capacity building, in the awareness of energy needs and their efficiency in the most different areas, which makes an excellent savings plan explicit.

Thus, the objective of this study is to propose improvements in the re-education of electricity consumption of an industry in Manaus / AM, based on lectures and awareness raising about the need for proper use of electricity and environmental resources in a sustainable manner. , and describe the changes that have occurred to this new process.

## 2. Materials and Method

The present work was carried out in an industry of Manaus Industrial Pole. Initially, the bibliographic survey was used to support the development of the research, in order to subsidize information and strengthen the debate around the theme in question.

As described [17] "bibliographic research puts the researcher in direct contact with everything that has been written, said or filmed on a given subject, including conferences followed by debates that have been transcribed in some way, published or recorded."

As for the approach it was used the qualitative research that [18] works with the universe of meanings, motives, aspirations, beliefs, values and attitudes, which corresponds to a deeper space of relationships, processes and phenomena that cannot reduced to the operationalization of variables

After bibliographic research, we opted for an applied research that according to [19] focuses around the problems present in the activities of institutions, organizations, groups or social actors, being committed to the elaboration of diagnoses, problem identification and search for solutions. . They respond to a demand formulated by "clients, social actors or institutions", where it aims to generate knowledge for practical application, directed at solving specific problems, involving local truths and interests.

Therefore, a case study was carried out in a factory located in the Manaus Industrial Pole - PIM, operating in the city for over ten years, with a total built area of 35.35 m<sup>2</sup>. The company is classified as large, has a total of 140 employees working in 3 shifts, working ninety-five hours per week, being divided into two areas, the production part and the administrative area. At the time, a lecture on energy efficiency and sustainability was given (Figure 1).



Figure 1 - Lecture with employees

Source: Own author, 2019

Continuing the project proposal, a survey of the company for employees was read with the objective of identifying their profile regarding the consumption of electricity within the industry and the reality of the company (Figure 2).





Figure 2 - Reading about the company survey

Source: Own author, 2019

In addition, information was distributed to assist in this process of understanding the conscious consumption of electricity, with their fixation in all sectors of the industry.

### 3. Results and Discussion

In the 1957s, electronic products migrated to the so-called Industrial District, a place intended for products manufactured and sold through the Manaus Free Zone, with the purpose of serving the Brazilian domestic market. However, the companies were predominantly multinational producers of consumer goods, in which the process was reduced only to assembly and imported components, not yet requiring as much electricity consumption.

The need for electricity in the industry is unquestionable, and from this condition arises the need to build a team that becomes responsible for the issue of energy management, for the continuous improvement of its energy performance, including at this level energy efficiency, use and energy consumption.

Given this scenario, the PIM industries have been seeking alternatives to make their employees aware of energy consumption and the adoption of the practice of sustainability. In this sense, it is important to reinforce that the measurement of indicators through the management of this efficiency process, which is becoming increasingly essential in industries, regardless of the area of activity.

The development and presentation of more practical, cost-effective and well-planned energy consumption reduction solutions in the industry concerned for managers and employees has become paramount so that they understand the importance of efficiency and sustainable use. This study has high relevance for industry, especially regarding the application in the industrial hub, responsible for the economic development of the Amazon, indicating where the appropriate and efficient use of energy should be present in the planning of industries integrating the consumption sectors of the energy manager. efficiency (Figure 3).



Figure 3 - Analysis of the industry's energy consumption sectors

Source: Own author, 2019

Each industry chosen for analysis has shown that energy-consuming systems have had significant energy consumption within the company, with some potential for energy conservation or need for energy efficiency improvements.

Based on the consumption sectors, the following characteristics are presented: use of electricity use identified the sectors responsible for the highest energy consumption, with proposals for control and elimination of consumption waste; presentation of the importance of strategic planning as a tool to reduce waste and better use of energy; proposals to combat losses and waste. The presentation of the savings achieved after the implementation of the actions, namely:

Lighting control management consisting of luminaires and reflectors. The proposal was directed to the managers of the sectors responsible for the maintenance for the exchange of luminaires for LED lamps, considered at the moment the most economical, accepted by the managers. At the time of its implementation, at the end of the activities related to the industry workers, they were asked to leave the lights when they left their environment, as there was no need to access them.

Much has been addressed about energy efficiency programs, but little is known about its performance as an energy management system added to the control, as a tool to reduce consumption, presenting as an effective result, efficiency, seeking to achieve cost reduction and productivity, making it competitive in the PIM industries.

Energy efficiency can be applied in a variety of ways in various segments of the industrial sector, from power generation to the consumer source. An industry that has energy efficiency as its pillar must invest in its maintenance by means of technology that is adequate to its structure, since a large part of energy losses and wastes can be reduced through appropriate actions in the maintenance area, not only corrective, but above all preventive, thus avoiding the high waste of electricity [11].

The intention within this process is always to raise awareness among all involved, recommending the need to make efficient use of energy and environmental resources available in our environment. In addition, encourage society as a whole to undertake actions aimed at energy efficiency, changing if possible, their daily habits regarding the use of energy.

Continuously the use of the resource should use the process of environmental awareness and awareness of individuals, having as a presupposition the decision making, since daily the population makes use of numerous resources that generate processes and products, which must be focused on conscious consumption and responsible [12].

Thus, the application of these measures seeking to achieve a sustainability model should be present in the habit of their working life, within the industry, putting into practice the guidelines on the proper use of electricity not only in the workplace, but also to multiply. in society, passing on the knowledge acquired in order not only to reduce expenses, but also to reduce the environmental impact caused. It should be noted that this study showed the real needs of the company and the engagement of its employees.

#### **4. Conclusion**

The present work presented the importance of studying energy efficiency, increasing its yields, and thus contributing to the electricity sector to meet the energy demand without necessarily increasing the generation of electricity.

Among the various manageable costs for a company in the industrial sector, energy has been assuming a growing interest every day, motivated by the reduction of costs resulting from energy availability or even by environmental restrictions. Whatever the motivation, promoting energy efficiency is critical. For this, knowledge must be applied in an applied way, employing the concept of electrical engineering to energy systems to reduce losses in energy distribution.

Given this scenario, it is essential that before carrying out any activity related to energy consumption, it is necessary to know the energy reality of the company, in order to situate the priorities and implement projects for improvement and reduction of losses, following this process continuously.

The results obtained in the study show that, for lighting, replacing incandescent light bulbs with 9w LED bulbs would provide a reduction in energy expenditure. The LED is made up of a series of layers of semiconductor material and is capable of converting electricity directly into light. Due to its low power consumption and long durability, it is an interesting option for better energy efficiency and is also interesting from an environmental point of view.

Currently the energy waste due to inefficient lighting is very large. Good lighting is still a prime factor for human well-being and can be provided by raising awareness of the cost of energy. Furthermore, the use of LED technology contributes directly to the preservation of the environment, where the efficient use of energy happens differently, and with various tools that can facilitate the achievement of excellent results.

Through this study it was possible to identify information about the energy efficiency of the industry and its energy consumption, which concludes that the energy efficiency indicators are essential instruments to identify the potentialities in the industrial sector, helping to improve the company's energy performance. .

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## Analysis of Logistics Infrastructure Characteristics in Amazonas

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### Abstract

*Logistics is an essential component of economic growth, the development of a country, as the element of production movement and regional trade, in which it directly affects competitiveness. Throughout the history of mankind wars have been won and defeated by the strengths and capabilities of logistics - or lack thereof. Transport infrastructure plays a significant role in the logistics process of a given region, as it impacts transport costs, causing barriers to economic and social development. It is often said that the problem of the Amazon region is not logistics, but lack of infrastructure to serve the region. Thus, this research sought to verify the scenario of distribution logistics in the interior of the Amazon, investments in transport infrastructure in the state of Amazonas. This article aimed to verify the importance of logistics in companies in the State of Amazonas and to analyze the challenges of small and large companies.*

**Keywords:** Logistics in the Amazon; logistical challenges.

### 1. Introduction

Logistics in the northern region has always been a challenge for companies, due to its distant location and its difficult means of distribution, currently the most widely used mode of distribution is the river squeegee, due to its many rivers that bathe the Amazon.

The absence of logistics infrastructure slows down orders from companies, where conditions are very precarious, a region far from the country's major shopping centers, impeding the development of economic activities in the capital and even more in cities in the interior of the state.

The lack of investment in and maintenance of highways is today an obstacle. Logistics spending is a key element for businesses.

Second (MARQUES 2010; MACIEL 2018), the conditions of the current transportation and logistics system that serve the municipalities of the interior of the state of Amazonas affect the economic and social development of the region.

The paper seeks to show the main problems occurring in the logistics service in the North region, besides portraying the complexity of the problem, also contributes to the reflection of the problems faced by companies in the region.

## **2. Methodology**

For the elaboration of the article the bibliographical research method was used, through data of articles in the logistics area to present the research objective. A bibliographic review of logistics and modalities was performed.

The documentary analysis made it possible to further highlight the reality of companies in relation to logistics in the northern region of the country.

## **3. Theoretical References**

### **3.1 Logistics**

In the past, logistics involved transporting food and ammunition to troops on the battlefield. At present, it represents the control of management processes, from transportation to the entry of raw materials in companies to the distribution of products to the final consumer.

In the past, wars were long and could take centuries to end, so logistics were needed. It was at the end of the nineteenth century that logistics was introduced as a subject in the United States Naval War College. Until World War I the word logistics was used in terms such as administration, organization, and war economy.

The term logistics came up many years ago, and came to speed up the processes, seeking to be more efficient and effective in the pursuit of cost reduction.

Logistics is intrinsically encompassed by the concept of an area of administration that performs various tasks aimed at planning the collection, locomotion (in its different areas: air, land and sea) and circulation of merchandises. (PEREIRA, 2010).

Logistics is the process of efficiently planning, implementing and controlling product flow and storage, as well as associated services and information, covering from point of origin to point of consumption to meet customer requirements. . (NOVAES, 2001).

In recent years, globalization has put logistics on a new level. With this large increase in the circulation of goods, the pressure to reduce costs and increase sales, companies have turned their eyes to the importance of developing an efficient supply chain (DIAS, 2012).

Physical distribution logistics consists of the business logistics segment that corresponds to the set of operations associated with the transfer of goods from the place of its production to the place of destination.

According to WANKE (2011, p. 256), “[...] [is] the development of a system that covers all activities, from the production line to the delivery”.

We note that this type of system is to achieve cost tracking through the logistics structure, avoiding the indiscriminate apportionment of costs.

Thus, it is possible to measure the costs of customer distribution channels and even deliveries. In the case of physical distribution, it is also emphasized that “in relation to costs, they refer to pricing, scenario simulation and cost control”. Prices are essential to the progress of any process. They are formed on the basis of direct costs, however, costs always influence price information. Thus, those responsible for physical distribution operate specific elements, predominantly material in nature: warehouses, transport vehicles, stocks, loading and unloading equipment, among others. WANKE (2011, p. 257),

There are usually two types of markets to plan for. One is end users, who are those who use the product to meet their needs as well as those who create new products, such as industrial consumers. The second market consists of intermediaries who do not consume the product but offer it for resale, usually to other intermediaries or end consumers. They are, for example, distributors, retailers, and end users. 'BALLOU (2008, p.40-41).

As stated by (BOWESOX, 2001) logistics is an effort made by companies that value and care about customer satisfaction, and for that they put in place strategies that build customer loyalty and bring them closer at the lowest price.

Therefore, logistics is mainly aimed at making products and services available at the right time and place, so that customers receive them with quality and at an appropriate cost.

### **3.2 Modalities of Transport**

Transport generally accounts for the largest share of logistics costs, both in a company and in the share of logistics costs involving other factors. ” For these reasons there is an ongoing concern with reducing their costs. We can highlight the various modes of transport, also known as intermodality, and the emergence of logistics operators, that is, integrated logistics service providers, capable of generating economies of scale by sharing their capacity and handling capabilities with various customers. (FIGUEIREDO; 2011)

#### **3.2.1 Road Modal**

The highway modal had its expansion with the end of World War II, mainly due to the flexibility achieved from the door-to-door delivery service, along with the intercity movement speed (CLOSS & BOWERSOX, 2007).

Road mode is defined as vehicles (cars, trucks, bitrens, trailers etc.) that move across a surface. Its advantages are mutual: mobility, that is, the ability to drive on highways; can be enjoyed on any product transportation; it's fast; no professional deposit required; inhibits management; easy management and can be used in conjunction with other modes (PRESTEX, 2015).

The use of this mode is recommended in cases of transportation where the products have ephemeral character and / or high values. This mode is an advantage as it has agility and availability of roads.



### **3.2.2 Waterway Modal**

The Waterway mode utilizes the largest natural resource available on the planet as the means for locomotion, water. This mode includes waterway transport (inland and lake), called the Inland Waterway and maritime transport, which is divided into long-distance maritime transport, characterized as international navigation taking place between ports of different countries, and cabotage navigation. This is the national navigation performed between seaports or located in rivers of the same country. In turn, cabotage navigation can be divided into small and large cabotage, according to its scope (ANDRADE, 2007; NOVAES, 2007).

Waterway transport has the following advantages: less environmental impact compared to other modes, less pollutant emissions, less nature degradation, less use of lubricating oils, no tires, almost zero accidents, more economical to implement, lower maintenance costs, increased transport reliability and safety. It is the most competitive modal, but does not work alone, depends on others.

The Waterway modality has as harmful the dependence of adequate places, rigid administration, professional terminals and a large amount of time to the final destination and this, in turn, ends up being one of the screaming bad characteristics (LOGISTICS FOR ALL, 2011 ).

### **3.2.3 Air Modal**

Air transport is used to transport cargo of high unit value (electronic goods, watches, high fashion, etc.) and perishable goods (flowers, noble fruits, medicines, etc.).

This mode has been showing strong growth in our country, and according to KEEDI (2005) seeks an adaptation to products that are not part of its traditional cargo, mainly through the expansion of aircraft. This can lead to a possibility of reducing freight through the increase in cargo provided by the increased capacity of air vehicles. Its increasingly frequent use has made it an alternative and more naturally thought out mode for transportation.

### **3.2.4 Rail Modal**

Rail transport is low cost, but not very flexible and delivery times are long and variable, and in some cases there is a need to change trains, as there are railways that have narrow gauge, while others have wide gauge. This type of transport is indicated for large quantities of products, long distances and non-perishable and non-fragile products (CALIXTO, 2011).

The rail modal is recognized as having a lower cost than the road modal simply because it consumes a smaller amount of diesel, this mode is limited to existing railways, where there is a possibility of locomotion. products by it, becomes practical considering medium and large distances.

This mode has as main characteristics the transportation of large amounts of cargo over long distances with a lower cost, lower theft rate. This mode has a difficulty regarding its flexibility, because it depends on another mode to deliver the goods at the recipient's door. The cargo transported by this are: cement, lime, ores, fertilizers, corn, wheat, soybeans, among others.

### **3.2.5 Dutorial Modal**

Pipeline or pipeline transport is a type of land transport based on a set of terminals, with propulsion

equipment, connected by tubes (CNT, 2012b), the type of product transported receives other names such as: pipeline (natural gas); pipeline (petroleum, fuel oil, diesel, alcohol, ethanol, LPG, kerosene, naphtha, among others); mining ducts (rock salt, iron ore and phosphate concentrate); aquaducts (water) or polyducts (various types of products). It represents 4% of the cargo transportation matrix according to the National Land Transportation Agency (ANTT).

The pipeline mode can also be divided into pipeline (oil), ore pipeline (iron ore), pipeline (natural gas), poly pipeline (two ores).

Brazil has about 20,000 kilometers of pipeline, and this number will increase by 2015 and PETROBRAS's subsidiary TRANSPETRO controls about 10,000 kilometers.

## **4. Study Application**

### ***4.1 The distribution logistics service of the interior of Amazonas***

According to SOUZA (2011), in his research done in the municipality of Parintins where; "Initially, we sought to know how the goods are transported from the city of origin to the city of Parintins. Thus, the following answer was obtained: 40% of the companies use a boat as a freight transport, the other 60% are divided equally by ferry, truck and plane. "

Where it was found that the failures in the distribution logistics process, these failures affect business activities along the transport of goods, which showed a high number of losses and consequently damage to goods.

The businessmen of the municipality reported that one of the factors that most impact are the breakdowns in goods and the high cost that carriers charge, according to carriers that charge a higher cost, to maintain the quality of service provided.

It was also reported the difficulty of dialogue with the government regarding the request for improvements in the infrastructure of the airport and the port of the municipality, which contributes to the economic development of the city.

The advancement of the air modality in the market is due to the export demands and the competition between the companies. The market has become very competitive, which makes entrepreneurs have a greater effort, so they end up joining the air mode, although the cost of this mode is higher, but this is the way that the product arrives faster and thus increasing competitiveness among its competitors.

### ***4.2 River passenger transportation: Logistics in the ports and itineraries of the State of Amazonas***

In his work BARBOSA, PRADO (2014), he deals with the fluvial transportation of passengers in the state of Amazonas, with an approach in the logistics of ports and itineraries. Bibliographic research reveals how river navigation has stood out in relation to the flow of production and displacement of people in the state over time, because river transportation is the main and most important means of transport in the region. In the port of Manaus Moderna, the starting point of the flow of navigation of regional boats, there is a lack of infrastructure and poor conditions of service to passengers; the boats are old and dirty, they trade dubious hygiene.

And on deck, goods and people occupy the same space, hampering traffic and increasing the risk of

accidents from non-compliance with safety regulations. Anyway, it does not offer a comfortable trip. Regional or pleasure boats as they are known do not have their established routes, they stop at various locations for loading and unloading people and cargo; thus, delay the travel, which becomes more tiring. This paper shows the importance of inland waterway transportation, the operation of logistics services in ports and the determination of the degree of difficulty for passengers to travel between neighboring cities and access to education and health; Finally, the relationship between this type of transport and activities such as passenger traffic, itineraries and safety as a means of guaranteeing economic development, respecting the characteristics of the region.

The interest in conducting the research is subordinated to the importance of river transport in the Amazon region and its representativeness in understanding the operation of regional logistics. Thus, the results of this research published here will be useful for the training of logistics technologists and administrators in the state of Amazonas.

The lack of infrastructure in the ports of the cities of Amazonas, today is one of the main difficulties for passengers who depend on this type of mode to get from their cities to other locations, not only infrastructure but also security; With this occurs the emergence of clandestine ports, where the boats are moored in ravines, without any security.

In order to have a safe transportation and as a suitable structure for users, according to ANTAQ (National Waterway Transportation Agency) it is necessary that the terminals have a suitable structure to facilitate the movement of users who depend on transportation.

#### ***4.3 Waterway Logistic Model***

Navigating the waterways of the Amazon Region has been causing inconvenience to the government with the demand for increasingly demanding solutions. In significant part of the municipalities of the State of Amazonas the only form of access is by waterway transportation. In the last decades, the lack of efficient strategies to transport the municipalities of the region in adverse events, such as drought or floods that make navigability of rivers difficult, cause the growth of social, economic and environmental impacts. The objective of the present work is to elaborate a modeling to support the decision making about the best configuration of the water transport pillars in order to generate a logistic system that meets the demand. SANTOS (2016)

Waterway transport is a low cost mode, but it is not an efficient mode, not only in costs but also in time to be transported the products. Knowing the great territorial extension of the State, causing that the installed infrastructure is not sufficient, or inefficient to serve some regions.

This deficiency of modal happens from the region's own natural condition: hydrographically rich and of continental geographical proportions. On the other hand, due to the administrative and financial fragility of the responsible institutions.

#### ***4.4 Container Logistics: A Competitive Advantage for Reducing Retail Operating Costs for Construction Material on the Santos-Manaus Stretch***

Container Logistics: A Competitive Differential to Reduce Construction Material Retail Operating Costs on the Santos - Manaus Stretch, which points out that in times of economy and market without frontiers,

companies are looking for new alternatives to survive in the face of the strong influence of competition brought about by the advent of globalization. In this scenario, logistics plays a significant role as it enables operations, creating new forms of development and business opportunities. In this study the hypothesis is a statement that logistics acts as a generating factor of effectiveness in organizational processes and as a strategic differential and competitiveness. Thus, the focus of this research is the strategic management process in the context of the supply chain, as it covers the activities related to planning, procurement, transportation, handling and storage. SOUSA (2016)

Companies need to integrate logistics as a strategic tool for business, the current market is very competitive among companies, where companies must always innovate, have a differential, and logistics is a strategic way, the way the product arrives. For end consumers, product quality is increasingly important in logistics.

#### ***4.5 Costs of the logistics chain of bananas produced in Presidente Figueiredo and the registration of prices practiced at the Producer's Fair in Manaus: a case study.***

A case study describes the processes carried out in the logistics chain of bananas produced in two sites located in the municipality of Presidente Figueiredo and records the prices practiced at the Producer Fair in Manaus. Some agricultural scholars think about banana particularities, systems theory, logistics history and its systemic approach, cost theory and some costing methods, as well as price and internal and external factors. that influence pricing.

Having as an object of analysis the logistics chain of bananas produced in Presidente Figueiredo and sold at the Producer Fair in Manaus; qualitative approach to the problem; and the instrument was systematic observation. The field work was observed and each of the necessary processes to the banana supply network was recorded, the costs related to each task were aggregated within these procedures and the logistic cost per banana bunch harvested in two was obtained. sites that served as the laboratory for the observations. MACEDO (2009)

Farmers in cities in the interior of the state of Amazonas have a difficult time disposing of their produce to state capital or to other locations. This is due to the fact that the process of distribution of the physical product (Outbound Logistics) in the cities of the state happens through the waterway modal, the rivers of the state of Amazonas are very extreme, bulky, and with that the distribution time of these products is long, and consequently the price of the final product increases.

#### ***4.6 Logistics and eco-efficiency in the public slaughterhouse of Parintins-AM***

Logistics is an area in constant development and is present in all fields of activity of man. In the agro-industrial sector, in slaughterhouse industries, meat processing chains need the managerial support of logistics to support the development of their activities, seeking a balance between the social, economic and environmental pillars. As a result, this study carried out at the Público Ozorio Melo slaughterhouse in the city of Parintins verified to what extent the processes developed are in line with the principles of ecoefficiency.

Using the monographic investigation method with field research and semi-structured interviews, the main objective of the study was to identify the logistics operation in the establishment, based on the description

of the slaughter process, the monitoring and detection of the resulting residues in each stage and finally by investigating the forms of management and destination used by the establishment.

The results showed that although there is compliance with some norms and decrees, the slaughterhouse has some structural and logistical difficulties that depend on many bureaucratic processes for its development. Thus, the suggestions proposed in this study aim to improve the quality of service, as well as the rationalization of resources and apply efficient management of by-products and waste. PIKANÇO (2017)

Logistics procedures we all know are key elements in a development organization, although the difficulties for company improvement depend on the public sector, but we have been able to observe some significant changes.

#### ***4.7 Logistics as one of the competitive factors***

The study is to discuss how logistics today is fundamental for a good competitive performance in a constantly changing market, where only the best stand out. This concern with logistics becomes essential, because in the search for differentiation, companies always try to get ahead of the competition in all aspects, with the help of software, planning and production management.

The increasingly competitive business environment contributes to logistics seeking this ever-increasing differentiation. Its strategic management of material use and related information efficiently and effectively drives products and services from one source to one destination. MAIA (2012).

According to Alarcón, Antún and Lozano (2012). Logistics has become a key factor in generating value for the product. Maintaining companies' logistics-related competitiveness depends on their ability to develop, implement innovations, recreate strategies in the practice of logistics throughout the supply chain, with the aim of reducing costs and increasing the level of customer service.

Logistic competitiveness is related to: i) the operation of the practical supply chain logistics processes of companies in the region; ii) infrastructure and management of factors for better logistics performance of companies increase the efficiency of the flow of goods.

To be more competitive with logistics, you need to know how you are performing against your competitor, how to improve infrastructure and the elements that increase logistics performance, how to improve process and logistics flow efficiency and quality, thus increasing the level of services by offering differentiation advantages to the customer, but always taking into account the regional characteristics involved.

#### ***4.8 Fluvial transport by mixed vessels in the Amazon: an analysis of the Manaus-Coari and Manaus-Parintins stretch***

Transport in the Amazon is essentially fluvial and it uses vessels to move both cargo and passengers. However, this system has been operating to this day, without proper regulation, with few technological investments and presenting social and environmental difficulties. Thus, the aim of this thesis is to establish a system of sustainable indicators for the Amazonian river transport sector using the Manaus-Coari and Manaus-Parintins stretches as a case study. Thus, an indicator called the Amazon River Sustainability Index - ISTFAM was proposed and generated through the Principal Component Analysis

(PCA) method.

The results showed that the weights obtained in the indicators and aspects were satisfactory to those obtained in the ranking of the vessels, being able to portray the reality of the mixed vessels in these sections. It was also found that the system is not in balance in the social, environmental and economic aspects, but also needs to consider the political (state participation) and cultural (local habits and customs) aspects to ensure its fullness and, therefore, guarantee the sustainability. Ferreira (2016)

River transport is the most used in the state of Amazonas, used for transportation of people as well as cargo, transport in the regions is characterized as mixed. There are many irregularities in this environment, such as excess passengers, illegal cargo transportation, documentation of overdue vessels.

## **5. Analysis of Results**

The situation of logistics infrastructure delays the economic development of companies. The process of product distribution is always difficult, when we talk about companies in the northern region, because it is the logistics complexity of the region and the distance, since transportation is considered a cost means in all commercial and industrial activities.

The commercial area of any company in the northern region, transportation is essential for the results achieved in the end-consumer service and for the company's suppliers and employees.

This highlights the role of transport in integrating all parts of logistics and the creation of flexible logistics chains with a high quality value to meet the demands of each company.

Without progress in logistics in recent years, Amazonas loses mainly in productivity and competitiveness. Although the waterway transport is more accessible, as was mentioned during the research, this mode is much more complex, because the delay in the delivery of the product, because we know that some parts of the rivers that cover the state of Amazonas are often difficult to traffic.

The transport infrastructure is centralized in the city of Manaus, powered by the industries of Manaus Industrial Pole, where it gathers most economic activities, generating high cargo movement in the region. Cargo transportation is very important for the Manaus Industrial Hub, for input inputs and for the final products output, whether for national or international markets.

Transport plays an essential role in the link between production and consumption, allowing for an integration of production versus consumption, contributing to economic growth, not only for companies, but also for suppliers, employees and consumers.

With the logistical difficulties in the region, the distance from major shopping centers in Brazil and suppliers, consequently the prices of companies' products increase. The greater the complexity of moving materials, the higher the final price for the consumer, as the harder the logistics process for the company, the higher the process costs.

Logistic efficiency is important for global trade and is related to the development, economic growth of the country. However, it needs political and governmental desire and needs to be standardized by public policies, because the costs are very high and reflect a lot on the cost of products, competitiveness and survival of companies in the market.

## **6. Final Considerations**

We understand that logistics is a key element in stimulating the development of commercial activities. When it comes to logistics in the northern region, the complex challenges of the region always come into the agenda. be it physical or geographical challenges.

The present study analyzed the current situation of the lack of logistics transportation infrastructure in the State of Amazonas.

Evidencing that the waterway modality, despite being more viable in

costs, and being more used, due to the lack of infrastructure on the roads of the State of Amazonas.

Planning an efficient transportation system will help to increase market competitiveness. Improving transport services, lowering the cost and price of products placed on the most distant markets, such as in the northern region of the country, thus making the region more competitive with other products in large regions of the center of the country. Therefore, it is necessary to make improvements in the implementation of the structures of the logistics processes of the State of Amazonas, capable of contesting the geographic problems of the region.

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## Proposal to Implement 5S in a PIM Gym Equipment Company

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### Abstract

*The Manaus Industrial Pole follows the worldwide trend of engagement on the issue of continuous quality improvement, especially with regard to the organization of work and cleaning environments. From this perspective, the company G. Equipamentos sought to improve its production process with the application of the 5S program, making it a more competitive company against others. This article basically describes the fundamentals, concepts and benefits of the implementation of the 5S program in the company G. Equipamentos at Manaus Industrial Pole - PIM, in the field of gymnastics and body equipment manufacturing. It was used a case study based research to carry out this project, as the objectives, we searched for a qualitative research, seeking to elucidate the data and solutions pointed by the quality tools used in the project.*

**Keywords:** 5S; Quality tools; Production process;

### 1. Introduction

Brazil, in order not to differentiate itself from words originating from the Japanese languages, used the word sense to describe the 5S, which in Brazil are the 5 senses, the words in Japanese to Portuguese are respectively: Seiri - Sense of use, Seiton - Sense of Ordination, Seisou - Sense of Cleanliness, Seiktsu - Sense of Health and Shitsuke - Sense of Self-discipline (COSTA, 2018).

According to Busa (2016), he also says that in essence, 5S generates a change of conduct that tends to mobilize the entire organization, thus the advantages of deploying 5S in one sector, and in the long run throughout the factory are numerous. It is possible to have immediate results, as is mainly the visibility of

the work you are doing when using the sense of use, and in the long run as the case of the sense of self discipline, for example the Japanese will teach the 5S culture to their and discipline them on these principles, consolidating and extending into adulthood, in society and in the professional

In order for the 5S program to be implemented in company G. Equipments, there was a need due to the excessive time wasted in searching for work tools, excess materials, not performing certain activities because the path was obstructed and so on. We need to develop a sense of urgency to make and maintain organized, lean and functional places (BOCK, 2015).

The overall objective of this article is to analyze cost reduction, reduce employee fatigue in looking for parts, things or equipment, and thereby improving employee quality of life, all through the 5S program, looking for the needs of the best possible needs. from all sectors of the company, encouraging employees to be able to implement the 5 steps of the 5S program and combat any lack of control, disorganization, cleanliness and health.

## **2. Theoretical Foundation**

For the effective accomplishment of this research work, we tried to substantiate considerably the use of the 5S Program as a proposal for implementation in a company of the Manaus Industrial Pole - PIM, specialized in gym equipment.

### **2.1. What is the 5S Program?**

Simply put, the 5S program is comprised of five Japanese words, namely: seiri, seiton, seiso, seiketsu and shitsuke, for each there is a respective representative for an associated sense, then we can better understand the description of each sense:

SEIRI - This first sense is associated with utilization, tidiness, organization and selection. It represents the action of leaving the work environment organized, eliminating the unnecessary and giving proper destination. avoid destination to what is considered unnecessary to the exercise of activities (COUTINHO; AQUINO, 2015).

SEITON - To this sense, it is closely linked to ordering, sorting, and / or how to better sort the area or work environment. Its main concern is associated with the constant search for the development of a better physical arrangement, which gives us a more functional experience in the workplace, without doubt in its implementation, this sense provides a significant increase in productivity, reducing costs and accidents. of work (FACHIN, 2017).

SEISO - It is associated with Zeal and Cleaning, its main association is to work in a preventive manner avoiding breakage of devices, deterioration of parts, machines, equipment, materials, among others, this through periodic maintenance with cleaning the environment. This sense does not need to be understood only in physical equipment, its scope can reach information that is also stored, such as the deletion of data and information that no longer interests us (MARTINS; MARTINS; FERREIRA, 2017).

Already the SEIKETSU - addresses a different approach, it is linked something related to cleanliness, integrity, hygiene and health. It is believed that with the practice of the first 3 senses, you will be guaranteed to get that sense. This sense will be related to the quality of life, because it includes the care

with personal hygiene, but not only taking care of personal hygiene, but taking care of the mind and image, he tries to work his self-esteem, emotional conflicts and empathy (DAUCH; DA SILVA ; BY SOUZA JABBOUR, 2016).

While SHITSUKE - brings us a sense of self-discipline, according to Nisiyama (2016), getting employees to have a vision of commitment to pre-established standards, moral, technical standards, focused on personal improvement associated with Company would be ideal. Where the pursuit of personal development, corroborating the improvements achieved, requires a very high level of maturity.

Figure 1 below is a copy of the 5S Japanese terms and their meaning in Portuguese.



FIGURE 1 - 5S Program

Source: Prepared by the Author.

Table 1 - 5S Program

Description In Japanese	Description In English	Context
<b>Seiri</b>	Use	Organization, storage and selection
<b>Seiton</b>	Ordering	Classification, better way of ordering the work environment
<b>Seiso</b>	Cleaning	Covers general cleaning on both physical equipment and information and data
<b>Seiketsu</b>	Health of	Hygiene and cleanliness, personal care
<b>Shitsuke</b>	Self-discipline	Owner's vision, business commitment

Source: Author by Author.

In the table of figure 1, we have a list of the terms in Japanese and their respective Portuguese, bringing a brief context for a better and faster understanding of the senses of the 5S program.

For Rossato, Boligon and Medeiros (2016) there are consistent direct results with the implementation of the “5S”, mainly related to the improvement of the organizational and work environment, through standards, procedures, with a more comfortable and cleaner environment. effort and especially time, thus

eliminating unwanted papers and objects, improving the layout and use of spaces more and better, we have a clearer and more evident internal communication, with a greater participation of workers and thus obtain from the 5S program in company.

With the implementation of 5S in a company or sector, it is possible to verify that people will have changes in their lives, on the behavioral side, because the discipline of the acquired culture helps in this improvement (DE SOUZA et al., 2018).

## **2.2. Quality Continuous Improvement Process**

Continuous improvement is based on a Japanese concept called Kaizen, which represents a crux of the philosophy of total quality, i.e. the main idea of the relentless pursuit of uninterrupted improvements in everything and every process the organization performs. This brief concept encompasses the emergence of a culture of constant learning and all activities of the company, company and / or organization (DE ALMEIDA, 2015).

For Franco (2016) continuous improvement mainly values the elimination of waste originated by processes, but of course, this elimination with common sense, through more economical solutions, which are based on creativity, innovation, and motivation of workers contributing to the improvement of practice of their processes.

By applying continuous improvement to your processes, you can see the improvement of your processes gradually and continuously. At the same time, workers become more involved and committed to everyday tasks, and this brings significant results to the company, for example in prolonging the market. For continuous improvement to work as it is intended to improve processes, the involvement of the company's employees is fundamental, and we must not only restrict production or area of operation, but continuous improvement should involve the entire company (DE MACEDO; SCARIOT, 2019). ).

## **2.3 PDCA Concept**

To have a better understanding of the meaning of PDCA we must first understand the acronym of PDCA, where “P” means PLAN, “D” means DO, “C” means CHECK and “A” means ACTION when freely translated the words correspond. a: Plan, execute, verify and act, in a very simple way we can say that within a company it is very important to do the planning first defining the methods, conduct the training for employees, so that they can perform what was planned , with this check the results obtained, and compare with the planned, and act when necessary, to prevent the effects of errors (DE QUEIROZ ALBUQUERQUE, 2015).



FIGURE 2 - PDCA Cycle

Source: Adapted from Falconi, (2015)

P - Plan: Identify the problems analysis and elaboration of the action plan to reach the goals.

1 - Identification of the problem; 2 - Analysis of the phenomenon; 3 - Analysis of the process; 4 - Plan of action.

D - Do: Execute action plans, execute and enforce standards.

5 - Execution;

C - Verify: Control the effectiveness of action plans, always monitoring the work in order to follow the results obtained.

6 - Verification.

A - Take Action: Take corrective action when necessary, act with standardization, review activities and carry out new planning.

7 - Standardization; 8 - Conclusion.

## 2.4 Brainstorming

Brainstorming Free translation means rain or storm of ideas, it is a technique commonly used to recommend suggestions for improvements and / or troubleshooting. In this sense it arises to propose for a recognized species of disability (BUCHELE et al., 2017).

The term brainstorming is associated with a certain atmosphere, where it implies joining a group and making it spell out various solution proposals to solve the issue or problem. At first, the group is exposed to a problem or a certain concern, which is kind of relaxed and informal, not leaving the atmosphere heavy, making the employees feel more comfortable to expose their ideas. The main goal of brainstorming is to gather a very comprehensive list of opinions so that they can later go through a second analysis. In the brainstorm, everyone without exception is encouraged to participate, and all participants need to be aware that all contributions have their degree of importance and value (DAYCHOUM, 2018).

## 2.5 5WH2

Guinzelli et al (2017) in their work can state that the 5W2H tool originated in English language terms

where: what, who, why, where (when), how, how much, and it's a checklist with a sequence of activities that needs to be done, and the information on that list needs to be as clear as possible from both the company, As for the employees ARAUJO, 2018) shows more succinctly a comparison between the 5W and 2H methods giving us a more general view of the 5W2H methodology.

The 5W2H tool is commonly used mainly in the activity planning stage, because it is in this stage that all the activities to be developed will be organized, who will do a certain activity, where it will be performed, where it will be done, how it will be done and so on. This tool becomes essential in determining action plans (LUMBRERAS, 2018).

## 2.6 Ishikawa Diagram

The Ishikawa diagram can also be called cause-effect diagram or fishbone diagram, it is a widely used tool among organizations and mainly related to process quality management.

To Penna (2019) in his studies he states that the Ishikawa diagram was affirmed in 1953 with directed studies, establishing a careful analysis of what are the causes, with the aim of showing the relationship between a quality characteristic its various Determinant factors. Cause and effect diagram are a tool that brings us the information in a visual way, is widely applied in organizations.

Ishikawa diagram has several benefits for organizations where when well employed in production and / or other areas. It can be used in conjunction with other tools, a classic example and Brainstorming, which has an exponential effect on the root causes of problems (SOUZA, 2018).

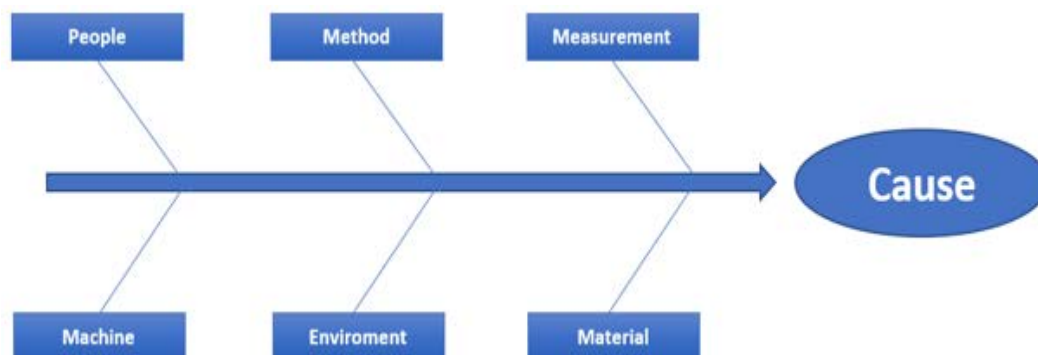


Figure 3 - Cause and effect plot or Ishikawa

Source: Liliana Adapter (2016)

This tool is very important in industrial processes, it is a user-friendly tool, especially for non-specialists to analyze and arrive at possible solutions to problems. The effects help us to diagnose the problems, and by attacking the root causes we will get the desirable improvements. The Ishikawa diagram can make the separation of the cause and effects of the problems, its possibility of use is very wide and can be applied in the most diverse contexts and in several possible ways.

The Diagram is characterized as a simple and easy graphical tool, easy to understand and understand and for senior management helps them in decision making, mainly by means of surveys of causes and effects.

### 3. Methodology

The tools used to compose the improvement actions were control spreadsheets in Excel, Presentations and Power point, periodic meetings during the implementation, at the end of the 5S deployment in the sector, an audit team was selected to be trained to perform correctly the verification of conformity and non - compliance using the Checklist.

In the Analysis of Results, in the verification items considered problematic, the 5W2H tool was used, which consisted of analyzing the root cause of the problem, through the seven questions: What, Why, Where, When, Who, How, How Much.

#### 3.1 Place of Study

G. Equipment's located at the Manaus Industrial Pole was founded in 2005, with specialized technical professionals capable of meeting market demands. Seeking to offer products, produced in Manaus Industrial Polo, that provide better quality of life and well-being for its customers, combining technology, quality and innovation with the best cost-benefit in the market.

G. Equipment's 'mission is to provide its customers with quality product and service solutions related to state-of-the-art fitness and body care equipment, comprehensive compliance with our customers' requirements, legal and associated requirements that aim for excellence in the form of act and offer continuous improvement to the quality management system.

Company Vision is the constant pursuit of excellence in its processes, with the purpose of bringing innovative solutions in products and services for gym equipment and body care, to our collaborating partners and shareholders with the focus on the development and contribution to the Industrial Pole. Manaus.

#### 3.2 Type of Study

In this work we used a research based on a case study, where the main concern is in a proposal of implantation of 5s in a gym equipment company of Manaus industrial pole called G. Equipment's.

According to Matos (2016) shows us in his projects that any research that demonstrates a kind of investigation, where an established phenomenon has been occurring and there is a search for the understanding of this phenomenon that is occurring within a certain and daily scenario, and with the objective main reproducing it is called a concrete case study.

The case study uses a qualitative methodology that usually comes in such a way that it wants to deepen an individual unit, mainly serves to answer questions where the researcher does not have much control. It is a methodology that uses means and forms and especially the reasons for which such a decision was reached (DA SILVA TEIXEIRA; OLIVEIRA, 2017).

As for the literature review comes as a base subsidy for the whole case study, which was conducted a qualitative bibliographic and documentary research, and starting from the literature review and knowledge area documents, aims to analyze the implementation of 5S in the literature. G. Equipment's and the main quality tools were used to analyze the implementation of 5S in G. Equipment's in the Manaus Industrial Pole.



The quality tools helped us to diagnose the identification of nonconformities, and to evaluate the proposed efficiency and process improvements. With this, this work will show us through five tools for the analysis and solution of the nonconformities evidenced: Brainstorming, Ishikawa Diagram, PDCA 5W2H and 5S.

The total of thesis articles, dissertations and documents consulted for the accomplishment of the objectives proposed in this research, to the review were made with 37 articles, 10 articles were discarded, and 27 published from 2012 to 2019 related to the theme were used. 5S implementation, and the use of the quality tools "that are in this paper. These documents analyzed the conceptual, historical and technical aspects of the main theme.

## 4. Analysis of Results

### 4.1 Current Scenario

As the images below show, the scenario we could see through figure 4 before the implementation of the program, we can easily understand that this is a widespread disorganization, this is undoubtedly the first impression that passes to anyone passing by. by the location.



Figure 4: General scenario before deploying administrative inventory.

Source: Prepared by the Author.

Movement to pass people was completely compromised, had several obstacles, and could undoubtedly cause accidents, for example, cones, Styrofoam, equipment, cabling, fan, misplaced stairs, and this can be evidenced in figures 4 and 5.



Figure 5: General Scenario Before Deployment Inventory and Equipment Area

Source: Prepared by the Author.

There were also small spaces where they were used as deposits of various materials, where no one knew what it was due to lack of identification and the boxes were badly packed, not organized, so that handling is easier and a better environment, as shown in figure 6.

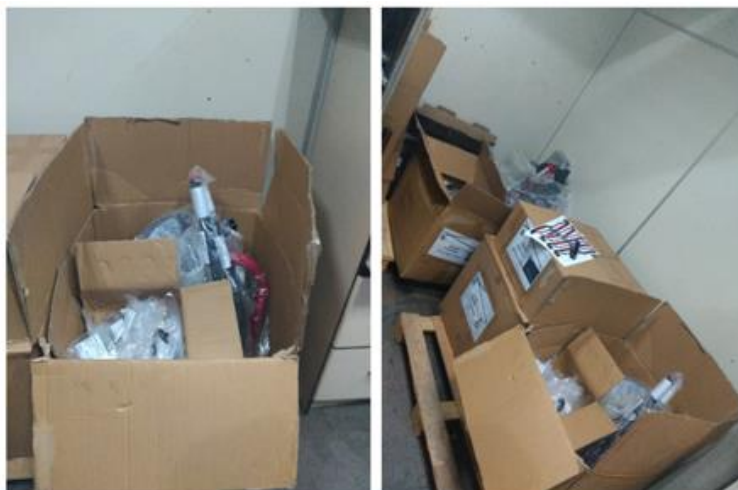


Figure 6: General scenario before deployment of parts inventory area

Source: Prepared by the Author.

#### 4.2 Brainstorming

After analyzing the situation of the company, we had a field meeting with the employees and made use of the brainstorming tool in order to promote a shower of ideas in order to solve the problems in question. During the raising of ideas and analysis of the possible causes of the problems and their respective solutions, and concluding with the definition of the necessary actions at the appropriate time, executing and evaluating the actions.

Characteristic Brainstorming needs an early stage where many ideas are generated without criticizing them and then focuses on the ideas generated in the previous step to choose which ones are best, thus making it useful when needed to generate it. many short-term ideas (ORTIZ, 2013).

### 4.3 Ishikawa Diagram

From the brainstorming tool, brainstorming, we made a second analysis, eliminating those that did not make a significant reference to the problem, and then we put the information in the Ishikawa diagram, fishbone, where we find as the main causes for the problem. effect on people, method, measurements, and environment as shown in figure 7.

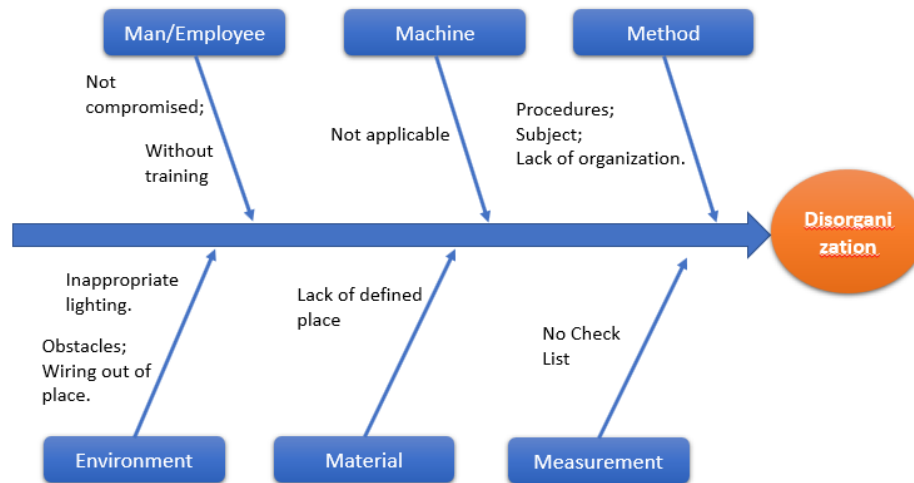


Figure 7: Ishikawa diagram with brainstorming

Source: Prepared by the Author

### 4.4 Action Planning

#### 4.4.1 5W2H

After all the analysis of the results we started to plan the actions started with a clarification meeting about the tool to be implemented. With the 5W2H tool was evidenced that to mitigate the main effects of failures that was disorganization, we can realize that the implementation of the 5S program was necessary.

The results of the analysis were presented to the managers, they had the understanding and bought the idea of implementation of the program, soon after it was given instruction to the employees and the actual application of the 5S program.

### 5. 5 S Program Using PDCA - Implementation Steps

The first step consisted of making a presentation to the Test Engineering Supervisor Rogerio Pimentel, responsible for the team, requesting the appropriate authorizations for the implementation, and authorizations granted by the same. The research project was implemented through the case study that starts with a planning stage where an execution schedule was defined, identifying the action, the responsible and the execution time.

The PDCA Cycle, which has four steps, 1- Plan, 2- Do, 3- Verify, 4- Act, will be covered by explaining each task performed in the deployment.

Table 2 below shows us the senses of the 5S program and how they were used throughout the project implementation.

Table 2: Action Plan of 5S Implementation Activities

SENSE	DESCRIPTION
<b>Seiri</b>	In the first week of project execution the command was to separate what is useful from what is not, improve the use of what is useful, keep only what is needed in the workplace, combat waste. Before week of use, it was possible to find several empty boxes in the industry taking up shelf space, many unused equipment for the productive area. In figure 4, 5 and 6, an analysis of the equipment was made, and many of them were sent to the sector responsible for obsolete equipment.
<b>Seiton</b>	In the second week was the turn of the related Sense Ordinance, the organization, where we performed at the disposal of tools and equipment in a better order for the workflow. The process was done in order to eliminate unnecessary movements.
<b>Seiso</b>	In the third week, we began to utilize the sense of cleanliness. At this stage it was important not only to perform environment and workplace cleaning, but also to maintain it. Education has been provided so as not to get dirty, and to look after everything that is our responsibility.
<b>Seiketsu</b>	In the fourth week, the Health Sense was implemented, with it the challenge was to keep what was already clean and organized, favoring physical, mental and emotional health, based on hygiene practices. A meeting was also held for suggestions and compliments, reinforcing a Harmonious working environment.
<b>Shitsuke</b>	In the fifth week, the Sense of Self-discipline was already present, since in the other senses this practice had already been stimulated, because the fact that every week,

Source: Prepared by the Author

### 5.1 CHECK

To maintain the 5S Program, a group was set up to conduct audit training with the SGI (Person responsible for the Integrated Management System), so that there was control and monitoring of the development of the implementation. The audit took place seven days after the deployment results release meeting, through a Checklist, shown in Annex A and B, produced by the IMS, where all 5S items that had been implemented were reviewed. The results achieved were very rewarding, although we did not have the highest score, but the team was able to pass the Audit.

## 6. Final Considerations

Throughout the project was evidenced a lot of resistance from some collaborators, especially the older ones, they always used the following terms, old parrot will not learn to talk, that change to what always was that way and negative thoughts saying that it would not work and this happened at various times and at various times, however, with the help of the 5s task force, with all engaged, it was possible to overcome this barrier.

The implementation of the 5S program was very significant for the company's top management and production and especially for all employees. Due to the actions of the program, several changes could be noticed in the company, examples, reduced time to look for something, less fatigue, higher employee

productivity, significant increase in the employee's quality of life, but better welfare for the employee. This also provided a better look of the desktop.

This work has given us the opportunity to show how important is the incessant search for the improvement of our processes, ensuring for the company a better placement in the market, and it is believed that this has greater share and competitiveness in the market. Thus, we leave here with this project an opening for further research such as program expansion, improving the audit process, implementing indicators and new quality tools to make G. Equipment's one more and more prominent.

## 7. Acknowledgments

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# Scrap Cost Reduction Process Improvement Actions in a Microwave Assembly Plant

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## Abstract

*Costs are indicators of the financial and economic health of a company, as they are part of the production chain and are therefore necessary for the manufacture of a product, but when extra costs are included in production profitability is compromised. This paper aims to present the reduction of scrap costs of imported materials, identifying the problems related to the product and its impact on the company. As specific objectives, it aims to understand the problems that occur for the amount of parts disposal; develop a containment and correction action plan; implementation of improvements to the inspection and receiving line. As a methodology, we used a case study in a microwave oven assembly plant, where technical visits were conducted by two leaders responsible for the assembly, inspection and receiving sector, where the collection instruments were performed. For the elaboration of the solutions we used the 5W2H tool and control chart to find the faults in the parts.*

**Keywords:** Scrap; Production cost; Cost reduction.

## 1. Introduction

The industry gives rise to costs that vary according to production, the assembly sector is part of the production of a finished product, when failures and scrap are costs that cost the organization's final value and profitability, also compromising other parts of the business. The costs that make the company profitable, if they outweigh the profitability soon the company also compromises its profitability.



Scraps of imported products make a difference within the costs of product completion. By not taking advantage of these parts, unit parts costs increase significantly, reducing the profitability of each finished product. The high costs with these failed parts are present in the monthly closings and it is a management meeting agenda, as it has high manufacturing costs.

This article aims to present the reduction of scrap costs of imported materials, identifying the problems related to the product and its impact on the company. As specific objectives, it aims to understand the problems that occur for the amount of parts disposal; develop a containment and correction action plan; implementation of improvements to the inspection and receiving line.

As a methodology, we used a case study in a microwave oven assembly plant, where technical visits were conducted by two leaders responsible for the assembly, inspection and receiving sector, where the collection instruments were performed. For the elaboration of the solutions we used the 5W2H tool and control chart to find the faults in the parts.

## **2. Theoretical Referential**

### ***2.1 Competitive advantage in the industry***

Over the past few years, companies around the world have gone through a series of transformations and innovations. First it went through a period of boom and expansion, with expectations of a bright, almost limitless future. After this period, consequently, an era of crisis and deep frustration set in when, at the beginning of the 21st century, a strong economic slowdown ensued, leading to a global crisis. Business got a lot more complicated, especially in the industrial sector, which was easy before, became very difficult and needed immediate repairs, strategic breakthroughs in order to deal with these new challenges. Also, according to the author, the secret to permanent success is operational excellence, that is, one must invest in strategies focused on production, technology and sustainability, always avoiding waste. In order to achieve this operational excellence and survive in this new competitive environment, companies were forced to adopt new strategies and new patterns of relationships, including the Production Strategy [1].

Thus, it is understood that with the intense existing competitiveness, companies from different sectors, but with emphasis on the industrial and production sector, are disposed to improve the productive processes, making them more efficient through the reduction of activities that do not add value and generate costs [2].

Thus, eliminating waste became a joint action of all stakeholders that the company can continue to be active in the market, because the reduction brings other details that makes it sustainable, by collaborating with the environment, where the value of total quality the product becomes better, thus becoming a competitive differential for the company [3]. With this, the organization is better able even to make new negotiations because their prices will have margin for it.

In this context, the electronics industry in Brazil, for years, has provided great growth in product sales. Among the main factors that motivate such increase are: the diversity of functionalities of the produced equipment, the reduction of the useful life, the reduction of the final cost of the product and the technological innovation [4].

By conducting a thorough analysis of the consumer market, it can be seen that there has been a change in customer behavior and satisfaction, where they have new quality criteria, where they become more demanding regarding price, quality, access, availability and also the sectors that involve the company's commitment to reduce consumption by worrying about waste [2].

As a competitive differentiation proposition, an organization's sustainability defines actions and activities that are geared to supplying needs without having to use more inputs or having to discard products in inappropriate places in order for material to be harnessed. In the best possible way, sustainability is directly intertwined with economic development without harming the environment, with both material disposal and overconsumption. Acting responsibly, taking advantage of products and inputs so that you do not have to dispose of them improperly or unnecessarily [5].

## **2.2 Cost reduction in production**

In a survey conducted, it was noted that the company one company had many additional costs due to the waste generated in the manufacturing process of a white goods assembler (treated by appliances in general), noted the need to develop a focused work reducing scraps, which are treated as defective parts. These wastes are production elements that do not add value to the product, add costs and time to the execution of activities. To effectively reduce waste, methods proposed in accordance with Lean Production concepts are proposed, focusing on identifying and eliminating waste in order to reduce costs and increase quality and speed of delivery to the customer [2].

Within production, lean approach is based on the just-in-time method, which is when the right parts needed for assembly reach the line at the right time and in the right quality, reaching the ideal state of zero stock, is grounded. eliminating all waste in order to develop a faster, more reliable operation that produces high quality products and services and, above all, operates at a low cost [6].

Lean Manufacturing, is another process used to reduce waste that has its origin in the Toyota Production System is an initiative that seeks to eliminate waste, exclude what does not add value to the customer and convey agility to the company [5].

To effectively eliminate waste, it is necessary to investigate and make a general survey and find out where the precise source of the problem is, which can be accomplished through lean production tools. Thus, the main tools used to implement the principles of the Lean approach are mainly Value Stream Mapping and Lean and Kaizen Metrics [2].

The activities proposed by the kaizen method are directed to the work done by small groups, organized as best as possible within the company to perform specific tasks in the work area, which are responsible for solving problems and making improvements. Also, according to Rotta (2017), kaizen are continuous improvement efforts, performed by all, and their central focus is the search for the elimination of waste.

According to Rother and Shook (2012), kaizen can be divided into two axes, which are flow kaizen and process kaizen, where their functions are, respectively, the focus on flow improvement and are directed at management, It involves planning and executing high-level improvements, and process Kaizen focuses on improving individual processes, eliminating waste, and is linked to teams and work leaders, where they involve modifications located at specific points in the production process.

### **2.3 Microwave**

The Brazilian home appliance market is becoming increasingly crowded, and the major companies operating in the country are investing and expanding their respective product lines. White goods include refrigerators, automatic washers, freezers, dishwashers, automatic clothes dryers, stoves, air conditioners and microwave ovens [2].

Thus, although the Brazilian white line market is managed by a few large companies, the number of manufacturers has been growing in the market. In order to increase their market share, companies have sought several innovations in their products, from the production process to the consumer public. For the businessmen, requirements such as flexibility, cost reduction, product quality and reliability and speed in meeting market needs are considered fundamental to business success. [1]. In order to achieve good results in these dimensions, companies have been developing various internal restructuring processes, from internal to external sectors of the company, in relationships with their customers and suppliers, and with new acquisitions to follow the new rules regarding safety and security. to the environment. Innovation and innovative capacity are characteristics highlighted by managers as decisive factors of competitiveness [2].

The operation and mounting profile of a microwave oven is classified, the essential part of the equipment for its operation is the magnetron valve, which is the microwave generator, it consists of a vacuum device which converts electric energy in waves. A constant potential difference is applied between the anode (which is a hollow circular cylinder) and the cathode. Electrons are accelerated from cathode to anode, but the presence of a strong magnetic field (produced by an electromagnet placed between the two poles) causes the electrons to describe a curved path and follow a spiral path, producing radiofrequency. Later, by a more complex mechanism, electromagnetic waves will emerge from an antenna placed directly over the anode. The produced waves will be guided by a waveguide to the cavity containing the material to be heated. The metal walls of the oven absorb very little of the energy. Most are reflected and dissipated in dummy load, which prevents waves from damaging the valve [4].

In this sense, the microwave oven is a device that over time, has become almost essential homes, due to its practicality, making the cooking time of food is much shorter than the time required by a conventional oven [1].

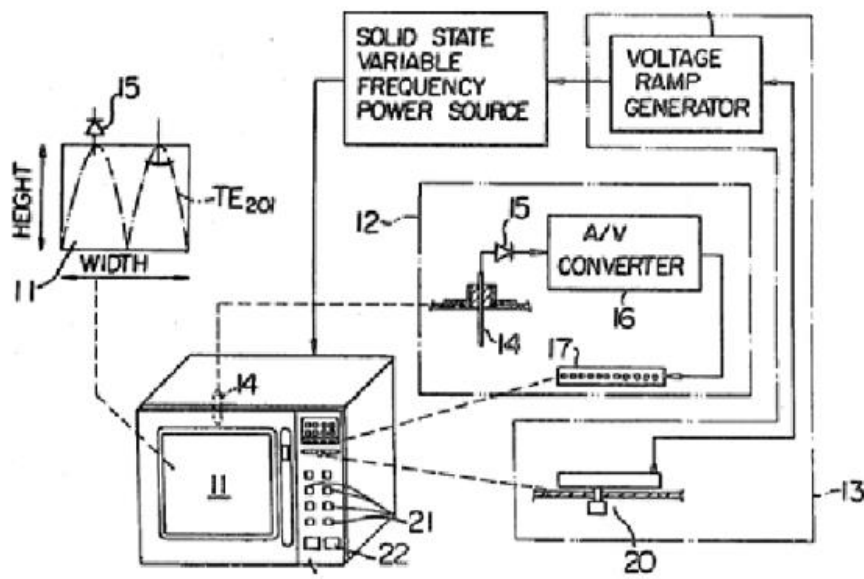


Figure 1: Microwave operation diagram

Source: Cacife (2010).

### 3. Methodology

According to a technical visit to a 30-liter microwave assembly plant, the observation and data collection was conducted as an instrument for collecting data through interviews to learn about the production processes that take place within the organization.

For all cost information to be ascertained it was necessary to carry out an in-depth mapping of the scraps, where the data were passed on to the control chart, pareto chart for visualization of failed waste and check sheet.

The research is inserted in a microwave oven assembly and manufacturing plant, where there are sectors divided according to the part of the product that needs to be assembled.

The sector studied is the revision sector, where the cover and door analysis of the product is performed, only after this inspection regarding the quality that is forwarded to the other sectors where the assembly will continue. For the planning of actions will be carried out planning using the 5W2H tool, from these actions proposals can be implemented.

### 4. Applied Studies

The inspection and receiving sector use two imported parts to assemble the product, these parts correspond to the cover and the door of the microwave oven. These parts arrive in a container and are stored in the factory stock, from where every morning is passed on to the revision sector to be able to go to the finishing sector. To list the fault quantities, tools such as control chart and check sheet were used.

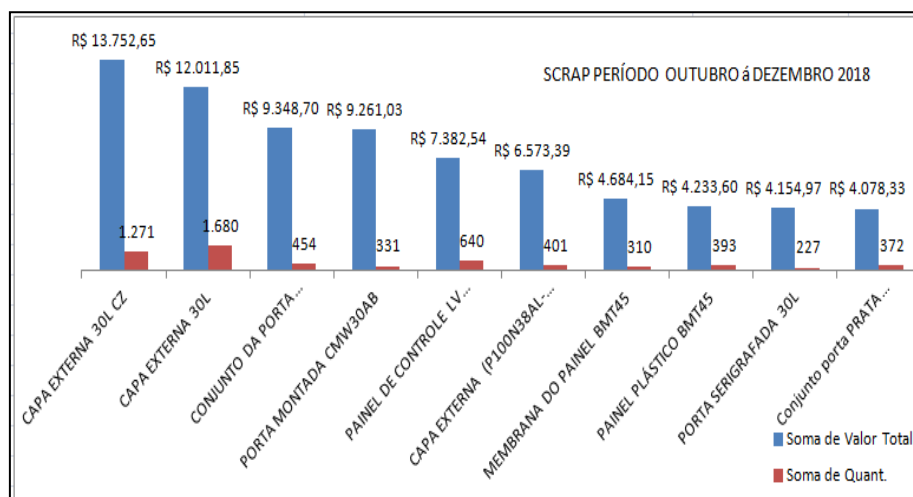
#### 4.1 Problems Identified

The research was carried out in the assembly line 18, where through the application of the collection

instruments it was possible to observe the problems that increase the internal cost with parts at the moment of the product assembly. The company specializes in microwave oven manufacturing and is located in the city of Manaus. During the visit and observation period, the main flaw that causes the quantity of discarded parts to increase is directly linked to the quality.

Lack of knowledge about acceptable failure quality acceptance standards meant that several Scrap pieces were discarded every day because they had characteristics that were unknown if they were acceptable. The collaborators in doubt regarding the aesthetics of the pieces discarded them, increasing the cost of each piece, which in turn was purchased from China for a low price, but when turned into scrap the unit cost consequently increased.

By investigating the cost burden on each component in the assembly control worksheets, taking into account what is used in the overhaul sector, the items such as cover, door and panel are the ones that present the highest cost increase. in manufacturing within the list of ten costly components in the 30L microwave oven assembly line, as per Graph 1.



Graph 1 - Higher Inspection and Receiving Costs

Source: Author, 2019.

According to the graphic above, it can be observed that the procedure of discarding parts that apparently are not useful for assembly causes new parts to be purchased, making the cost higher for each production. In 2018, when the parts supplier had improved quality, but with scrap it still showed high costs on parts. However, in the year 2019 with the switch to a Chinese supplier that presents parts with

However, the company has two shifts composed of 12 hours from Monday to Friday, where a cover piece is assembled every 6 minutes, and a door every 5 minutes, considering that the value of the cover pieces 30L and Door Mounted are, respectively, \$ 5.80 and 7.80. When observing the line, it was found that for each assembled part, two are discarded. Thus, 10 covers per hour and 12 doors per hour are assembled, if for each assembled piece two are discarded on average, so the current costs with discards from October to November / 2019 are R \$ 2515.00, equivalent to 18.18% of the total value. That is, of the 1271 pieces of the 30L CZ outer shell in this period, 233 were discarded; Of the 1680 pieces of 30L Outer Cover, 305 pieces were discarded. Of the 454 Door Set pieces, 82 were discarded; Of the 331 doors assembled, 60 pieces were discarded in this selected period.

## 4.2 Control Chart

By observing the internal processes that focus on the disposal of waste in the assembly, it is possible to ascertain the main characteristics that motivate the disposal of parts when surveying and mapping the assembly process using a control chart. , as can be seen in Figure 2, below.

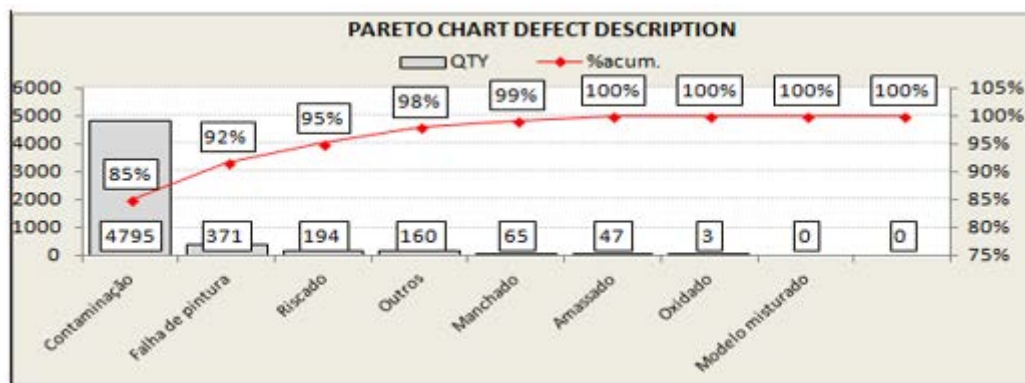
NAME:		MODEL:			DATE:		TOTAL REVISED:		
RE:		CODE:			PO:				

Defects	07:00 às 8:00 17:00 às 18:00	08:00 às 9:00 18:00 às 19:00	09:00 às 10:00 19:00 às 20:00	10:00 às 11:00 20:00 às 21:00	11:00 às 12:00 21:00 às 22:00	12:00 às 13:00 22:00 às 23:00	13:00 às 14:00 23:00 às 00:00	14:00 às 15:00 00:00 às 01:00	15:00 às 16:00 01:00 às 02:00
Scratched									
Rusty									
Smoothie									

Figure 2 - Part Fault Control Chart

Source: Author, 2019.

From this it can be seen that the main problem found in the pieces is equivalent to scratched, oxidized, dented, mixed models, stained, contaminated, with paint failure, and other deformities that were used as a discard criterion. In the data collection performed through internal control spreadsheets, the main impacting failures in the sector are clearly and clearly represented by Graph 2, below:



Graph 2 - Pareto of the demonstration of major defects in parts

Source: Author, 2019.

Based on the statements, it can be known that the main reasons for discarding are contaminated or failed paint parts. This factor has been found to be constant due to the choice of the supplier, who in turn offers a larger product for a lower price, that if the losses are taken into account, the unit price is similar to the costs offered by suppliers offering parts with better quality.

### 4.3 5W2H

In order to elaborate an action that could offer the reduction of costs related to the assembly, observations were made in the parts, price knowledge, creation of new criteria that could use the parts that present insignificant flaws. This process was only possible with the presence of a person in charge of the assembly line, who presented the entire process, and it was possible to find the reasons for the increased costs with SCRAPS and the elaboration of the action plan.

Table 1 - Action planning

WHAT	WHY	WHO	WHEN	WHERE	HOW	HOW MUCH
<b>Quality Management Training in the Sector</b>	Increased knowledge by sector managers	Leaders and managers	20 days	In the sector	Inspection	\$ 500.00
<b>Elaboration of criteria for the acceptance of parts with small defects.</b>	Acceptance of minor mounting failures	Mounting Sector	When selected defective parts	In the sector	Line	Free of charge
<b>Implementation of 8D methodology.</b>	Parts Testing Application	Assemblers	At the time of knowledge of part failures	In the sector	Line	Free of charge

Source: Author, 2019.

## 5. Results and Discussions

Through the cost analysis with the discarding of the pieces were made new analyzes aimed at the cost reduction. However, by applying the 8D methodologies it was possible to select the parts and define the problems that are found in them, it was necessary to contain this problem through a solution focused on the feasibility of using parts that have flaws that can be disregarded at the time. of the assembly.

Based on this, new criteria for the use of covers and doors were elaborated, where they were defined as:

- 1) Provided there is no definition of the technical drawing, the definitions of the visual inspection areas are defined according to the consumer's interface with the product. For high gloss parts they should be considered Class A.
- 2) Area A: All regions of the product or component which, in the most common installation position, are extremely visible from the consumer's point of view, usability, or specified in technical design;
- 3) Area B: All regions of the product or component which, in the most common installation position, are highly visible from the consumer's perspective or specified in technical drawing. Usually considered upper, lateral and other peripheral regions of the product.
- 4) Area C: All regions of the product or component which, in the most common installation position, are moderately visible from a consumer perspective or specified in a technical drawing. Usually considered the sides and backs of the product.

Pontos	Contraste	ÁREA A			ÁREA B, BR e BL			ÁREA C, CR e CL		
		Tamanho do defeito	Quantidade aceitável	Distância mínima entre defeitos	Tamanho do defeito	Quantidade aceitável	Distância mínima entre defeitos	Tamanho do defeito	Quantidade aceitável	Distância mínima entre defeitos
		<0.5 mm	1	-	<0.5 mm	2	150 mm	<1 mm	2	250 mm
Amassado, Cônico, Convexo	Sim	<0.5 mm	1	-	<0.5 mm	2	150 mm	<1 mm	2	250 mm
	Não	<1 mm	1	-	<1 mm	2	250 mm	<1.5 mm	1	-
Riscado	Sim	<0.5 mm	<2 mm	1	<0.5 mm	<4 mm	1	<0.5 mm	<8 mm	1
	Não	<1 mm	<4 mm	1	<1 mm	<6 mm	1	<1 mm	<8 mm	1

Figure 4 - List of acceptable criteria

Source: Author, 2019.

After these criteria about 5 employees were summoned to perform the visibility test by the consumer. Thus, a distance was established for the evaluation, taking into consideration the possible view that the consumer may have of parts that have some kind of failure, whether or not perceived by the target audience.

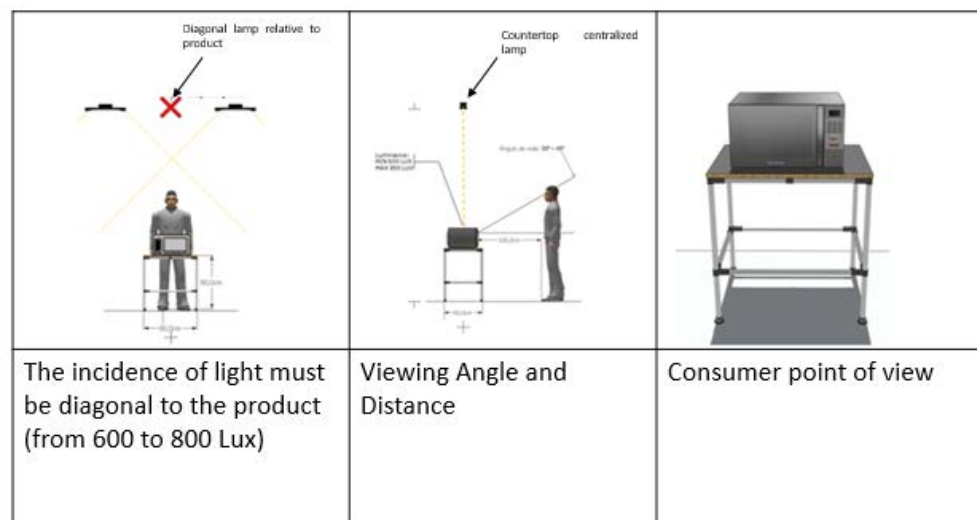


Figure 4 - Position in which the tests were performed

Source: Author, 2019.

It was found that the parts do not emphasize acceptable details, and some details on the covers are imperceptible, and thus, the parts that were within the fault visibility criterion were no longer discarded, but used in the assembly.

As a result of this new acceptance of parts, disposal has reduced on the assembly line. The number of pieces that were definitively discarded dropped to an average of 5 pieces per shift for both cover and doors. If the company maintains this result, the amount of unused failures discarded is a margin of 220 monthly pieces, which cost an average of 6.00, making it approximately \$ 1,320. Before the changes, the costs with losses averaged R \$ 2,515.20, leading to a cost reduction of 52.48% in the number of SCRAPs from September to October 2019. The statement of this result in the economic scope of the company is evidenced according to Graph 3.



## Graph 3 - Comparison of part quantity

Source: Author, 2019.

## 6. Final Considerations

According to the studies raised in the process of assembling the microwave oven factory, it can be observed that the cost of unused parts can compromise a considerable part of the variable costs of the organization, causing the company to have a reduction in profitability and may even compromise the financial health of the business in future times. Employees' commitment to quality and better use of inputs brings significant returns to the company.

The lack of knowledge about the norms and criteria of acceptance of the parts and actions aimed at the visualization of the finished product made the parts accepted as inputs and could be used in the assembly line, not requiring the purchasing or quality sector to come into contact. Contact your overseas vendor to reach a consensus on re-billing as this would take time and cost.

Just one organization, applying the 8D methodology was enough to make the quality and assembly team reach a criterion where it does not compromise end customer satisfaction.

As a result, the results were impressive because more than half of the parts that were previously discarded started to be used in the assembly and the quality remained the same. It can be considered that the scrap or discarded parts in the production process and how much the unit cost of the purchased parts will be taken advantage of will become lower as their use increases and it makes sense to buy low priced parts from the Chinese supplier.

It is suggested new studies focused on the field of use of failed parts where they can be 100% used, because in this study only those parts that were within the new acceptance criteria that became part of the assembly line, the parts significant defects continued to be ruled out.

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## **An analysis of the compliance aspects of NR 10: a case study in a substation of the Manaus Metropolitan Region - AM**

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### **Abstract**

*The Regulated Standard (NR-10) is a standard that establishes minimum requirements and conditions with the stated objective of guiding the adoption of preventive systems control measures. The objective of this study is to analyze the compliance of NR 10 in a substation, analyzing as inherent activities to the enterprise according to the standards of standardization. A research was conducted based on a descriptive and observational study, and was implemented through an on-site study based on data collection and information gathering in a substation located in the southern region of Manaus - AM. It is responsible for the distribution of energy throughout the south and center-south of the city, feeding about 450,000 people with the availability of 188,890 kW of power. It was concluded that it is essential that the electricity supply companies are fully in compliance with the requirements and surveillance standards in the country, given that the conservation of workers who deal with direct work in high and low pressure spaces be observed with a much more accurate strategic look.*

**Keywords:** NR-10; Maintenance; Substation;

### **1. Introduction**

Large cities, especially metropolitan regions, need large energy production to be able to feed local production and move energy consumption to supply society. Substation studies show how these large companies develop methods and actions that serve society from the power supply.

In addition to the energy supply aspect, there has been a concern, in recent years, over the adequacy of standards and standardization panoramas for space adequacy, in order to increase occupational safety and make risk mitigation more effective. and improving the most appropriate space-assurance techniques for doing work.

Energy supply can be considered as one of the main services offered to society, either through public concession or by state modality, so that its distribution is fundamental for social development. To this end, there is a need to develop mechanisms that ensure the full maintenance and adequacy of distribution spaces so that the preservation of the environment, the safety of life and the full functioning of distributors do not adversely affect society.

In addition, it is understood the importance of standardizing procedures and adjusting power distribution spaces to ensure integrity and safety in the power supply process. Therefore, the objective of this study is to analyze the compliance of NR-10 [1] in a substation, analyzing the activities inherent to this undertaking according to the standardization norms.

Maintenance has its appearance in the period of antiquity with the emergence of the first major constructions demands for economic growth and to meet the demands of society. In the period of the Industrial Revolution, the rise of new tools with the expansion of industrial machinery brought to light the academic debate on the need to improve tools and control mechanisms to maintain machine operation and optimize production [2].

NBR 5462 [3] conceptualizes maintenance as a set of activities that aims to apply procedures that guarantee the full functionality of a product in order to optimize its resources. For this, it is understood that maintenance is not an isolated step, that is, it consists of a systemic procedure integrated with other functionalities.

According to [4], maintainability refers to the conservation method or result for performing ordinary functions, such that there is full conservation so that its usability can be extended despite the frequency of use. This concept derives from the relevance of maintenance in the production process, so it is understood that it is necessary in the strategic and operational planning of any organization.

[2] discusses that the mission of maintenance goes beyond the operational phase, being also present in the tactical and strategic planning process of the organization. Maintenance actions can be planned periodically, aiming to actively participate in the production cycle in the organization.

[5] analyze that maintenance can enter the organization planning in a broad and objective way, according to the proposed actions and their determined role in each phase of production. The objectives of maintenance in an organization can be developed in several lines and fronts, being necessary to be predetermined and subordinated.

[6] mention that maintenance objectives need to be aligned with an integrated set of actions that determine their role in each phase of production. The life cycle of an accurate equipment is accompanied by a series of maintenance actions from a present and active monitoring program in order to offer quality parts and thus ensure their best performance.

This standard applies to the generation, transmission, distribution and consumption phases as well as included in the construction, assembly, operation and maintenance projects of electrical installations and any work carried out in close proximity to areas with electricity, in accordance with current technical

standards. [7]. [1] is a standard based primarily on guidelines that address operator safety when contacting objects or environments where electrification is present.

Note that [1] is a standard that establishes minimum requirements and conditions with the primary objective of guiding the adoption of control measures for preventive systems. In addition, its scope of action is direct prevention in guaranteeing the safety and health of workers, as well as directly guiding the methods and the way of working in electrical installations [8].

The NR-10 can be applied to the main stages of the control process in electrical installations: generation, transmission, supply, distribution and consumption. In addition, it can also act in the design and implementation phases of the distribution companies, such as: construction, assembly, operation, maintenance of building installations in its electrical composition aspects and any other work developed around an electrical distribution area [1] [9].

It is observed that the NR-10 acts as a regulatory instrument with application in the most diverse areas and stages of execution in the development of activities within the power distribution [1]. [10] argues that NR-10 is involved in the implementation of control measures to avoid risks and ensure the safety and health of work exposed to risk, ie, it instructs companies to perform tasks that enable the safety condition. in the provision of work.

## 2. Methodology

The substation is located in the southern region of the city of Manaus - AM, being responsible for the distribution of energy throughout the south and center-south of the city, feeding more than 450 thousand people with the availability of 188,890 kW of power.

The inspection period was July 10-20, where from a preliminary study, according to data provided on the company's website, it is able to meet demand growth of up to 35% by 2023, to supply local and other parts of the city. The distribution covers about 16 neighborhoods and the current space covers a total area of 88,000 m<sup>2</sup> - including all workstations and access areas, as well as administrative and operational management buildings.

The research was conducted based on a descriptive and observational study [11], being implemented through an on-site study, based on information gathering for direct application in the substation workspace, with measurements, capture and information records. and images for data processing.

The research schedule was defined according to the technical visits made on site, together with the presence of responsible team that guided the entire process. The study was divided into three stages:

(i) Area inspections; (ii) initial diagnosis and preliminary report of spaces; (iii) preparation of the proposal to adapt to NR 10 [1].

From this adequacy, it is suggested an adequacy report based on NR-10, which was presented: Guidelines for improvement actions (preventive); prevention actions based on work risk analysis; work operationalization measures in the substation; recommendations.

## 3. Results and Discussion

The presentation of the study was through an analysis that took place through technical visits to the

energy distributor. Follow-up was performed by a technical team and the collected data were made available in tables for better identification. Subsequently, the estimated measurements and observations regarding NR-10 adequacy [1] were recorded.

For an inspection analysis it is necessary to know where to apply, the possible potential risks and adequacy measures. Thus, Table 1 presents the schedule of the inspections carried out in the initial and preliminary phase of the study from the technical visits in the energy distribution sectors.

Table1. Ccheck list presenting exercises for different activities linked to NR-10.

<b>Place</b>	<b>Potential Risks</b>	<b>Estimated Measures</b>	<b>Comments</b>
<b>Electrical Components Sector</b>	Risk of accident	Sector Signage	Low brightness of workspace
<b>Maintenance Sector</b>	Ergonomic risk	Inadequate workstation structure	Lack of work real estate suitability
<b>Production and Operations Control industry</b>	Accident Risk and Ergonomic Risk	Low light; No signaling	Adequate space to make shift work easier, especially night shift.
<b>Administrative sector</b>	Risk of accident	Lack of planned real estate for the sector	Perform maintenance on power distribution boards
<b>South and North Alaskan Logistics Sector</b>	Risk of accident	Electrical Wiring Display in Control Wing	Suit the spaces
<b>Machine Operation Wing</b>	Risk of accident	Visual signage	Perform signaling by machinery.
<b>Machine Operation Wing - Part 2</b>	Risk of accident	Operators Signaling	Perform signaling by machinery.
<b>Periodic visits in the distribution yard</b>	Accident Risk and Physical Risk	Operators Signaling	Perform the signaling of spaces. Identify the distribution grids of distribution networks.

Source: Own authorship (2019).

The stage of the technical visits was the initial and preliminary diagnosis of the study to collect data and observations about the site. The inspections were performed by department and according to permission instructions from the Maintenance Coordination (CM).

The identification of the risks was categorized according to [1] and the observations of [12] as “accident risk”, “ergonomic risk” and “physical risk” - these three categories are fundamental for observation in an adequacy survey in a risky workspace.

For the initial diagnosis phase, it started by capturing information collected during the technical visits and, subsequently, by identifying the items of the [1] that fit according to the situation observed in the survey process. Table 2 presents the initial checklist stage, which corresponds to the general survey of electrical installations according to their suitability and safety aspects.

Table 2 - Checklist for verification of the necessary items in the electrical installations.

Item #	Item from	Item Description
1.1	NR-10	Correct identification of access wings.
1.2	10.3.9d	The standardization of outgoing accesses that are within the specified standards according to NBR 140390.
2.1	10.10.1, NR-26, NBR 14039	Visibility of appropriate access doors with signage.
2.2	10.9.4	Doors with emergency exit.
2.3	10.12	The power distribution boards are fixed at points with isolation.
2.4	NR-23	Signaling in hazardous areas.

Source: Adapted from EletroPaulo (2009)

The checklist was also based on NBR 14039 - Medium voltage electrical installations and NBR 5410 - Low voltage electrical installations. In this topic there was comparability of the data collected during the technical visits with the adequacy study conducted by the EletroPaulo team (2009). This comparison allowed, as noted [16], a holistic analysis of employee circulation spaces, so that space adjustments in line with regulatory standards are crucial to avoid any type of accident.

After performing the technical visits in the preliminary stage together with the data collected in the initial diagnosis, the preparation of the NR-10 adequacy proposal was initiated after the checklist as a guiding point [1]. Furthermore, according to [12], the NR-10 compliance phase is a crucial step in any company's work safety planning, and it is the sole responsibility of the company to provide the necessary adjustments to ensure the employee's quality of work. .

### 3.1 - The first phase of the analysis was carried out in Central Area 1

Which is located in the northern range of the distributor. This area comprises 42% of the local supply and distribution of energy to the neighborhoods that the distributor feeds.

Table 3 shows the phase of proposition of adequacy for the Central Area 1 (Power Sector) of the energy distributor. This area consists of one of the main areas of energy supply and distribution.

Table 3 - Suitability Proposals - Central Wing 1 (Covering and Protection Network).

	Procedure	Potential Risks	Control measures	Comments
	<b>CENTRAL AREA 1 - FOOD SECTOR</b>			
<b>VISUAL INSPECTION</b>	Energy distribution (Inspection of conservation status)	Risk of accident (tensions)	Prune outdoor areas (trees)	Outside area with tall trees, without pruning, and with very low wall.
<b>PREVENTIVE ACTION</b>	Adjust the mains according to the maintenance time of the power cables (check the maintenance schedule)	Risk of accident (tensions)	Update the power cable cabling maintenance schedule	Increase the power grid by 1.5 m at the front side next to the generator.

Source: Own authorship (2019).

Adjustments according to [1] in the schedule of building maintenance and spatial adjustments are fundamental to ensure the maintenance of equipment equipment, especially those that make up the power grid. [14] notes that the adequacy of physical structures is important to avoid accidents, such as areas exposed to natural elements such as lightning, trees, animals, etc.

Table 4 shows that the risks in the high and low voltage areas were detected based on the space analysis, which identified the presence of large trees that could cause an accident if there is no control on pruning. [18] analyzes that every high voltage (AT) physical structure needs to be regulated by specific technical standards, such as NR 10, so that the entire structure that makes up the distribution system is preserved and functioning properly and effective.

Table 4 presents the analysis performed in the Central Wing 1 (Maintenance Sector). The sector is responsible for the entire system of maintenance of the small, medium and large equipment of the power distribution company.

Table 4 - Suitability Proposals - Central Wing 1 (Maintenance Sector).

	Procedure	Potential Risks	Control measures	Comments
<b>ALA: CENTRAL AREA 1</b>				
<b>LOCATION: MAINTENANCE SECTOR</b>				
<b>VISUAL INSPECTION</b>	Conducting power cable changes for motors and power generators.	Physical risk  Risk of electric shock	Space signage  Safety Plate Replacement (Upgrade to NR-10)	Include this information in the annual schedule.
<b>PREVENTIVE ACTION</b>	Realization of exchanges of parts of the power supply circuit of the generators.	Physical risk  Risk of electric shock	Use of PPE  Equipment Acquisition	Purchase of safety equipment for all employees, including those on duty.

Source: Own authorship (2019).

According to [14] the electrical installations need an adaptation and a maintenance program in continuous regime, that is, so that the parts with higher wear rate are replaced in a timely manner. [1] in its topic 10.2.9.1 guides the need to use individual equipment in any environment where the worker is exposed to imminent risk.

Electric shock, according to [14] is the reaction in the body caused by nerve stimuli generated from an electric discharge, ie, contact with a passage of electric current from an external source. In the case of electricity distributors, the accident rate is very high and the demands of the occupational safety team need focused attention to reduce the risks of electric shock and, consequently, the risks of physical damage, which may eventually lead to accidents. death.

Table 5 presents the analysis performed in the Operations Control Sector. The sector is responsible for the coordinated maintenance of operations in general: logistics, material transportation and storage of inputs.



Table 5 - Adequacy Proposals - Central Wing 1 (Operations Control Sector).

	Procedure	Potential Risks	Control measures	Comments
<b>ALA: CENTRAL AREA 1</b>				
<b>SETTING: OPERATION CONTROL</b>				
<b>VISUAL INSPECTION</b>	Work Area Inspection (internal and external)	Risk of accident  Physical risk	Isolation of risk areas through sector reallocation	The sector is close to an area of difficult access. Changing to another nearby room at the side entrance is recommended.
<b>PREVENTIVE ACTION</b>	Readjustment of operating and inspection spaces	Risk of accident  Physical risk	Reactivation of the external and internal illumination of the central passage	-

Source: Own authorship (2019).

For [16], the adequacy of the physical space in the control, operation and inspection areas is essential to avoid any problems related to physical accidents in electricity areas. The NR-10 in its topic 10.4.3 for the preservation of space with electrical equipment and spatial adjustments of buildings to preserve the protective features of the site [1].

### 3.2 The second phase of the analysis was performed in the Central Area 2

Which is located in the southern range of the distributor. This area comprises 58% of the energy supply and its main characteristic is the size of the physical space (about 800m<sup>2</sup>) and where the low and high voltage areas are located, concentrating the power phase with the highest energy supply capacity.

Table 6 presents the Low and High Voltage Area (Control and Maintenance). This area concentrates most of the power generators, as well as the electrical structure that feeds the distribution process. The space verification and the adequacy proposition according to [1] were performed.

Table 6 - Suitability Proposals - Central Wing 2 (Low and High Voltage Area).

	Procedure	Potential Risks	Control measures	Comments
<b>ALA: CENTRAL AREA 2</b>				
<b>LOCATION: LOW AREA AND HIGH VOLTAGE</b>				
<b>VISUAL INSPECTION</b>	Protection of supply areas (Generators)	Physical risk Risk of electric shock Risk of death	Protection with 3.3mm screen reinforcement on the side of the generators.	Include proposal in the company's physical fitness schedule.
<b>PREVENTIVE ACTION</b>	Change of protection standards (Generators)	Physical risk Risk of electric shock Risk of death	Carry out the placement of the guards and signal with new plates according to NBR 13434.	-

Source: Own authorship (2019).

The suitability of low and high voltage work is paramount for ensuring the safety and health of the worker in the operation of any service performed in this area, where [17] describes the conduct of a study in which the assessment performed in high voltage sectors. The risk of accidents is measured by up to 32% in energy distributors in Brazil, ie, a risk that needs to be avoided through precaution, based on the guidelines presented by the adequacy and regulation standards.

Table 7 presents the Coordination of Energy Distribution and Measurement Control. The sector is responsible for the coordination of the high and low voltage areas and for the management of the distributor (Central Wing 1 and Central Wing 2) with the function of controlling measures, variability and changes in distribution.

Table 7 - Adequacy Proposals - Central Wing 2 (Coordination of Energy Distribution and Measurement Control).

	Procedure	Potential Risks	Control measures	Comments
	<b>ALA: CENTRAL AREA 2</b> <b>SETTING: ENERGY DISTRIBUTION AND MEASURE CONTROL COORDINATION</b>			
<b>VISUAL INSPECTION</b>	Observation of physical area coverage.	Physical risk  Risk of electric shock	Supported tent construction to isolate administrative sectors  Relocation of the administrative area of the generator contact area	Control rooms are just 2 meters from one of the power generators
<b>PREVENTIVE ACTION</b>	Build temporary zinc or other metal tents in steel frame mode the physical safety of space.	Physical risk  Risk of electric shock	Verification of close space for relocation of administrative areas.	Present this measure in the planning of the company's Occupational Safety Coordination.

Source: Own authorship (2019).

It is noted that the Coordination of Power Distribution and Measurement Control has a location that did not follow the expansion of power generators in the distributor. Although the physical space is high, the control rooms and administrative rooms are very close to the generators and the high and low voltage areas, offering an imminent risk.

[14] analyzes that the protective measures recommended by NR-10 in item 10.7 recommend for worker involvement in high voltage areas, especially regarding the proximity of space in the execution of their activities. Therefore, it is understood that the energized facilities must be built in a way that does not compromise the physical integrity of the worker, therefore, the companies need to observe the composition of the physical space.

### 3.3 As recommendations

The stage after the initial diagnosis (checklist) and preparation of the NR-10 adaptation proposal is the presentation of the study recommendations. The study, based on [1], made some general

recommendations regarding the adequacy of physical space, adequacy in the service improvement structure and the presentation of solutions and implementation measures in the medium and long term.

**Implementation of the Annual Predictive Maintenance Program (PMPA):** It was observed the company's immense difficulty in keeping up with the maintenance deadlines of the generators and equipment of the Central Areas 1 and 2, mainly due to the large physical space and little specialized labor. Therefore, the creation of the PMPA was recommended as a strategic tool for the implementation of a specific policy directed to the maintenance of the generators of the supply units (UF) under the direction of the Maintenance Sector. Currently the company does not have a specific maintenance policy for predictive maintenance, only for corrective maintenance.

**Improvement in the signaling of internal and external areas:** perhaps one of the administrative decisions that, at first, may show a certain inaccuracy or a sense of needlessness. However, it was observed that the substation has a huge gap in the signaling aspects (administrative areas and risk areas) - which leads to an imminent risk to the health and quality of life of the worker. For this, it is recommended to change all nameplates from [1] in order to standardize access spaces and avoid future problems.

**Systematization of maintenance actions with the work safety coordination** It was observed that there is a distance from the work safety coordination planning actions, with the substation maintenance sectors. In order to have a coherent maintenance planning, it is necessary to align actions so that the two wings participate. It is recommended that a standard operating procedure (SOP) be created to standardize maintenance actions along with the needs of sector adequacy to preserve worker health. This document will serve as a guiding principle for participatory and continuous joint decision making.

#### 4. Conclusion

It is essential that the electric power companies are fully in compliance with the principles and regulations in force in the country, given that the preservation of workers who deal with direct work in high and low voltage spaces must be observed with much more accurate strategic look.

In order to avoid problems such as accidents in contact and exposure to electrified systems and reduce the possibility of unforeseen events, such as environmental factors, it is necessary to create adaptation policies that primarily address the conservation of worker health.

The NR-10 is a norm that promotes and structures the actions and guidelines that help in this process of adequacy, being primordial to adjust the routine work procedures according to actions that value, first of all, the worker's life.

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# How to Reduce Motorcycle Theft in Parking at a Manaus Shopping?

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## Abstract

*According to a survey conducted by the Brazilian Association of Shopping Centers in 2016, every nine days, a mall is robbed in Brazil. Faced with this scenario, shopping malls are increasingly concerned with customer safety, as they sell to consumers the idea of safety, convenience and comfort. In mall X, located in one of the busiest Manaus (Amazon capital in Brazil) city avenues, it was found that expenses with robberies and theft reimbursement in parking areas increased considerably in 2015. Thus, this article aims to propose low cost actions to reduce robberies and theft in the parking areas of this mall with the highest incidence of claims. Data were collected through spreadsheets and reports from the Customer Service System (CSS) and the outsourced contractor to operate the parking service. After data collection and analysis, it was concluded that motorcycle parking is the part of parking most affected by the problem, and possible solutions such as control by labels and helmet locks are suggested, and it is up to the mall managers to choose which of the improvement proposals are more feasible.*

**Keywords:** Mall; Robberies; Theft;

## 1. Introduction

According to the Brazilian Association of Shopping Centers (ABRASCE, 2016), a Shopping Center would be:

“[...] a shopping center designed under a single administration, made up of stores intended for commercial operation and services, subject to standard contractual rules, to maintain the balance of offer and functionality, ensuring integrated living and paying accordingly. with billing.

In general, shopping malls have a differential compared to traditional forms of commerce, because they sell the idea of safety, convenience and comfort, mainly due to their larger and better structure, which adds market advantage over the competition.”

Nevertheless, a survey conducted by this Association in 2016 revealed that every nine days, a mall is robbed in Brazil. The study recorded 203 robberies in five years, considering the period from 2008 to 2013. In addition, it was found that jewelry stores, because they have high value products, and parking

areas, because they are isolated and poorly monitored, are the targets. most targeted by the bad guys.

In Manaus, capital of Amazon state, Brazil, the situation seems to be so different, according to a survey conducted in 2009 and released in 2010 by the city's State Department of Public Security (SSP), the number of shopping mall robberies nearly doubled when compared to the two years. There were 20 thefts in 2010 and 11 in 2009. In addition, from January to August 2010, there were 205 cases of theft, of which 149 occurred in shopping malls in the North Zone.

In light of the above, the question is: "How to reduce the number of robberies and thefts in the Mall parking through the use of Industrial Engineering management tools?".

To answer this question, we chose a mall called X to serve as a case study for the research. It is located at Avenida Djalma Batista, close to schools and universities which justifies the large flow of vehicles and people, considerably larger than in other malls in the region.

The study was developed in Shopping X's Operations Department, which has among several responsibilities to reduce expenses generated by thefts and robberies in the parking areas of this mall.

The search is relevant for the following reasons:

First) for Shopping Managers: reduction of claims directly affects the company's image and increases sales. Thus, the research is relevant because it helps to reduce costs and give more security to those who use the project, and can be used as a benchmark for other mall managers;

Second) for Shopping Customers: Shopping mall customers are looking for a safe and comfortable environment, with concepts of home, shopping and entertainment. Claims reduction provides safety and comfort;

Third) for academia: knowledge of quality tools and their applications in a commercial sector, such as shopping malls, helps and enriches the debate in academia, as well as may point to new research needs on the subject. Also the article could be used in the class rooms for educational purposes.

Thus, the general objective of this paper is to analyze and suggest economic actions to reduce the amount of robberies and theft at the X shopping mall parking lot in Manaus.

The research has the following specific objectives:

- 1) Map the parking areas and their surroundings with the highest occurrence of accidents;
- 2) Identify the causes related to the problem, as well as possible solutions;
- 3) Select the most viable solutions with their respective budgets as proposals for improvements to reduce theft and parking theft.

## **2. Theoretical Referential**

### ***2.1. Statistics on robberies and theft in Manaus***

According to the Brazilian Institute of Geography and Statistics (IBGE, 2010) Demographic Census, Amazonas is the 14th most populous state in Brazil with 3,590,985 inhabitants, being the capital, Manaus, occupied by 1,861,838 residents, representing 51.84 % of people living in the state.

The city of Manaus is divided into 63 neighborhoods distributed in 6 administrative zones (Midwest, Mid-South, East, North, West, South) that concentrate quite heterogeneous housing contingents (Figure 1). The northern zone is the most populous, with more than 500 thousand inhabitants.

The capital was considered in 2016 as the 23rd most violent city in the world, according to an article written from OGLOBO (2016). In addition, a survey of the State of Amazonas Passenger Transport Union (Sinetram) found that more than 2,600 burglaries were reported by the ten companies operating in Manaus public transport between January and November 2015. According to Sinetram, this number represents an average of 7 rounds a day.

Due to the large population, according to the State Department of Public Security (SSP), the North Zone in 2010 was considered the most dangerous. It was record-breaking in the number of thefts, with 12,076 records compared to a total of 36,056 cases in the capital.

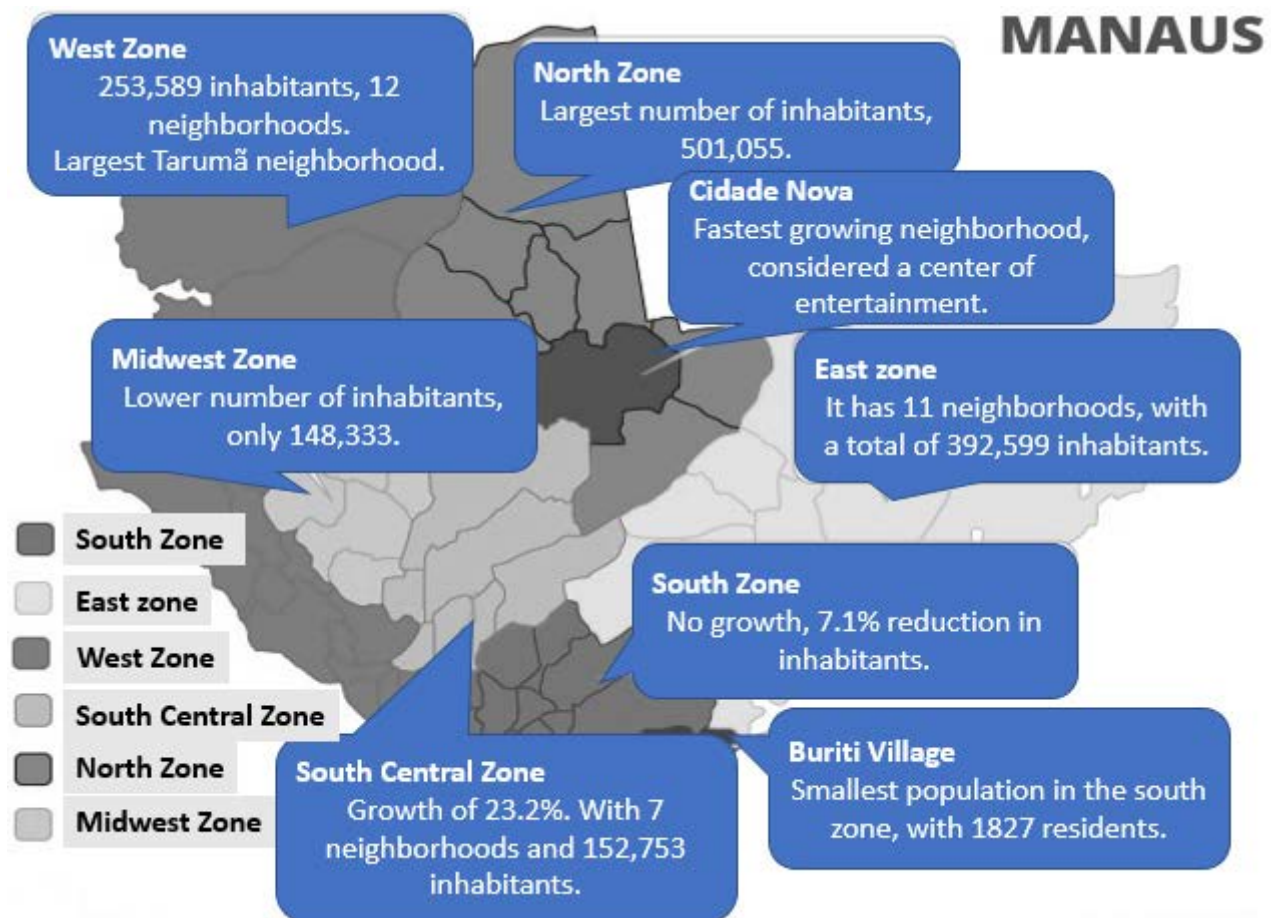


Figure 1 - Map of Manaus zones

Source: Demographic Census (IBGE, 2010).

Still, according to the SSP, the most common types of crime committed in the city are robberies and theft. Approximately 52% of police reports filed at police stations are robberies and 19% related to thefts, mainly cell phones and handbags.

## 2.2. Solutions to reduce shopping center claims

According to researches surveyed and reported by the Brazilian Association of Shopping Centers (ABRASCE, 2016), technological advances and team training are becoming increasingly efficient and accurate regarding the security of large shopping centers.



Most shopping centers have, besides the human effective, high quality cameras with excellent image resolution, with presence sensors and visual identification. In addition, monitoring social networks is essential and important to track external movements such as trawlers and similar claims, as well as applications that map areas and indicate preventive actions.

Currently, monitoring rooms are intelligence centers responsible for security management. In this place, specialized professionals gather data capable of mapping information of crimes committed in the region where the enterprise is located, such as patterns of robberies and demonstrations that may hinder the flow of visitors.

In addition, shopping malls need to increasingly invest in specialized security guards to deal directly with security management. Training, theoretical or practical, is important to prepare the workforce, but not only to support and provide information to clients, employees must be prepared to respond appropriately to any type of claim.

Still on a news article published on Abrasce's website, Seg One, a company that offers consulting and training, developed an application to perform an audit of mall security processes, helping the manager to have real-time information on what is happening. According to the company, another application that can be used is the panic alarm that has low cost and can be installed on a computer store or mobile phones of people working on the site, just having access to the internet.

In addition to applications, a security company, Cocil, has revealed that some image analytic software is effective when it comes to shopping mall security. They have artificial intelligence algorithms that analyze camera images in real time to detect non-standard behaviors that can lead to risk situations.

A company that performs cleaning services, Verzani, has developed software that maps all occurrences, showing the places with the highest occurrence and indicating the areas that need security reinforcement. After entering the data, their analysis is done by the technical area that generates a mathematical matrix identifying the areas of highest risk and level of each: low or high.

In addition, stores now have an alarm system that prevents theft. It works through an antenna and a printed circuit that are discreetly hidden under the bar code label, so the sensors in the circuit are detected by the vertical bars on the shop door. These bars emit electromagnetic waves, so when someone passes them carrying an unpaid product, the sensor attached to the object interacts with the waves and makes the alarm ring.

### **2.3. *Quality tools***

#### **2.3.1. Stratification**

According to Werkema (2006), stratification is the division of a given data group into several subgroups according to desired factors, which are known as stratification factors. In other words, the causes identified in processes that have some kind of variation are stratification factors of a data set. Factors such as: machines, time, methods, people, measurements and others are natural factors for data stratification.

As an example, it is possible to stratify: 1) the time, where results vary at different times of the day; 2) the location, where results have significant variation across different plants or areas; 3) inputs, when it is possible to verify variation for each supplier and 4) the individual, the difference in results is related to

the type of employee in a particular job.

Stratification can be done in various ways, being at the author's discretion to use and identify the one that best fits his studies, and can be done by graphs and tables. However, it is necessary to emphasize that any and all factors that undergo alteration must be registered in order to have a complete diagnosis in order to list the main causes of the problem.

### 2.3.2 Verification Sheet

The Verification Sheet, as shown in Chat 1, is a means of facilitating, organizing, and standardizing data collection and recording so that further data compilation and analysis is optimized.

**Motor Assembly Check Sheet**

Name of Data Recorder: Lester B. Rapp

Location: Rochester, New York

Data Collection Dates: 1/17 - 1/23

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Supplied parts rusted								20
Misaligned weld								5
Improper test procedure								0
Wrong part issued								3
Film on parts								0
Voids in casting								6
Incorrect dimensions								2
Adhesive failure								0
Masking insufficient								1
Spray failure								5
<b>TOTAL</b>		10	13	10	5	4		

Chat 1 – Verification or check sheet example

Source: ASQ's Excel Template

A check sheet is a form in which the items to be examined are already printed to facilitate data collection and recording (WERKEMA, 2006).

The main objectives of using the check sheet are: a) to facilitate the work of the data collector; b) organize the data during the collection, avoiding the need to organize the data later and c) standardize the data that will be collected, regardless of who performs the collection.

Among several kinds of check sheets, the following stand out: a) the distribution of an item is used to analyze the distribution of the values of a control item of interest associated with a process. It is usually necessary to use the histogram to this kind of analysis; b) classification used to subdivide a particular characteristic of interest into its various categories, for example, a check sheet that points out the types of

problems that cause a product to fail; c) troubleshooting is used to identify where certain defects are occurring in a product, for example; and d) troubleshooting is very similar to that of classification, but it allows for a more detailed stratification of factors, making the work of identifying the causes easier.

According to Werkema (2006), to elaborate a verification sheet, the following steps are followed:

Step 1) Define the purpose of data collection;

Step 2) Determine the type of check sheet to be used;

Step 3) Establish an appropriate title for the check sheet;

Step 4) Include fields for the registration of the names and codes of the departments involved;

Step 5) Include fields for the registration of the names and codes of the products considered;

Step 6) Include fields to identify the persons responsible for completing the check sheet;

Step 7) Include fields for data source record;

Step 8) Present in the proposed verification sheet simplified instructions for its completion;

Step 9) Raise awareness among all persons involved in the process of obtaining the objective data and the importance of the collection;

Step 10) Inform all persons involved in the data collection process exactly what, when and how it will be measured;

Step 11) Instruct all persons involved in data collection on how to complete the verification sheet;

Step 12) Ensure that all stratification factors of interest have been included in the check sheet;

Step 13) Perform a pre-test before using the check sheet to identify possible failures in the preparation of the sheet.

### 2.3.3 Pareto Diagram

The Pareto Chart is made through the results of an analysis, with the objective of classifying the items in order of priority. Studies by Vilfredo Pareto found that the 80/20 ratio occurred very often, i.e. 80% of quality problems occurred due to 20% of the probable causes arising from them.

According to Corrêa (2007), Pareto is conceptualized as a way of separating the few vital elements in an analysis and separating them from the most trivial ones.

According to Werkema, (2006). The Pareto chart is a bar chart in which the bars are sorted from highest to lowest and a curve is plotted showing the accumulated percentages of each bar. It can be of two types: Pareto Chart for effects and Pareto Chart for causes. The first orders the problems presented by the company so that the main problem can be identified, while the second orders the causes of each problem presented by the company.

The Pareto for purposes chart can be used to sort problems in the five dimensions of Total Quality, such as: 1) quality, for example, number of customer complaints, percentage of defective products, etc; 2) cost, maintenance costs, warranty repairs, and others; 3) delivery, lack of raw materials in stock, wrong delivery rates and delays in delivery; 4) morale, absenteeism and labor claims rates; and 5) safety, such as the number of accidents suffered by product users, the severity rates of accidents and the number of occupational accidents.

The Pareto chart (Figure 2) for causes may refer to: 1) process information or measurements, measurement methods; 2) equipment such as maintenance; 3) methods or procedures, such as clarity of

information; 4) inputs, batch, storage; 5) environmental conditions, such as lighting, supplier and 6) people, such as age and training.

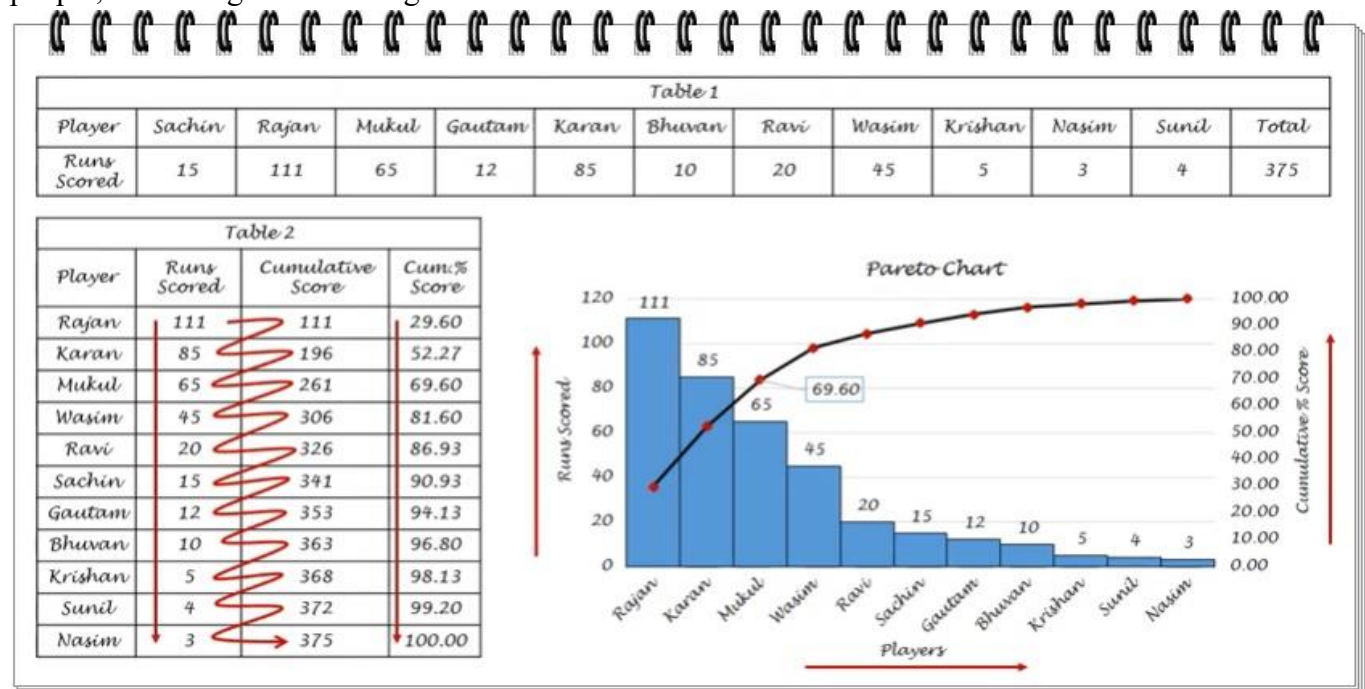


Figure 2 - Pareto chart example

Source: Sharma Narender <<https://www.youtube.com/watch?v=bZ5SYjzmRsk>>

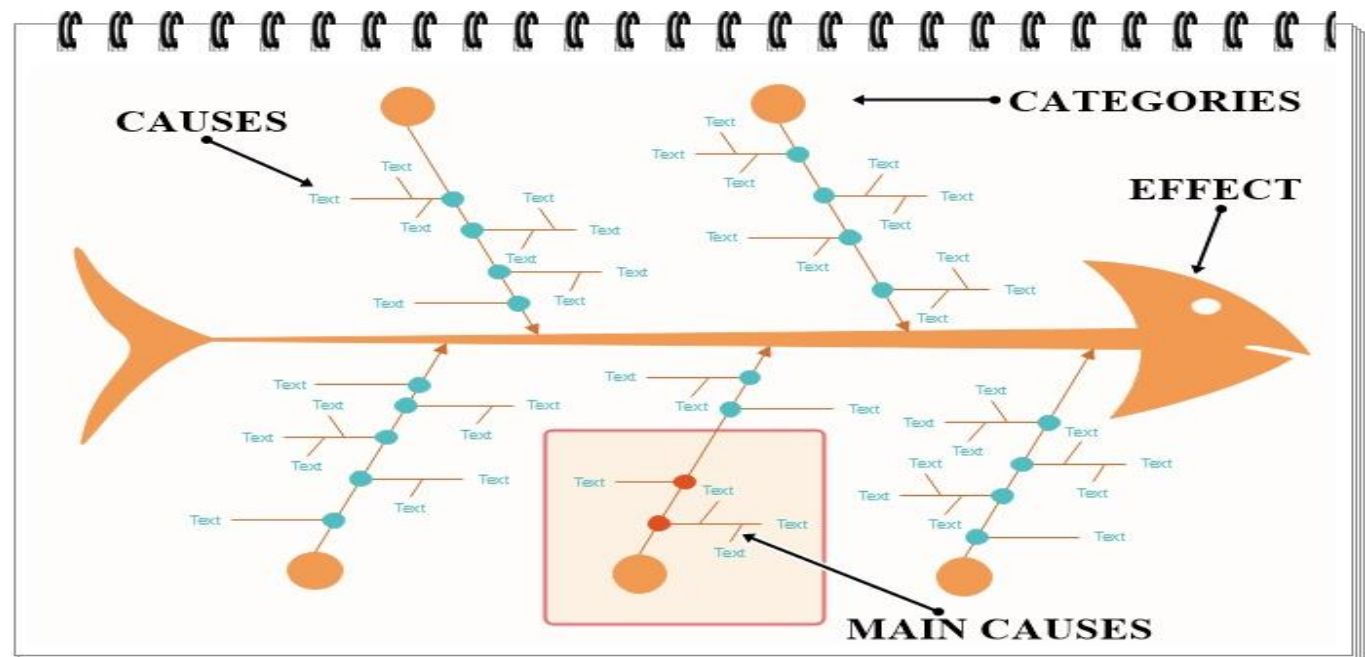


Figure 3 - Causes and Effect Diagram Example

Source: Adapted from Edraw Max version 9.4.1

### 2.3.4 Cause and Effect Diagram

Created by Dr. Kaoru Ishikawa, it is a well known quality tool used to determine the causes of a given effect. According to Tubino (2007), the cause and effect diagram allows complex processes to be divided into simpler and therefore more controllable processes. Which means that the effects would be split into

several other minor problems. In other words, the diagram helps to get an overview of the problem, making it easier to understand the solutions to them.

The cause and effect diagram is a figure composed by an effect, the categories and causes (Figure 3), which represent a significant relationship between an effect and its possible causes. There are probably several categories of major causes. Often these fall into one of the following categories: Man, Machines, Methods, Materials, Measure, Environment (Meio Ambiente) known in Brazil as the 6Ms (RAMOS, 2000, p. 98).

In Japan, this tool is used also to identify causes to explain why a project is successful or for prevention reasons (Figure 4).

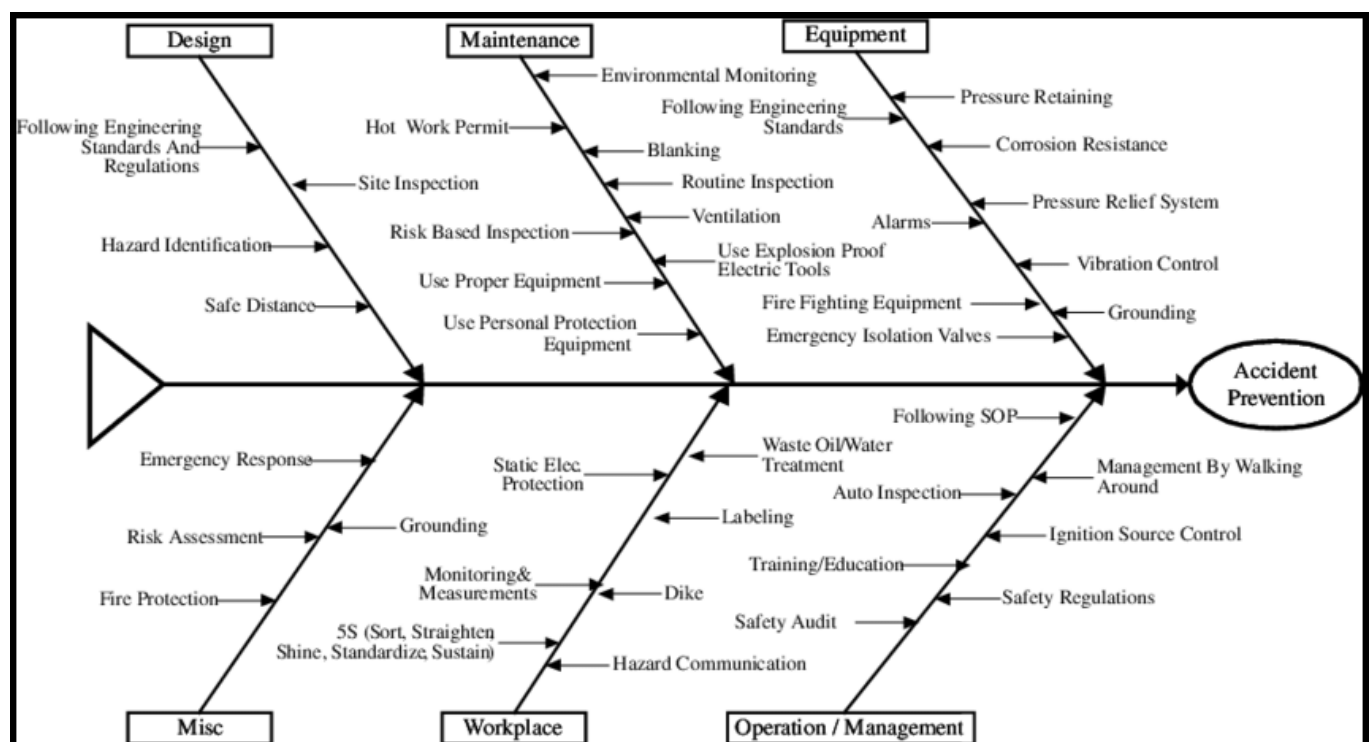


Figure 4 – An example of cause and effect diagram used for prevention aims

Source: Chang and Lin (2006 p. 55)

### 2.3.5 Flowchart

The flowchart is the diagram that represent various stages of the process. Diagrams are made up of sequential decision and action steps, each of which has its own symbology that helps to understand the system of its nature. Much of the variation in a process can be eliminated only when the manufacturing process is known. This means that the production sequence, or stages, influences the ultimate variability of product characteristics (RAMOS, 2000 p. 102).

A flowchart can be used for project development, project management, development of knowledge, to improve communication, process, as well as to identify risks and contribute to solve problems (TAGUE, 2005 p. 7 and 8).

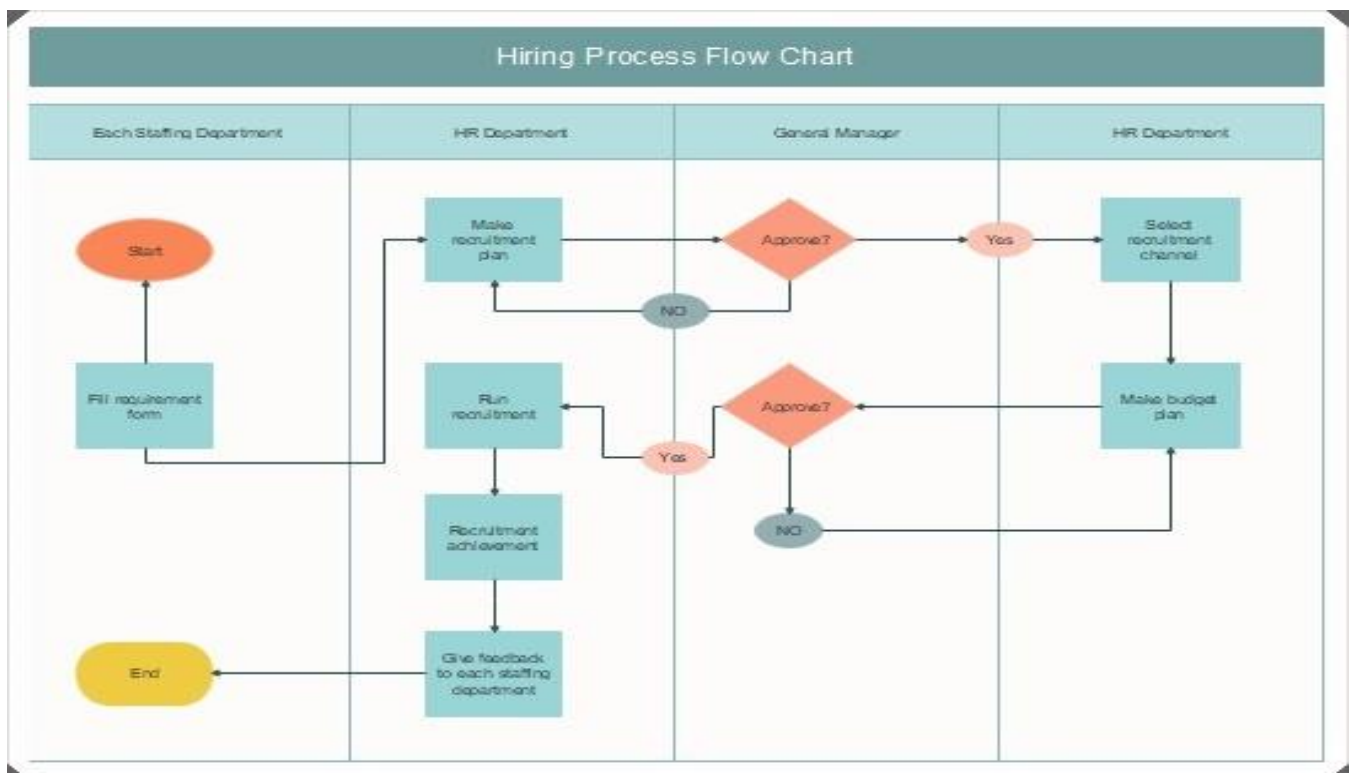


Figure 5 – Example of Functional Flow Chart

Source: EdrawMax 9.4.1 version

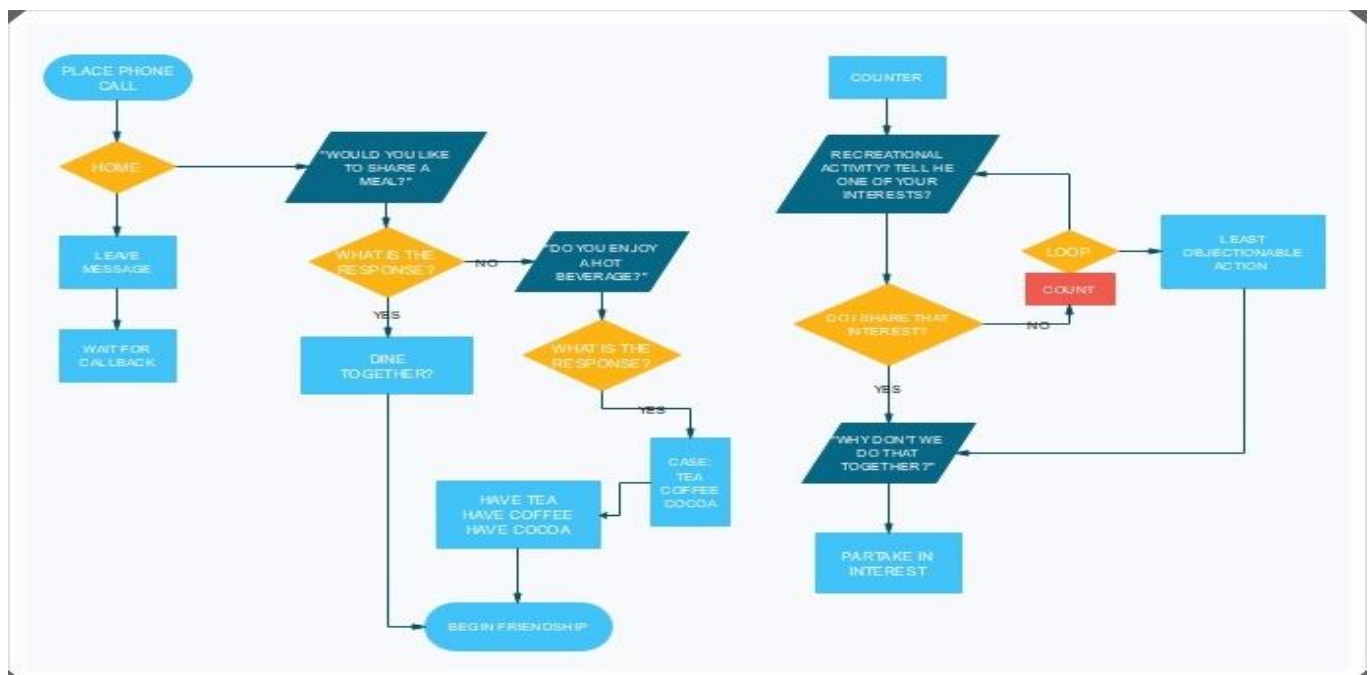


Figure 6 – Example of two Linear Flow Chart

Source: EdrawMax 9.4.1 version

Granfelt (2017) proposed some orientations to help micro and small businesses to understand how to use flowcharts to document their processes, including suggestions of some software. However, since the valuable contributions of Frank and Lilian Gilbreth (GILBRETH; GILBRETH, 1921), as well as Goldstine and Neumann (1947 and 1948), several evolutions happened with flowcharts, from the



standardization (ISO 1028:1973; ISO 5807: 1985; ANSI 2016) with guidance, until the creation of several types of flowchart in the market such as functional (Figure 5), linear (Figure 6) and vertical (Figure 7).

VERTICAL FLOWCHART						Lead Time (in hour):		04:14:34	
Main symbol	■	Operation	Total	10	02:14:24	52,80%	Company: X		
	➡	Transfer of material		0	0	0,00%	Type of process: Standard New		
	◆	Decision or Measure		5	2:00:10	47,20%	Process` name: Energy System Measurement		
	■	Documentation		0	0	0,00%	Department: Quality Assurance		
	▼	Storage		0	0	0,00%	Data: September 17th 2016		
Steps	Symbols					X Time	Accum.	% Accu	Type of operation and description
1	□	➡	◆	□	▼	00:04:00	00:04:00	1,6%	Manual: to prepare the sample and connecting the cables
2	□	➡	◆	□	▼	00:00:15	00:04:15	1,7%	Manual: open the Energy System Measurement
3	□	➡	◆	□	▼	00:01:44	00:05:59	2,4%	Manual: to insert sample data
4	□	➡	◆	□	▼	00:00:01	00:06:00	2,4%	Manual: to start the test by clicking START
5	□	➡	◆	□	▼	00:01:52	00:07:52	3,1%	Automatic: to stabilize sound and adjust image
6	□	➡	◆	□	▼	01:00:00	01:07:52	42,4%	Automatic: to put the sample in Standby mode
7	□	➡	◆	□	▼	00:40:00	01:47:52	42,4%	Automatic: to measure the power in static mode
8	□	➡	◆	□	▼	00:10:00	01:57:52	46,3%	Automatic: to measure the power in dynamic mode
9	□	➡	◆	□	▼	00:10:00	02:07:52	50,2%	Automatic: to measure the power in internet mode
10	□	➡	◆	□	▼	00:00:05	02:07:57	50,3%	Automatic: to set up the sample for the factory mode
11	□	➡	◆	□	▼	01:00:00	03:07:57	73,8%	Automatic: to put the sample in Standby mode
12	□	➡	◆	□	▼	01:00:00	04:07:57	97,40%	Automatic: to measure the power in Standby mode
13	□	➡	◆	□	▼	00:00:10	04:08:07	97,47%	Automatic: to measure the area and the screen visible diagonal
14	□	➡	◆	□	▼	00:00:10	04:08:17	97,53%	Automatic: to generate the report
15	□	➡	◆	□	▼	00:06:17	04:14:34	100,00%	Manual: to pack the sample

Figure 7 – Example of a Vertical Flow Chart

Source: Author

### 2.3.6 5W1H or 5W2H

According to Candidio (2009), it is a recommended quality method for the elaboration of the action plan. Its construction is simple, widely used by organizations.

For each goal to be performed, there is the establishment of the actions to be performed, as well as the deadlines and responsible for each of them. In addition, all actions to be developed are in the form of a schedule. Basically, it consists of answering 7 questions: What?; Where?; Who?; When?; Why? How and How much (optional) ?

The 5W2H is used to diagnose a problem and built a plan actions. The method visualize the appropriate solution of a problem, with possibilities of monitoring the execution of an action. Seeking to facilitate understanding by defining methods, deadlines, responsibilities, objectives and resources. To illustrate, Figure 8 shows parts of an Action Plan developed in 2018 by Industrial Engineering Course of FT/UFAM

to help graduate students to decide the immigration or not to a new Pedagogical Project Course.

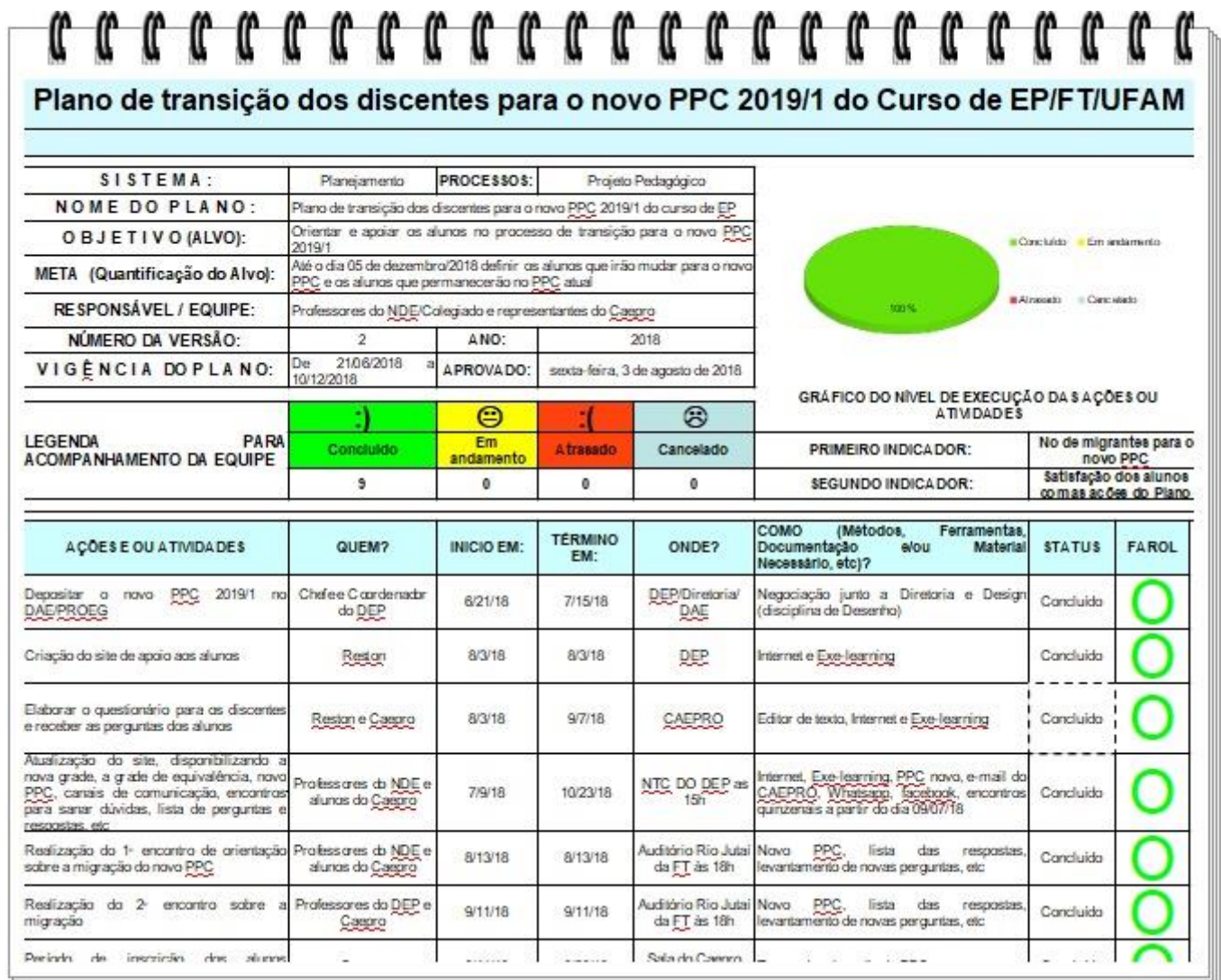


Figure 8 – Example of an Action Plan developed by using 5W1H method.

Source: Author

### 3. Case study profile

The study was conducted at Shopping X, located in the city of Manaus, on Djalma Batista Avenue, an interconnection road for the entire city, reason by which it is one of the most popular shopping malls in Amazon's capital. This scenario contributes to the ranking of 13th place as the highest revenue mall for the company that manages it.

The research was specifically carried out with the mall's operations sector, whose main function is parking control, which has 1,754 vacancies, 1,185 of which are located in the garage building that supports most of vehicles; 59 in the VIP parking; 76 in motorcycle parking and 434 vacancies in open areas near the main shopping access entrances.

According to reports extracted from the parking system used in the mall itself, the flow on normal days (considered here, days without promotion and far from festive dates) is 800 to 900 vehicles; On holidays, holidays and promotional periods, the flow is between 1,000 and 1,080 cars, including motorcycles.



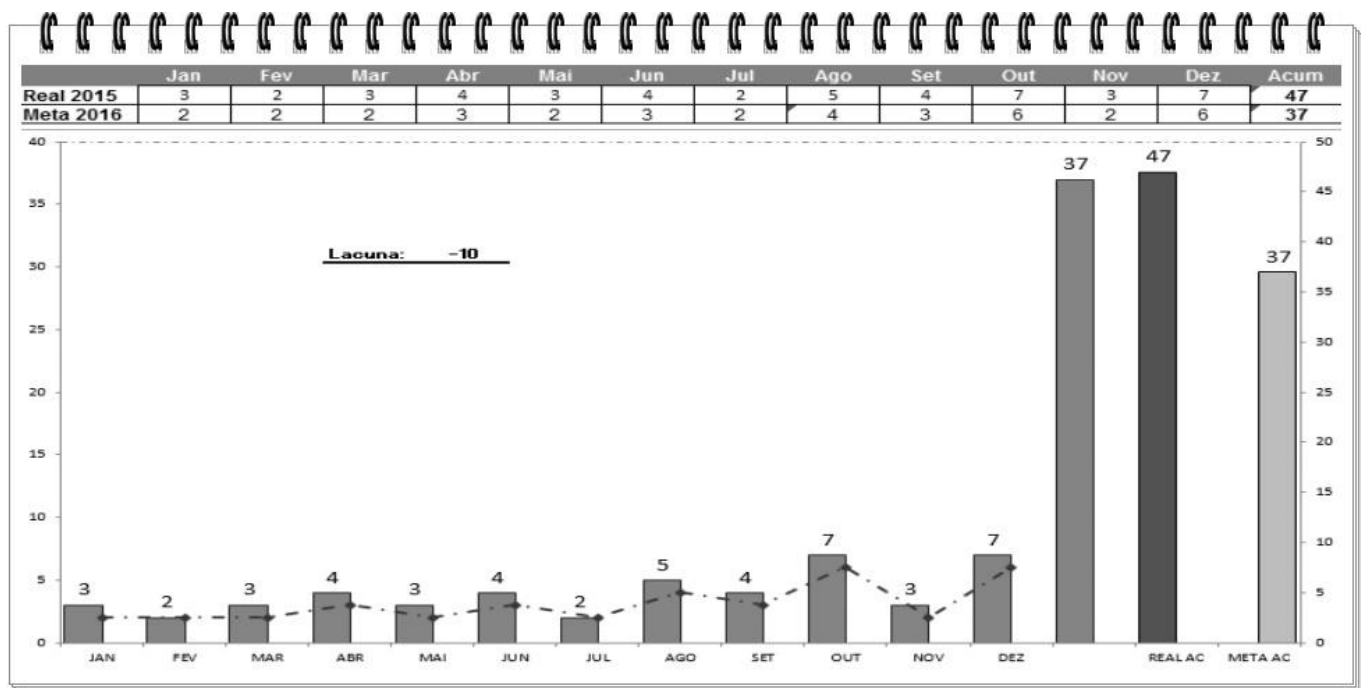


Figure 9 – Complaints numbers (Real 2015 x Target 2016)

Source: Author (2016)

In the last year of 2015, the department diagnosed a considerable increase in complaints related to parking robberies and theft. The number of customer service reports (CSS) has been tracked by managers on a daily basis, as well as expenses related to refunds and reimbursements arising from this issue.

Figure 9 shows the number of complaints (excluding material damage from this analysis, verifying only robberies and thefts), which occurred in 2015, as well as a management goal set for 2016: reduce the number of complaints by 20% in relation to each month of the previous year.

#### 4. Methodology

This is an applied research, characterized as quantitative, because the collected data were pointed numerically according to the frequency of reports and expenses raised monthly in relation to shopping mall claims. It is also considered as qualitative since it is a case study with biography and document investigations. It was part of a research plan developed by the author to conclude the Industrial Engineering Course at FT/UFAM. The stages of the research are detailed in Chart 2, prepared between the second semester of 2016 and the first semester of 2017.

With respect to data collection, it happen between December 2 and 16, 2016. Much of the data was already recorded in spreadsheets and competency reports of the Customer Service System (CSS) and others were extracted from the accounting balance of the parking companies responsible for operating the parking service.

CSS reports and spreadsheets record information on general claims, such as: vehicle breakdowns, as well as parking robberies and theft. The number of alleged robbery and theft occurrences was recorded daily over a two-year period from January 2015 to December 2016 by CSS assistants. These records were compiled in spreadsheets and subsequently viewed in graphs and tables for better understanding.

The accounting balances of parking companies have a field of operating expenses, which can verify the amount paid in claims. For this research, were raised monthly amounts paid, from January 2015 to December 2016, with parking robberies and theft. These costs have been digitized into spreadsheets, especially for charting. In addition, attached with the monthly balance sheets, there are all justifications for reimbursement forwarded by the legal, thus enabling the investigation of possible causes of service delivery of the mall with regard to customer safety.

After gathering the information mentioned above, the data were analyzed from December 16, 2016 to January 21, 2017. In this analysis we used the main quality tools already mentioned through spreadsheets to propose robberies and theft reduction solutions in the Parking.

Schedule 2016 and 2017	November	December	January	February
Presentation of article template	04			
Theme presentation	04			
Introduction	04 – 08			
Development: discussion presentation of the bibliographic review	18/11 - 02/12			
Data collect		02 - 16		
Data analysis		16/12 - 21/01		
Discussion of results			21/01 - 11/02	
Final considerations and delivery to advisor			21/01 - 11/02	
Simulation of presentation and article correction				11 - 15
Slide and article improvements				15 - 18
Article defense				22 - 24

Chart 2 - Research plan

Source: Author (2016)

## 5. Discussion

The discussion of the results took place from January 21 to February 11, 2017. For a better understanding of the results it was necessary to investigate:

First) the history of occurrences of accidents in the parking lot, in order to quantify robberies and theft records;

Second) the history of reimbursement expenses, with the purpose of measuring the amount paid monthly with reimbursements;

Third) the possible causes related to compensation;

Fourth) and stratify the occurrence by location, in order to understand which parking areas have the highest occurrence record;

Fifth) the main causes with compensations;

Sixth) and classify the causes that most impact the results, prioritizing actions to reduce them.

### 5.1. Occurrence of Parking Claims

According to information recorded by the Customer Service System, in 2015, the number of claims

reported by the mall's customers is 47, with attention to the months of October and December, where there can be noted the spikes of events related to parking claims. These values can be explained in these months due to the higher vehicle flow that is directly related to promotion periods and holiday season dates.

Compared to 2015, Figure 10 demonstrates that 2016 started with an increasing number of reports, which can be observed until May, in the following months, there was a reduction in complaints. This reduction may be justified by the hiring of an employee to supervise the parking of motorcycles, as well as the free use of luggage storage for the storage of helmets. However, this reduction was not significant regarding the management target set for 2016, 20% compared to 2015, so it was necessary to obtain a maximum of 11 CSS records related to robberies and thefts.

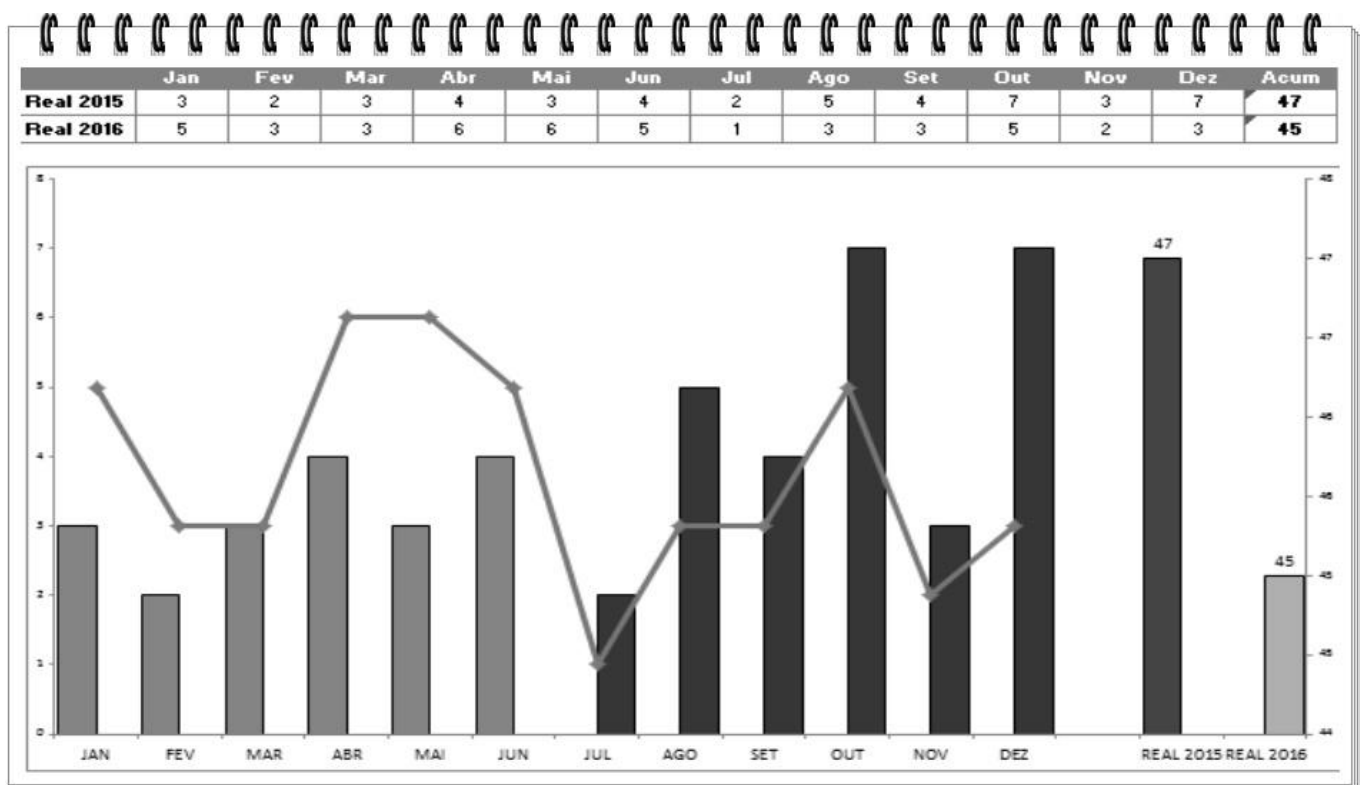


Figure 10 – Number of occurrences of Parking Claims (2015 x 2016)

Source: Author (2016)

## 5.2. Claim Expense History

The Figure 11 shows the amount paid monthly with parking claims reimbursements.

In 2015, the accumulated R\$ 29,737.41 represents a significant amount when compared to 2016. In the latter there was a significant reduction in expenses of this kind.

This is due to some actions implemented such as hiring employees and space to store the helmets, as already mentioned in the previous item.

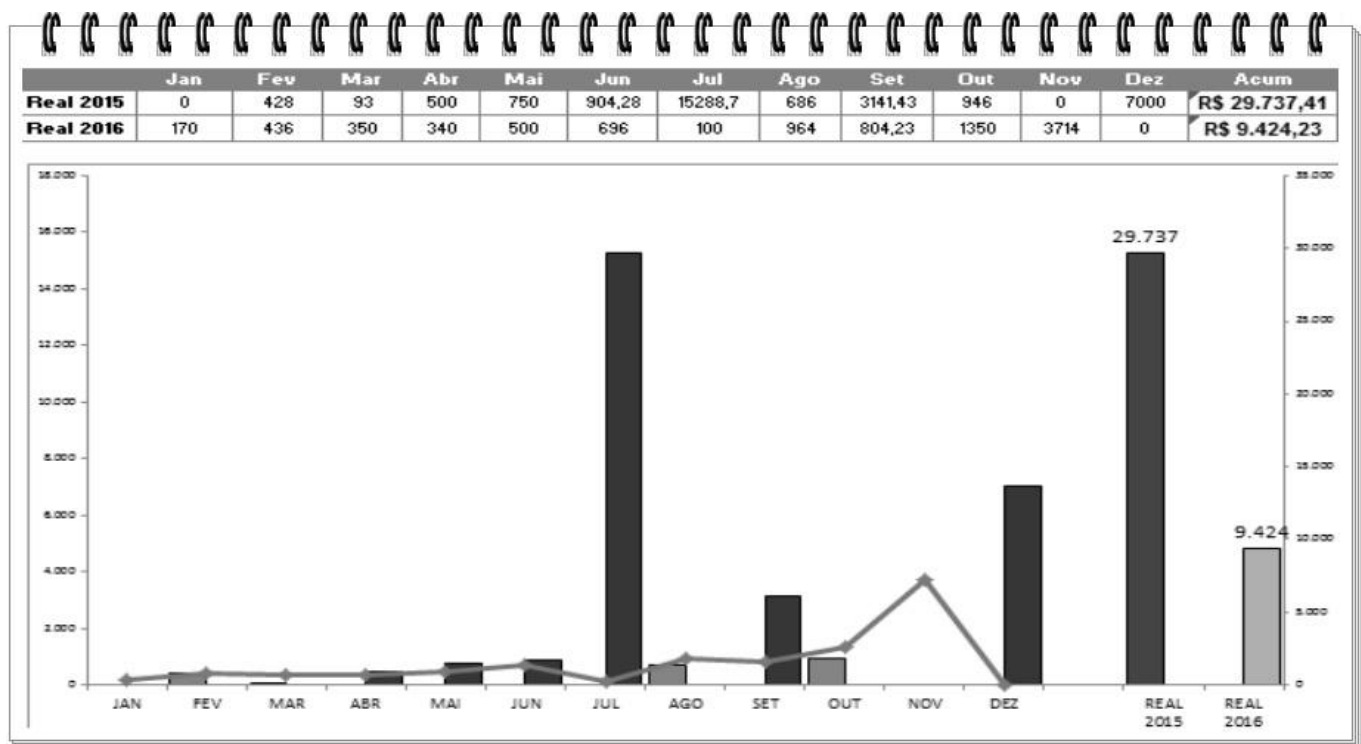


Figure 11 - Expenses with Compensations (2015 x 2016)

Source: Author (2016)

### 5.3. Possible Causes Related to Compensation

To discriminate the possible causes related to the considerable payment with reimbursements, it was used the cause and effect diagram that follows as Figure 12. Noting that the completion of this tool was performed with managers and parking operators.

Among the causes considered for theft in motorcycle parking was the signaling warning to customers to take the helmet with him or to keep it in the space intended for this, which is insufficient for the number of spaces available. There is only one sign in the parking lot giving orientation to not leave the helmet on the bike. For the left volume locker, there are 30 for 76 spaces. In addition, the hypothesis of inadequate guidance given to customers by employees staying in the parking has been hypothesized, they should guide customers as signposts suggest.

Regarding theft occurrences located in the VIP area, it is known that the checklist of vehicles is a standard procedure that must be performed, but in some cases the document is not filled due to the high flow of cars.

Regarding the cases that occur in the garage building and in outside parking areas, the possible cause is due to the absence of images that can prove that this happened, which is directly related to the positioning of the cameras in these locations.

In addition, there are rounds at specific times in all these areas, but they have not been appropriate, which may be related to the poor positioning of the rounds, and it is necessary to readjust them in the hardest hit areas.

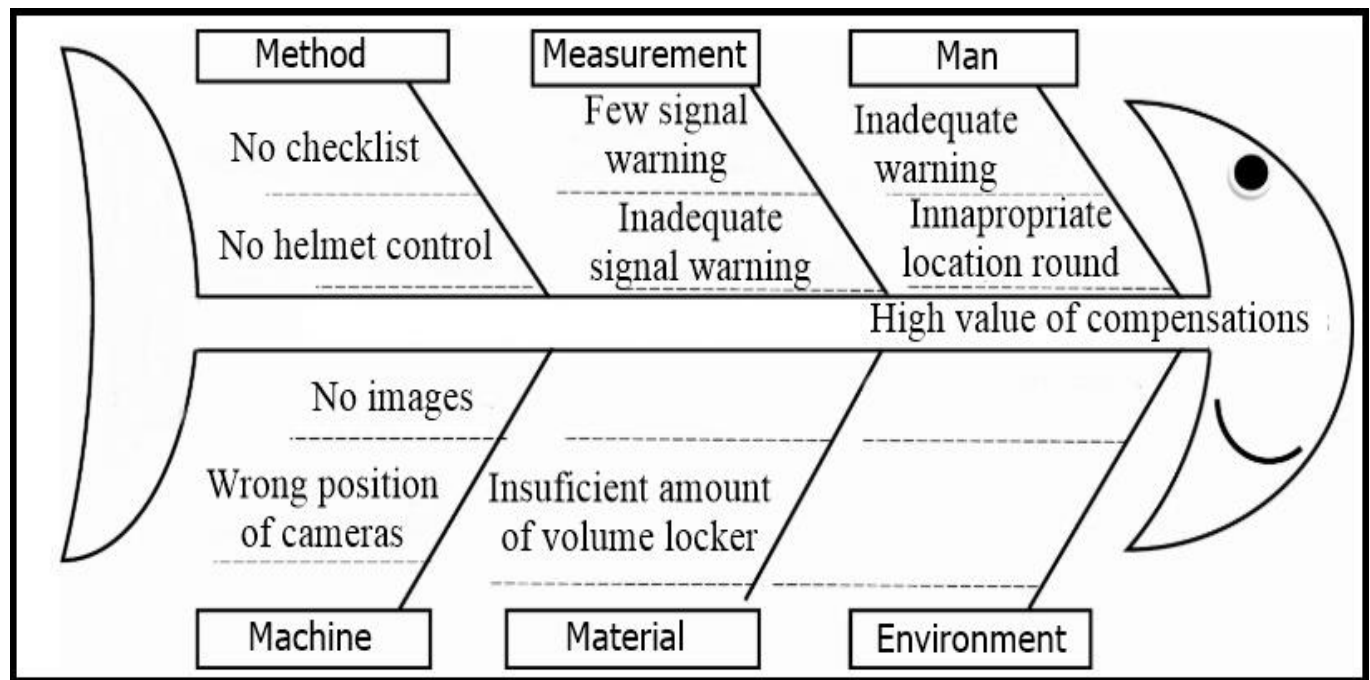


Figure 12 - Possible causes related to the high value with compensations

Source: Author (2016)

#### 5.4 Claim Stratification by Location

To better understand the data recorded by the CSS in 2015 and 2016, it was necessary, first, to understand the parking areas most affected by robberies and thefts (Figure 13) by location in 2015.

Figure 13 shows the percentage of parking lot robberies and thefts reported by customers in 2015. It can be seen that among the 12 mapped areas, motorcycle parking is the place with the most reports related to robberies and thefts, with 41.7% of occurrences. The second most critical location is G1, with 21.7%.

It is important to note that these areas are the closest to the main entrance to the mall, located in the middle of Darcy Vargas Avenue, which concentrates a very expressive daily flow.

In 2016 (Figure 14), motorcycle parking and the G1 remain the critical areas. However, it can be verified a reduction of claims occurred in G1, comparing with 2015, this finding can be justified by the renting of the space for marketing events.

In short, motorcycle parking is the area most targeted by villains. In addition, it is possible to verify that the VIP area, despite not having a considerable percentage of claims, is a place of attention, as the region is controlled by the parking valet and is widely used by customers with higher purchasing power.

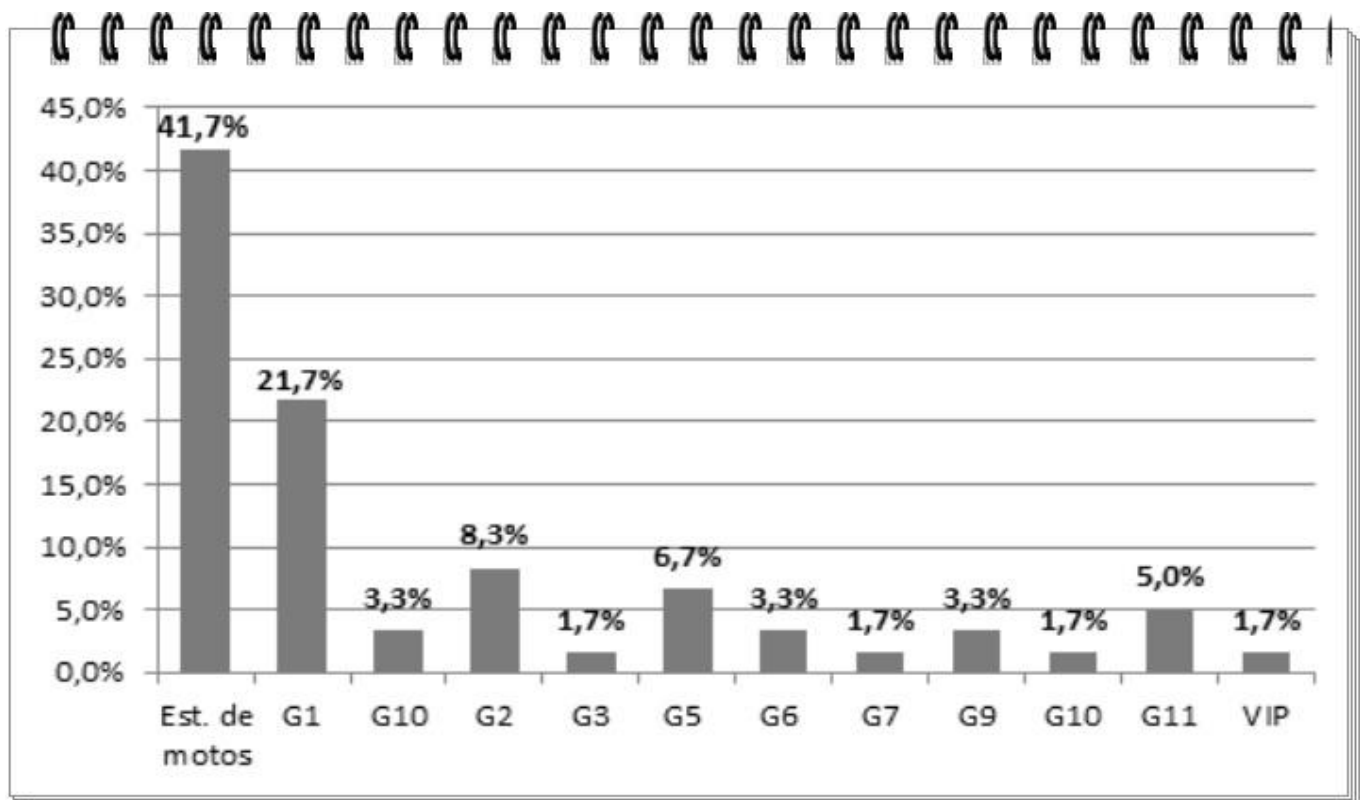


Figure 13 - Percentage of Claims by Location in 2015

Source: Author (2016)

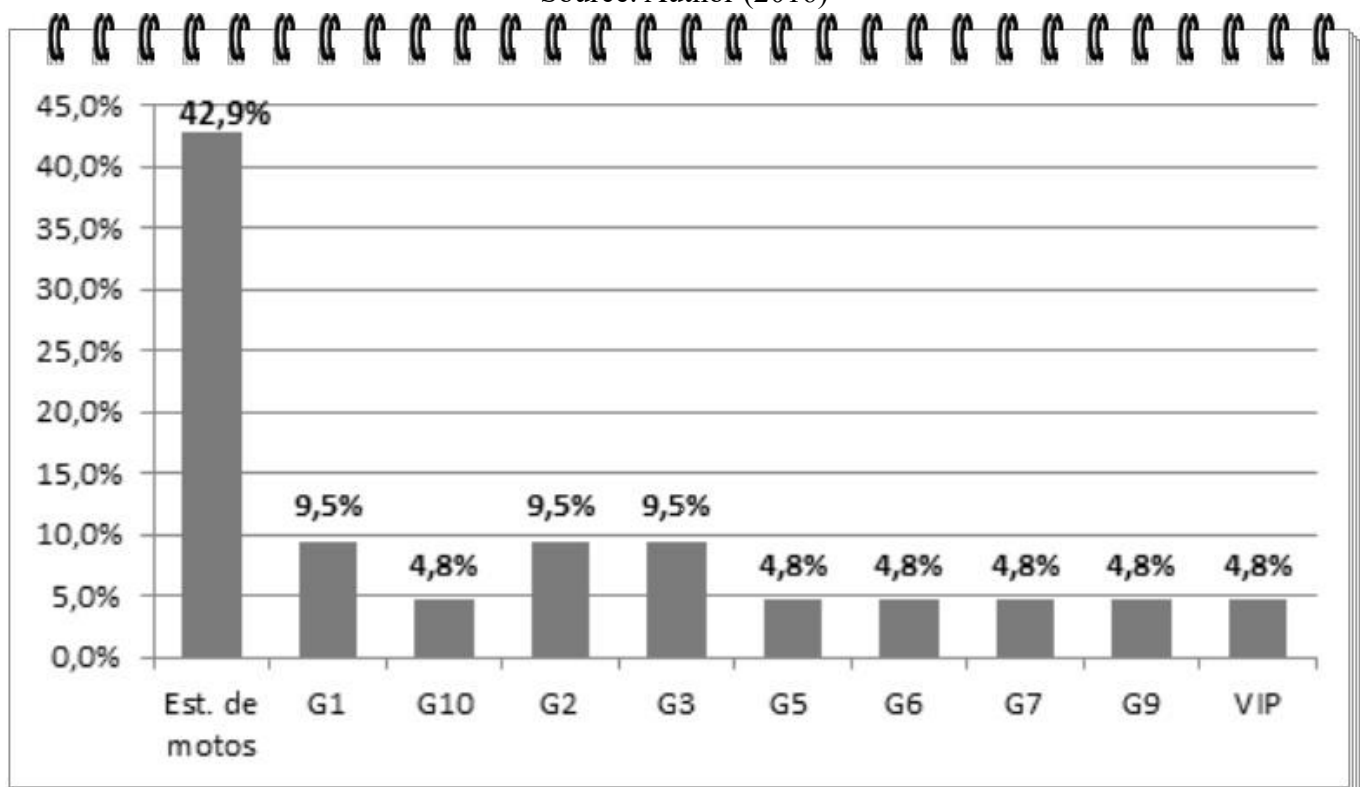


Figure 14 - Percentage of Claims by Location in 2016

Source: Author (2016)

### 5.5 Top Causes of Motorcycle, G1 and VIP Parking Claims

In this analysis, all accounting statements and reimbursement responses sent by the legal entity for each

specific case were considered.

Considering Chart 3, it can be seen that the mall reimbursed 42 cases related to helmet thefts in 2015 and 2016. In these cases, the legal department advised compensation for failing to provide services such as:

- a) the absence or insufficient space to store helmets;
- b) lack of signs in the motorcycle parking informing the customer to take the helmet with them when all luggage is occupied and not to leave the helmet on the motorcycle, storing it in a designated place, as directed by the mall.

As for the theft of money, cases that occurred in the VIP parking lot, the legal department suggested compensation for not filling the check-in list of vehicles, which is directly related to workforce failures. It must be filled daily by the valet hired for this and other functions.

In cases related to steppe theft and other belongings of less value, the compensation occurred due to the lack of camera images in specific locations of the garage building, which may be related to the poor positioning of the cameras. In the garage building, cameras are placed at the entrance of each floor, making it difficult to keep up with possible theft or suspicious movement near vehicles.

In addition, it can be seen (Chart 3) that approximately R\$ 22 thousand were spent in 2015 and 2016 on expenses for the reimbursement of helmet theft in motorcycle parking.

Items	Helmet	Money	Steppe	Other
2015	22	5	7	13
2016	20	7	8	10
Total Frequency	42	12	15	23
Cause	Little or no storage; signs	VIP checklist not completed	No camera images	No camera images
Expenses (R \$)	R\$ 22.322,13	R\$ 235,00	R\$ 1.120,00	R\$ 15.484,51

Chart 3 - Compensations data (2015 and 2016)

Source: Author (2016)

### 5.6 Prioritization of Actions

As shown in Figure 15, more than half (55%) of reimbursements are related to insufficient storage (volume locker) and inadequate signage in motorcycle parking.

Given this finding, some cheap actions to reduce helmet theft expenses will be suggested.

After conducting a study on how to reduce helmet theft, it was suggested two actions:

Tag Control and Helmet Lock Control.

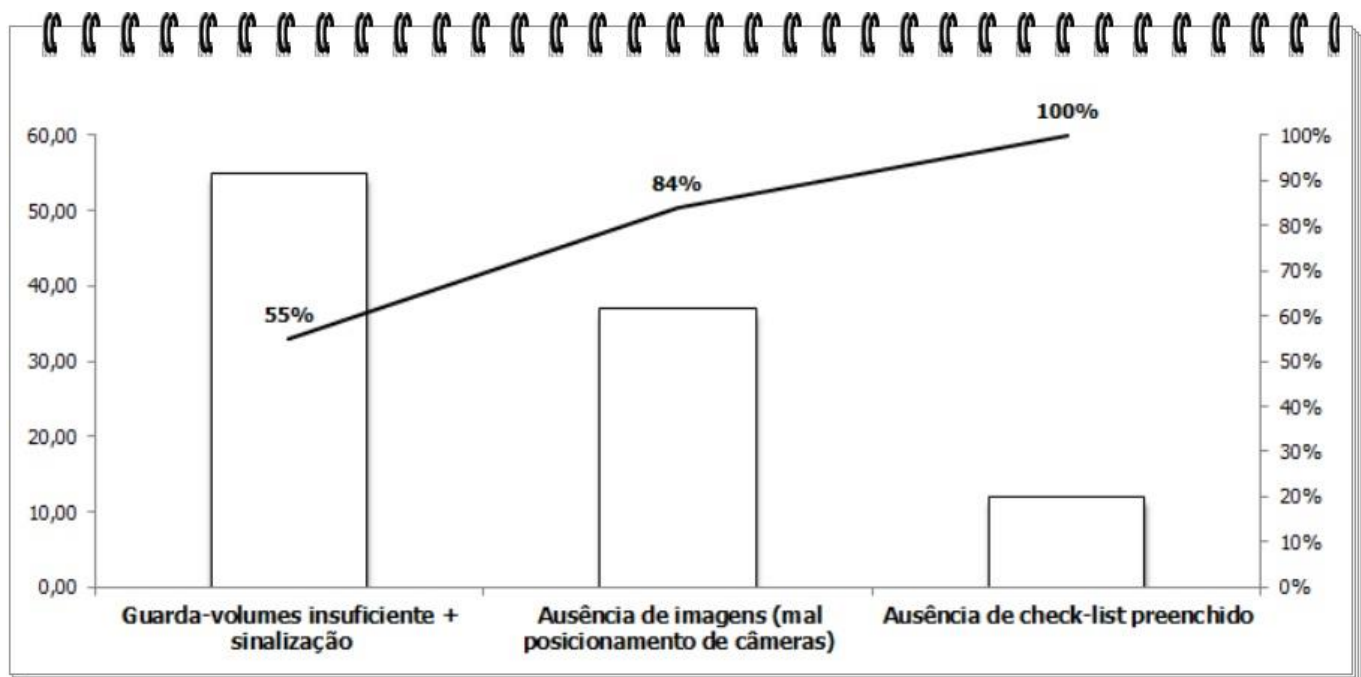


Figure 15 - Main causes that impact reimbursement expenses

Source: Author (2016)

### 5.6.1 Tag Control

This proposal is based on a tag control. With the help of a label maker, as shown in Figure 16, the employee in the motorcycle parking lot would approach each customer as soon as he entered and exited the parking lot, performing the five steps of the procedure shown in Figure 17.



Figure 16 - Brother Pt 80 Labeler

Source: Free Market.



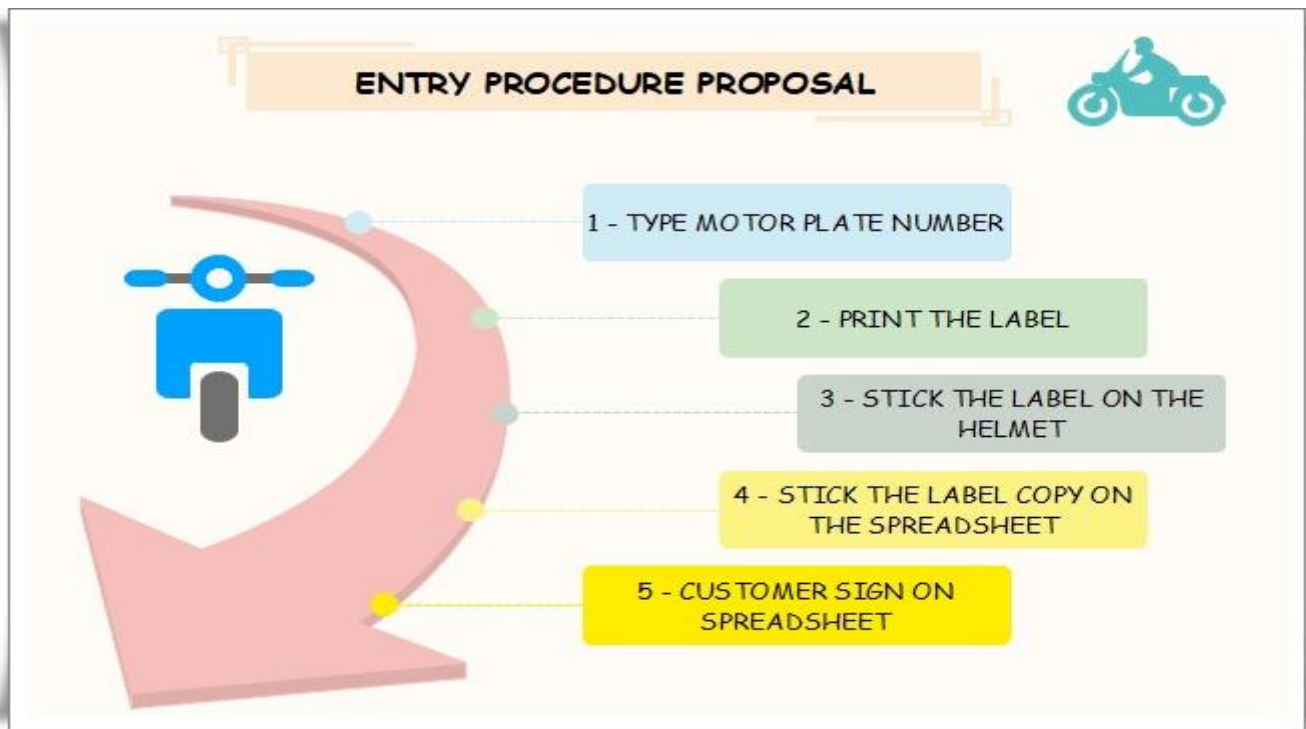


Figure 17 – Entry procedure proposed flowchart  
Source: Author (2016)

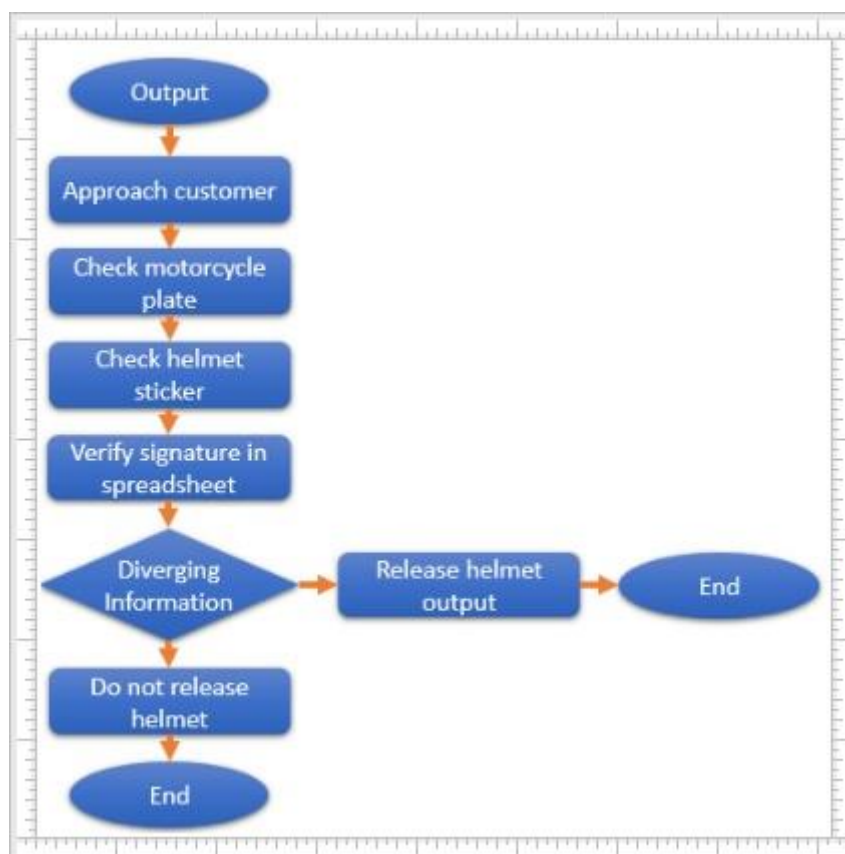


Figure 18 - Exit Procedure Flowchart proposal  
Source: Author (2016)

Basically, it will take five steps, to type the motorcycle license plate, print the label, stick it to the helmet and a control sheet, and request the customer's signature. The spreadsheet should contain at least two fields, one for pasting the label and the last for customer signing.

The checkout procedure (Figure 18) is just a conference, the employee with the control sheet in hand would approach the customer at the checkout terminal to verify the label on the helmet by crossing this information with the worksheet. With converging information, the customer would be released, otherwise the helmet exit would not be allowed. In cases where the customer does not have a helmet label or control sheet record, the customer would normally be released, indicating that the employee located in the parking lot has failed.

After propose the two procedures, it was made a market research to identify the most viable solutions, as a result, Chart 4 presents the resources to be used, as well as acquisition costs, with the lowest market prices according to the free market.

Resources	Lowest price
Brother Pt80 Labeler	R\$ 192.00
Brother Ribbon (231-Piece Reel)	R\$ 51.30
A4 Fill Paper (500 pcs)	R\$ 168.85
TOTAL	R\$ 261.14

Chart 4 - Resources and Costs of the solutions

Source: Author (2016)

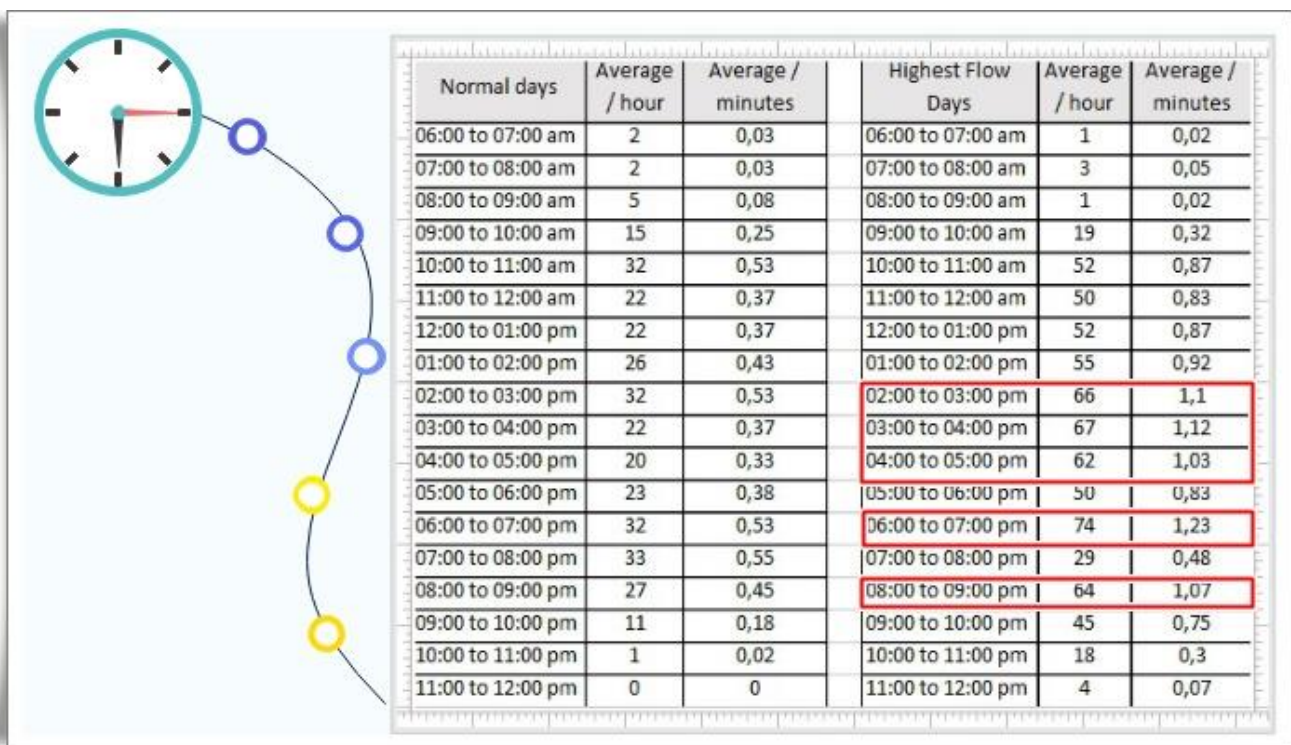


Figure 19 - Average time (in min) of motorcycles in normal and highest flow days

Source: Author (2016)

The solution presented requires time to execute, so for the simulation purposes, several parking reports

have been pulled from the system to evaluate the parking entry flow per hour on high and low flow days. Figure 19 shows an average time of motors per minute on normal (excluding weekends, promotional and holiday periods) and in highest flow days. In this accounting were chosen 3 days of January and 3 days of February 2015.

It can be seen that the motorcycle flow per minute is less than 1, so that the checklist can be completed and the procedures described could be executed in appropriate time.

Already on high flow days (this weekends, holidays and promotion periods have entered this calculation) the average of bikes per minute is approximately 1, only in some specific hours as highlighted in red color. This finding is not disadvantageous, since the employee would be able to do the two procedures suggested. According to specifications of the labeler (Figure 16), the print speed is a maximum of 7.5 mm per second, making it possible to perform the entire procedure.

### 5.6.2 Helmet Lock Control

Control by helmet locks is one of the simplest proposals among those mentioned.

It does not require any manual control, just that the motorcycle parking attendant approached the customer when he entered, would later attach the helmet to the motorcycle with the help of one of the suggested locks below and save the key, in cases where exist. On leaving, the client would ask the employee to unlock the helmet and he would be released.

Figure 20 presents options for keyed helmet locks that will be held by the employee. These options are the best priced on the market, however, they are easy to damage. However, with the frequent presence of the employee overseeing the parking lot, this would not be a serious problem, because even if the employee was absent from the parking lot, it would take some time to be able to violate one of these materials.



Figure 20 - Option 1 and 2 for Helmet Locks

Source: Free Market

On the other hand (Figure 21), option 3 is a hard-coded helmet lock. Very simple to apply, having the advantage of establishing a unique helmet release code that would only be known to the parking attendant. The only disadvantage is that its acquisition cost is relatively higher than the other options mentioned above.



Figure 21 - Option 3 for Code Helmet Lock

Source: Free Market

Finally, Chart 5 shows a column recording the acquisition value for 45 units of each option mentioned above, this amount (45) is the difference from the 75 spaces with 30 luggage storage units that motorcycle parking already has.

Resource	Lowest price	Price of 45 units
Option 1 - Key Lock	R\$ 24.99	R\$ 1.124,55
Option 2 - Key Lock	R\$ 49.90	R\$ 2.245,50
Option 1 - Code Lock	R\$ 199.00	R\$ 8.955,00

Chart 5 - Optional Features and Costs of the products

Source: Author (2016)

## 6. Final Considerations

The general objective is to analyze and suggest economic actions to reduce the amount of robberies and thefts in shopping mall motorcycle parking X. The following specific objectives are: 1) Map the parking areas and their surroundings with the highest number of accidents; 2) Identify the causes related to the problem, as well as possible solutions; 3) Select the most viable solutions with their respective budgets as proposals for improvements to reduce robberies and thefts in the parking.

Data collection and analysis were performed in the Shopping X Operations department. Data were mapped according to the occurrence of claims registered by the CSS. Through this information, it was possible to stratify the parking areas with the highest incidence of claims, revealing that parking motorcycles had 41.7% and 42.9%, in 2015 and 2016, respectively, the highest percentage of thefts, with G1 being the second parking area with approximately 20% of occurrences.

Subsequently, possible causes related to theft in motorcycle parking and G1 were raised. In the first, the helmet was the most stolen object, having as its main causes the insufficient amount of luggage and signaling, arranged in the motorcycle parking lot. In the second, various types of belongings were stolen, having as main cause related to the absence of images from the cameras, due to their mispositioning. Without these images it was impossible for the legal entity to establish a non-compensation opinion. However, among the causes cited, the insufficient amount of luggage and signaling represent 55% of

reimbursement expenses, meaning that most reimbursements are related to helmet thefts in motorcycle parking.

Given the above scenario, actions were suggested in order to reduce such problem. The first proposed solution was to control the entry and exit of the motorcycles using a label labeler, with an investment cost of only R\$ 261.14. The second proposal focused on the control of helmets by key locks, option 1 and 2, and code, option 3. Being the cheapest option 1, approximately, R\$ 1,000.00 and the most expensive option 3 costs R\$ 8,955.00. This amount of 45 locks is considered enough to meet the demand of 75 vacancies. Option 2 is the best cost-effective choice, because the investment is not so high and the process control would not require much execution time.

The main lessons learned were the use of quality tools for schematic and problem solving, as well as generic knowledge about the mall market and its security systems that are constantly disclosed by ABRASCE.

One limitation of the research was regarding the disclosure of images of the parking areas studied, being restricted due to the organization's confidentiality policy. Thus, it is suggested that the mall managers opt for the solution proposal that is within their budgets and can contribute significantly in reducing theft and helmet theft. And for future research, it is recommended to investigate the impact of the news procedures on the reduction of robberies and thefts, as well as on customer satisfaction.

## 7. Acknowledgments

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## **Proposed Use of Photovoltaic Energy in a Traffic Light System**

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### **Abstract**

*The implementation of the replacement of a conventional semaphore system with one powered by photovoltaic energy in the city of Manaus. Nowadays, energy generation has been approached as one of the vitally important issues. The increasing demand for energy in the country and the importation of new technologies conditioned to the use of electricity have been demanding better energy planning, given the energy potential of the northern region for the implementation of a photovoltaic system directed to the semaphore system. In this scenario it is important to identify the impacts caused by the replacement of incandescent lamps with LED technology with the consequent reduction of energy consumption and maintenance costs. In addition, the purpose of this study is the inclusion of photovoltaic panels in traffic lights, seeking a sustainable form of operation. It is noteworthy that the process of analyzing the results of this project was based on measurements made before and after the replacement of the equipment, thus reflecting the actual values of electricity consumption and active power demand.*

**Keywords:** Solar energy; Traffic lights; Energy efficiency;

## 1. Introduction

Some energy efficiency projects focused on traffic lights have been carried out in Brazil in recent years. One of the major changes to increase efficiency at a second traffic light [1] is the replacement of incandescent bulbs with light assemblies composed of light-emitting semiconductors, called LEDs - Light Emitter Diode, which convert electricity into light radiation.

With the purpose of seeking greater energy action, reducing demand during peak hours and reducing electricity consumption, as well as improving the conditions of signaling services, these incandescent bulbs are being gradually replaced by LED light assemblies. [2]. For intersection interventions with maintenance traffic lights, the less time the equipment is turned off or defective, the better the traffic flow.

The text also highlights its maintenance, given the facts it is clear that the country has a large number of traffic lights in continuous operation and consuming energy 24 hours a day. In this type of signaling, according to [3] incandescent lamps have always been used, whose use is being abolished for the inclusion of new more economical technologies. To reduce all this installed power, energy efficiency measures are required in this equipment.

In this line of thought with the constant growth of electricity demand, it is increasingly necessary to search for projects that aim at energy self-sufficiency, thus reducing the overload on the national electricity system and developing the concept of distributed generation. In this regard, the viability of the photovoltaic power system in a semaphore array system powered by photovoltaic solar panels becomes quite reasonable for the Municipality.

With regard to the photovoltaic generator system, the studies by Edmond Becquerel, who in 1839 first observed the photovoltaic effect, when dipping silver and platinum metal plates in an electrolyte, noticed a small potential difference when the plates were exposed to light. About fifty years later, Hertz, when experimenting with electrolytic cells, observed that when exposed to the incidence of ultraviolet light, it caused air to rupture with a smaller potential difference between its electrodes and then deduced that metals emitted electrons by the action of light [ 4].

In 1873, W. Smith observed the ability of light to conduct selenium, called photoconductivity, where Siemens designed a photometer, emphasizing the phenomenon. Seven years later Fritts built the first photovoltaic cell, with approximately 1% efficiency [5]. Only in 1954 was the first photovoltaic cell presented, which was developed half a year earlier by Bell Labs scientists (Calvin Fuller and Gerald Pearson), with approximately two square centimeters in area and 6% efficiency, generating approximately 5 mW of power. Around 1956, photovoltaic cells began to be produced industrially taking advantage of new microelectronics solutions and driven by the need to supply electricity to remote regions [6].

Solar energy is a term that refers to the energy coming from the light and heat of the sun, used by different evolving technologies such as solar heating, solar photovoltaic energy. The solar ray is transformed into electricity in a photovoltaic cell, made of materials called semiconductors, with silicon being the most used. Sunlight, made up of small elements called photons, when they reach the photovoltaic cell, part is absorbed by arousing the electrons of the semiconductor material, thus generating electricity.



The greater the intensity of sunlight, the greater the flow of electricity. In other words, we can say that the generation of electricity through light is via the use of photosensitive cells or commonly called photovoltaic cells, which grouped in modules or panels make up the photovoltaic solar panels [7]. In the authors' conception a system is composed by the panel, charge controller, accumulator and accessories, called as photovoltaic generator.

A semaphore set can, from this idea, use plates that capture sunlight on top of the device, where the traffic light uses an LED light that allows both the green, yellow and red signal to occupy the same single space, instead of three, thus being easier to supply it with solar energy, the differential of this type of traffic light for the others is the fact that it works by means of energy from the sun [8].

Unlike most semiconductors, the cell used in the manufacture of photovoltaic equipment does not use the normal silicon structure, as in LED and diodes, to increase the electrical conductivity of the material, a thin layer of transparent oxides is inserted [9]. In silicon, solar irradiation is converted into electrical energy through the photovoltaic effect, which consists in the generation of an electric potential difference through radiation. LEDs have great potential in the street lighting market. The energy savings that can be achieved and the improved lighting quality of cities due to the high color reproduction rate can now be seen in existing installations around the world.

The same author mentions that the photovoltaic effect occurs when photons strike atoms, causing the emission of electrons, generating electric current. This process does not depend on the amount of heat, on the contrary, the yield of the solar cell decreases when its temperature increases. The conversion efficiency of solar cells is measured by the proportion of solar radiation incident on the cell surface that is converted into electrical energy.

Like the weather-dependent photovoltaic panel, the use of equipment that ensures the power supply to the load during periods of insolation and at night is indispensable. In the design of the battery bank, two parameters must be considered: system autonomy (number of days the battery can meet the energy demand without the need for photovoltaic panels), and the depth of discharge (life-determining factor). , given the number of charge and discharge cycles) [2].

In some photovoltaic installations you can see a single panel made up of a large number of modules, but in fact you can have several panels from an electrical point of view. When the power of a panel is high, such that the generated electric currents are too large for the control devices, it is preferable to subdivide it into smaller panels, which can be accommodated in a single structure, and their connectors will be led to different connection boxes, and hence to the corresponding control devices.

The photovoltaic system is a process where the conversion of solar radiation into electricity occurs using a set of equipment for photon capture and absorption, even on cloudy or rainy days, but the greater the solar radiation the greater the amount of electricity produced. This system comprises a grouping of photovoltaic panels and other conventional equipment that transform, convert or store electrical energy so that it can be used in homes under the same conditions as conventional electrical energy [10]. Importantly, the photovoltaic system can be implemented as a power source in a semaphore system.

Among other factors, the design of a photovoltaic system involves the correct direction and inclination of the photovoltaic modules, availability of area for installation, the solar resource and the demand to be met [11]. With population growth and modernization of roads in the early twentieth century, cities began to

offer increasingly current products and new inventions such as cars, being one of the first motorized, the Ford T model, where only in the United States, the vehicle fleet jumped from 8,000 in 1900 to 2.5 million in 1908.

On American streets and in cities like London, England, cars mingled with carriages, bicycles, and pedestrians, who had less space. Soon several attempts to control traffic began to emerge. For [12] the first traffic light, dated 1868 was installed in London, with gas lights to be seen at night. It had two arms, moved by police: when they were horizontal, they indicated that the vehicles stopped; at 45 degrees, they should follow for less than a month since it exploded, injuring the policeman who was handling it.

Shortly after, in Berlin, Germany, towers were built in the middle of intersections with booths where police officers sat changing lights throughout the day. This type of tower has been altered for decades, used in New York since 1916.

From 1912 onwards, successive inventions gained notoriety in the United States, including the three-color sign, suitable for crossroads invented and installed by police officer William Potts in 1920 in Detroit. [12] Today, with an explosion in the increase of the vehicle fleet and, consequently, with the increasingly saturated streets and avenues, there are numerous conflicts at intersections. Coupled with this need for traffic organization, the safety of drivers, cyclists and pedestrians must be ensured.

Therefore, it is necessary to use traffic control equipment, as is the case of traffic lights, or simply traffic lights, which aims to optimize, standardize and control the right of passage of vehicles and pedestrians. For [12], the traffic light is a set of components that are installed at road intersections and is responsible for the light signals that indicate the right of way for drivers and pedestrians. To provide this light signaling, a whole structure capable of generating and bringing the color information of the controlling electronic element to the respective pathway is required. Being part of the composition elements as: semaphore controller; focus group; cables; pipes; columns and arm (Figure 1).

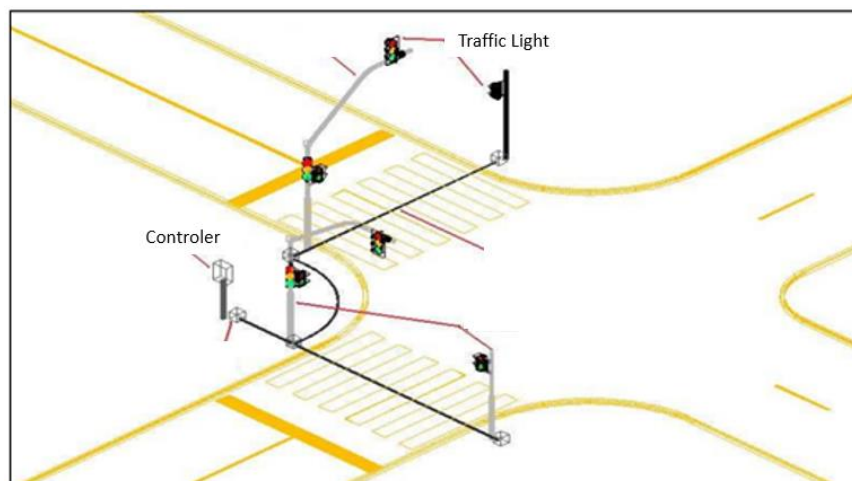


Figure 1 - Main structures of a traffic light

Source: [12]

The use of traffic lights at intersections is intended primarily to ensure two operational attributes: safety and flow. By alternating the right of use of the intersection area, the traffic light can contribute to reducing the time wasted on it, and the number of certain types of accidents. The design of operating a traffic light consists of the development of traffic light plans that optimize vehicle control at road

intersections to the best of their ability. The semaphore plane of a semaphore network consists of four elements: phase, cycle, interval and offset or offset. [13]

The semaphore control is the equipment that controls the color sequence and determines the signaling time of the traffic light by switching its lamps. It can be of the electromechanical type in simpler and older models, or electronic in current models. Nowadays automatic controllers that operate in different ways are used, depending on the type of equipment used, and are classified in three basic ways: fixed time controller, semi-actuated and actuated controller [14].

A. Fixed time semaphore controller: most common controller, operates following a predetermined time schedule. The determination of these parameters is based on the characteristics and average volumes of local traffic. When programmed, phase indication orders and durations will occur at the intersection until the controller settings are manually reprogrammed or the fixed duration setting is selected.

B. Semi-actuated controller: uses uncoordinated phase detectors to provide more flexible use of green time. A fixed length cycle remains in effect and the timing of each phase may vary. The addition of this degree of freedom in green time management is achieved by detectors installed and monitored.

C. Traffic-actuated semaphore controller: operate in real time, i.e. according to changes in vehicle or pedestrian traffic at the intersection. Environment information is captured through pedestrian crossing detectors or pushbuttons and sent to the controller who processes the information and responds according to the control strategy to which it was programmed. Its purpose is to dynamically adjust the traffic light control according to the traffic fluctuations that may occur at the intersection.

Given the facts, traffic lights depend essentially on a source of electricity and a light source for operation. In the case of traditional traffic light systems, which use tungsten filament incandescent lamps, in addition to low efficiency, the existence of a single filament results in frequent maintenance and increased traffic incidents due to faulty lamp inactivity. In these situations, the system may be compromised, malfunctioning and flashing yellow indicating signal failure [15]. In semaphore modules based on LED technology, printed circuit boards are used where several LEDs are fixed [3].

In this context, some studies suggest a semaphore signaling system independent of the electricity distribution network. In this case, the proposed system operates on solar energy aided by a battery bank with autonomy of one or two days to supply electricity at night or in cloudy periods [13] [16]. Also, in the design of [16] they highlight the advantage that photovoltaic power generating equipment can be installed in remote places where there is no connection to the power grid.

Thus, this study aims to evaluate the operation and structure components of a photovoltaic power system in a semaphore complex in the city of Manaus, AM.

## 2. Materials and Methods

The implementation of an independent semaphore energy system, based on solar energy collection technology through solar panels, as a substitute for electric energy contributes to greater traffic safety and also savings in the public electricity system, as well as the possibility of reducing accidents when there is a power outage provided by the utility.

One of the advantages of photovoltaic systems is the absence of moving parts with low maintenance.

They have a modular feature (from mW to MW), fast installation and a high degree of reliability. Thus, they enable the integration of the urban environment, quiet, clean and renewable.

Thus, solar energy is a term that refers to the energy coming from the light and heat of the sun. It is used by different technologies that are constantly evolving, such as solar heating, solar photovoltaic energy. The solar ray is transformed into electricity in a photovoltaic cell, made of materials called semiconductors, the most used is silicon. Sunlight is pure energy, made up of small elements, photons. When the photons reach the photovoltaic cell, part of them is absorbed. These photons awaken the electrons of the semiconductor material, thus generating electricity.

The greater the intensity of sunlight, the greater the flow of electricity. In other words, we can say that the generation of electricity through light occurs through the use of photosensitive cells or commonly called photovoltaic cells, which grouped in modules or panels make up photovoltaic solar panels [7]. In the authors' conception, a system composed by the panel, charge controller, accumulator and accessories are called Photovoltaic Generator. In this line of thought the semaphore set system is a common traffic light, such as those installed in streets, avenues, highways and others.

With plates that capture sunlight on top of the device, the traffic light uses an LED light that allows both the green, yellow and red signal to occupy the same single space instead of three, so it is easier to supply it with solar energy. . The differential of this type of traffic light to the others is that it works by means of energy from the sun, solar energy [8].

The system consists of solar panel, the traffic light, the traffic light support arm (pole); photovoltaic plate (s); batteries and the control box where the circuit used in the drive is located. Depending on the type and model of traffic light to be used, the photovoltaic plates will be sized, as well as the batteries to be used, which may be led / acid; nickel / cadmium; nickel / metal hydride, among others, thus adapting to regions with low incidence of sunlight.

Solar-powered semaphore internal circuits may be integrated, electrical and / or electronic, and may contain sensors for warning light triggering, lockout to prevent triggering of identical signals (green / green or red / red), mechanisms sequential drive (green wave) and other technologies, without prejudice to their quality and efficiency.

With this mechanism the inventor provides the saving of conventional electricity and avoids the serious disturbances caused by blackout. Its use is very wide and allows the use of various electro-electronic operating and driving technologies, including printed and / or integrated circuits.

This "solar-powered traffic light supply system" design allows, depending on the location and physical conditions, that the photovoltaic plate (s) and its batteries can be installed on or off the traffic light post or body itself. of the traffic light, forming a single set, in case of support of the traffic light by cables [17].

Currently Manaus, puts in practice in some peripheral areas of the city the traffic light operating with photovoltaic energy. According to information from [18], tests were started on a prototype energy storage device in the Manaus semaphore signaling network. According to the agency, the measure aims to maintain the operation of traffic lights even in the event of interruption of electricity supply.

There are two different prototypes installed on the city's signaling network. Model 1: A solar panel at a traffic light located at the intersection of Avenida Mario Ypiranga and Salvador Street, Adrianópolis neighborhood, South Central Zone of Manaus. Models 2: Traffic light located at the junction of Avenida

Constantino Nery and Pedro Teixeira, Alvorada neighborhood, Midwest Zone, a battery prototype was also implemented, but still in the installation phase (Figure 2). In order to guarantee the autonomy of the traffic light, a switching system has been created for the power grid. This will only come into operation in case of emergency, such as several cloudy days or any other factor that interrupts the traffic light supply by the energy generated through the photovoltaic plate.



Figure 2 - Traffic light with photovoltaic power system in Manaus

Source: [18]

Figure 3 shows the traffic light installed with photovoltaic system, in order to get the most from solar energy, that is, using sunny area available for such purpose. Solar Powered Traffic Light "aims to use solar energy, captured through photovoltaic plates (s), in traffic lights, providing energy savings and low cost.



Figure 3 - Traffic light with photovoltaic power system in Manaus

Source: [18]

Despite the feasibility of implementing the photovoltaic system in a semaphore array system, the disadvantages regarding the initial cost of investment are also highlighted, as the financial return occurs in the long term. However, analyzing the advantages presented by the photovoltaic system, it is

understood that photovoltaic solar generation is a source of energy with great potential, although the cost of technologies for harnessing available solar energy is relatively high, and still requires investment for the development of this type. technology and the consequent reduction in these costs.

After data analysis, it was verified that the implementation of a photovoltaic system in a semaphore system is already happening in the city of Manaus, demonstrating that it is a viable system, even though it is still being tested for its continuity.

Some of the characteristics of the semaphore system implemented in the municipality of Manaus were made available [18]. However, due to the lack of detailed information on the consumption of the signal system, it was considered based on the nominal values of the network, the installed devices and the operating cycle of the traffic light. For simplicity, only one traffic light plan was adopted to estimate consumption, not considering the programming difference between one traffic light and another, given the location of each traffic light.

The terminal cables of the photovoltaic modules installed at the traffic lights must be adequately insulated to the maximum system voltage and have the ability to withstand the weather, and are designed for grid-connected applications and are supplied with pre-installed cables with sufficient compliance for its connection to another equal module in its photovoltaic arrangement. In general, these cables have a quick-fit system to ensure good connection quality [19]. It is important to point out that the cables should not be loose and subject to the action of the wind, but attached to the photovoltaic panel structure.

In studies carried out by [20] the result pointed out that there is still no consensus on the efficiency of the photovoltaic energy system, since in most cases it varies between 70% and 90%, indicating that solar radiation levels influence the design of the solar system. average monthly electricity consumption.

Also, according to [20] the photovoltaic panel is weather dependent, the use of equipment that ensures the power supply to the load during periods of insolation and at night is indispensable. In the case of the battery bank, two parameters should be considered: system autonomy, which is the number of days that the battery can meet the energy demand without charging the photovoltaic panels, and the discharge depth, which is the factor. which determines its service life due to the number of charge and discharge cycles.

For the process to be put into practice, the standardization rules that regulate the micro generation and mini generation systems of electric power distribution and compensation systems were followed through its Normative Resolutions [21] and [22]. In accordance with the provisions of Resolution [22], which amends the wording of Resolution No. 482/2012, micro generation is characterized by powers lower than or equal to 75 kW, while mini generation has installed power greater than 75 kW and less than equal to 5 MW in the case of a power generation center using qualified cogeneration or for renewable sources of electricity connected to the grid.

Thus, the calculation of load consumption (Table 1) uses the loads to be fed: Equipment - list the electrical equipment powered by the system; Voltage (Volts) - electrical voltage of the equipment; Power (Watts) - nominal power of the equipment; Current (Ampere) - nominal electric current of the equipment (Power / voltage of the battery bank); Use (h / day) - average number of daily hours for effective use of the equipment; Consumption (Ah / day) - average daily electricity consumption of equipment at battery bank voltage (12 V). Equipment powered by direct current multiplies by Current (A) and Usage (h / day).

Table 1. Application of energy consumption

System Survey						Icc consumption	
Item	Equipment	Tension Battery (v)	Power (W)	Use (h / day)	Consumption (w / day)	Current (A)	Consumption (Ah / day)
1	LED traffic light	12	4	24	96	0,33333	7,99992
2	LED traffic light	12	4	24	96	0,33333	7,99992
3	LED traffic light	12	4	24	96	0,33333	7,99992
4	Controller	12	5	24	120	0,41666	10
Total	-	12	17	24	408	1,41665	33.99976

Source: Adapted [23]

It is concluded that the system should generate a minimum of 528 Watts per day for the application, calculating the capacity of the battery bank taking into account the consumption and reliability required for the system. This capacity (Ah) is calculated using one of the two expressions below (consider which results in the highest capacity):

$$\text{Capacity (Ah)} = \frac{\text{Total Consumption (h / day)} * \text{Autonomy (days)}}{\text{Depth discharge at the end of each night}}$$

Capacity (Ah) = 22,666A h

Total consumption (Ah / day): according to table 1.

The autonomy (days) should provide for a sunless period of 3 to 5 days according to the local climate and the desired reliability, but normally in telecommunication systems it takes 4 to 5 days, having a discharge depth at the end of the autonomy ( pu ) - 0.5 to 0.7 (deeper discharges mean shorter battery life). The value normally adopted for stationary calcium lead batteries suitable for photovoltaic systems is 0.6 and for automotive batteries 0.5.

$$\text{Capacity (Ah)} = \frac{\text{Total Consumption (h / day)}}{\text{Depth discharge at the end of each night}}$$

Capacity (Ah) = 16,999Ah

Total consumption (Ah / day): according to table 1.

The default value for stationary calcium lead batteries for photovoltaic systems is 0.6. For automotive batteries 0.5 should be considered and the depth of discharge at the end of each night (pu) - 0.15 (battery life 5 years) to 0.20 (battery life 4 years) ), with typical values ranging from 0.20 (stationary) to 0.15 (automotive) [24].

For depth of charge we should never completely discharge a lead acid battery. The discharge depth, around 20% of rated capacity, tells us that of the 2.5 Ah of our battery we can only use Ah = 0.5, otherwise we will damage it. Nickel cadmium accumulators, by contrast, must work in full charge and discharge cycles to avoid shortening their service life.

For the design of the photovoltaic panel must be used: Minimum generator power (Wp): Total minimum power of the module set required to produce the energy requested by the load; Vmp module: maximum power voltage of the module to be used (or of the modules in series); typically 17.4 V for isofoton modules on 12 V systems; Loss factor and safety: Considering the reduction of module generation due to manufacturing tolerance, working temperature, dust, degradation, misalignment shadows, battery losses,

controller, installation, consumption uncertainty etc., with typical value: 0.8; equivalent hours of full sun (h / day): depends on the latitude and cloudiness of the site, considering the average level of the most critical month in the chosen plan to install the modules, which should have a slope that favors the worst month.

$$\text{Generator Minimum Power (Wp)} = \frac{\text{Total Consumption (Ah / day)} * V_{mp} \text{ Module}}{\text{Full Sun Equivalent Hours} * \text{Safety and Loss Factor}}$$

$$\text{Generator Minimum Power (Wp)} = 123.249\text{Wp}$$

### 3. Conclusion

By analyzing the information, it is possible to state that solar energy is a rapidly expanding reality in many countries around the world. The search for non-polluting sustainable energy forms is a global necessity. Even though Brazil has great potential for photovoltaic power generation, it takes little advantage, the obstacles that impede the growth of the sector in the country are being minimized, but still block accelerated growth.

Finally, it is clear that for Photovoltaic Energy to become representative in the face of the energy matrix there is a long way to go, for this, a set of complementary coordinated actions is necessary to provide an orderly development. In addition to the Energy aspect, it is important to highlight Technological development, since Photovoltaic Energy is not only a sustainable solution to generate Energy, but also a way to generate wealth and knowledge for Brazil.

The traffic lights with photovoltaic system are micro processed and can also be controlled by a traffic monitoring center via Wi-Fi, fiber optic or GPRS / GSM, which in my work is not necessary of the system. The traffic management software has an open protocol, thus allowing integration with the municipality's mobility and security solutions. The LED traffic lights are compact and also operate in sunlight with 12V battery, keeping in operation for several hours after a power outage, and also saving about 80 to 90% energy compared to the common traffic lights.

In addition, the traffic light system has a priority manager, enabling the passage of ambulances, fire engines and vehicles safely through intersections. It can be programmed to prioritize public transport as well. Given this perspective when it comes to the photovoltaic system in a semaphore array system, it is assumed that although still need economic incentives to become popular, the photovoltaic system is already used in some streets of the city of Manaus.

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# Piezoelectric Energy Characterization: Materials and Utilization

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## Abstract

*This article exposes a new form of alternative and clean power generation. Being its objective to characterize, the models and use of the existing materials that comes to be more useful to generate energy. Bibliographic research was used as a method for data collection, through the study of existing articles that open the piezoelectric system. From the evaluation of the existing data, it was observed that to quantify the energy generation of these materials, besides simulating in software the amount generated is made the prototype for accurate measurement of the generated energy values. However, this is a task that requires a lot of study, so that, finally, it can reach usable values to supply the desired electrical systems. The results show that the amount of energy generated is different for each method used, which depends on the type of material and the harvesting procedures performed, among the most used materials is the "cantilever" being the best in relation to the generation of Therefore, it is evident that the present article seeks to demonstrate the existing modes of generation through the use of this piezoelectric effect. Thus, it is expected to draw attention to this type of electricity production.*

**Keywords:** Piezoelectric effect; Alternative source; Renewable energy;

## 1. Introduction

Given the problems faced by the energy market, factors that remain evident is the search for new sources of energy generation given their environmental interface, thus, research continues to be conducted, focusing on alternatives on the use of natural resources.

The concept from the generation of renewable energy or alternatives related to this proposal arises from

the scarcity of fossil fuels and its relationship with climate change, where thus there is a need to seek the development of systems that take advantage of existing resources in the environment. or even products generated by humans, a technique known as “Energy Harvesting”. From this observation is the interest in piezoelectric materials, a source of energy still little explored. This alternative uses piezoelectric transducers in the harvesting process associated with movements as a source of vibration causing deformation, which enables the generation of electrical energy [1].

In this way the vibrational energy resulting from our movements, made when walking on sidewalks, streets, squares, shopping malls, universities, etc., would be harnessed and converted from vibrational kinetic energy to electrical energy through the use of piezoelectric sensors enabling the harnessing of large amounts of energy lost in the form of heat and friction, as it can react to the mechanically generated deformation and in turn, convert the absorbed energy into electrical energy to be reused [2].

As noted by [3], the piezoelectric effect was discovered by brothers Pierre and Jacques Curie in the year 1880 and can be characterized by a property that certain crystals possess when subjected to an electric charge differential, first used by Paul Langevin in sonar in the first world war. Thus this innovation highlights the new search for clean, sustainable and alternative energy.

According to [4], piezoelectric materials have two electrical or mechanical power generation properties, depending on the state change, the direct piezoelectric effect corresponds to the electric power generation as a result of the application of a mechanical force; and the inverse piezoelectric effect is a mechanical change due to the application of an electric field.

As mentioned, [4] clarifies that piezoelectric materials generate electrical or mechanical energy because they have these properties in their crystalline structure when undergoing changes in their state. [5] mentions that the reverse effect was discovered by Gabriel Lippmann in 1881, where there were various applications in motors, transducers, sensors, actuators among other utilities, materials that have these conditions by nature are: tourmaline, quartz, topaz, sugar. cane and Rochelle salt.

According to [6] piezo comes from the Greek "piezein" which means to press, that is, electricity by pressure, being these piezoelectric materials built with quartz crystals and given some difficulties there was a need to improve them, creating synthetic materials in the 1940s. and 1950. The so-called PZT (lead zirconate titanate) piezoelectric ceramics have several variations, besides the quartz used to convert mechanical energy to electrical energy.

Thus, piezoelectricity can be considered a sustainable energy source as it does not use fossil fuels. It is important to consider that clean energy means to produce or consume energy without generating or generating in minimal quantities, waste and greenhouse gas and global warming [7].

The conversion of electrical energy to mechanics is found in: sound buzzers, microwave generators; ultrasound and electrotherapy devices. The reverse effect observed on spark generators on lighters or stove lighters and on the production of electricity. Virtually all applications are satisfied by synthetic quartz.

PZT-type ceramics have small crystals of Perovskite-like crystalline structure, with tetragonal symmetry, rhombohedral (A crystal with diamond faces) or simple cubic, depending on the temperature of the material [8].

The aim of this study is to analyze the models and processes of piezoelectric energy utilization, aiming to

identify and characterize the existing methods and materials used in mechanical pressure energy generation, demonstrating the amount of electrical energy generated by piezoelectric sensors.

## 2. Materials and Method

For the development of the present work we used the bibliographic research procedures that according [9] are elaborated mainly by sources such as books, magazines, newspapers, monographs, dissertations and theses, based on scientific publications of studies on the piezoelectric properties. Therefore in this way we seek to make this property more explicit.

We can conceptualize as a qualitative research. So one must assume that it is a method that aims at understanding people without worrying about numerical relationships. Certainly because it is an approach that seeks to explain the reasons and how the problems will be solved, with exploratory and descriptive objectives, since it is evident that this approach has the objective of clarifying an existing fact or phenomenon, that is, make a study about the object of observation [10].

Through consultations and analysis of scientific sources it is possible to demonstrate the electrical potential of piezoceramics, verified through a simulation in software with the help of experimental benches and through the assembly of prototypes used to measure power generation.

## 3. Results and Discussion

For a long time the piezoelectric effect has been used as, for example, in medicine in ultrasound and electrotherapy apparatus; transducers, sensors, actuators, in sound amplifiers, scales, among other utilities in which its application is useful. According to [11], zinc sulfide, sodium chloride, magnesium chloride, tourmaline, quartz, zinc carbonate, topaz, sugar, sodium potassium tartrate, barium titanate, lead zirconate titanium and fluorine polyvinyl are some materials and crystals that suffer the piezoelectric effect.

There are several types of piezoelectric ceramics on the market that are characterized according to their structures. The Navy has created classifications of PZT composites that serve as a standard for all piezoelectric ceramic manufacturers and define the characteristics and performance of materials, which have been divided into six types [12]:

- **Navy Type I:** suitable for constant and repetitive conditions of medium and high power, producing large amplitudes and keeping dielectric and mechanical losses low, containing an active system in power generation, being applied in ultrasonic cleaning and sonars, under the tradename PZT-4.
- **Navy Type II:** It has high sensitivity, permittivity and time stability when used as a low power receiver or generator. Dielectric and mechanical losses make high-intensity excitation unfeasible, but can be applied to hydrophones, accelerometers, and flow and level sensors, bearing the trade name PZT-5A.
- **Navy Type III:** Used in high frequency applications with high mechanical qualities after converting twice the power and keeping mechanical and dielectric loss low. In addition, it has better power handling capacity, similar to Navy Type I, but less sensitive, having application in the ultrasonic welding and materials processing system, bearing the trade name PZT-8.
- **Navy Type IV:** Medium power application, consisting of BTs (Barium Titanate) becoming obsolete and replaced by Navy Type I. Its application is in the maintenance of old equipment, under the trade name

Barium Titanate.

- **Navy Type V:** Used for high energy application and potential differential, being an intermediate composition of Navy Type II and VI, used accordingly in the application of impact detonators, under the trade name PZT-5J.
- **Navy Type VI:** Applications that demand large mechanical deformations, having very high permittivity, coupling and piezoelectric constant, but with low time stability. It can be applied to positioners and actuators, with trade name PZT-5.

Currently there are already some applications, both in Brazil and in other countries. In this context, to [12] claims to deal with a concept still little known, but widely used in everyday life, noting some applications of materials.

In Canada, two engineers inserted the energy-generating piezoelectric ceramics into car tires, covering the inner surface area of the rim 14 tire with the flexible PZT (lead zirconate titanate) elements, while driving 100 km / h 2 , 3 watts per tire [13].

Atelier DNA, New York's design laboratory, created for the planned city of the Emirates Masdar Abu Dhabi in 2010, a wind-powered electricity generator called Windstalk, which are piezo-coated ceramic rods and electrodes, all of which are connected, where when there is wind, there is also movement of the rods, which are forced by compression, generating current, and where a generator converts kinetic energy into electrical energy [14].

Piezoelectric generators developed by Innowattech Company, used on train tracks in Israel, have shown that areas where ten to twenty trains per hour can produce up to 120 KW / H. The company also installed energy-producing road systems through a pilot project with the installation of piezo plates on roads, train tracks, airport runways and subway stations, noting that up to twenty cars pass an expressway. every minute and can generate 200 kW / h, enough to supply a home for a month. The founder of the organization, Haim Abramovich, explains that on an avenue less than a mile long, four lanes, which run about 1,000 vehicles per hour, can generate approximately 0.4 MW, enough to power six hundred (600) homes [16]

The Haifa-Israel-based company has developed a system based on piezoelectric generators that can be installed under concrete or asphalt layer in road, rail and pedestrian traffic. Thus, the busier the road, the more energy is produced, where the heavy vehicles produce more energy [17] from the conversion of mechanical energy to electrical energy, also for use in traffic lights, radars or grid connected.

Pavegen founded by London-based Laurence Kemball-Cook in 2009 works with floor development and manufacturing that converts steps into energy and data. One such project was called the internet of beings at a facility in Cambridge; Another analysis looked at 200 projects in 30 countries, with smart urban developments, retail destinations and educational institutions in countries such as Hong Kong, India, Korea, Thailand, United Arab Emirates, United Kingdom, and the USA. Customers include Abu Dhabi International Airport, BNP Paribas, Ellandi, Google, Siemens, Transport for London and Urban Renewal Authority [18].

In this context, [19] exposes that Pavegen created a soccer field using the conversion of energy from slabs that collect energy, in the hill of Minas Gerais / RJ, in 2014, in partnership with Shell.

Tables 1 and 2 present some bibliographies that use computer simulation and prototypes, using piezoelectric

materials generating usable electric energy.

Table 1- Power generation values by computer simulation.

Computational Program	Piezoelectric Materials	Frequency (Hz)	Deformation ( $\mu\text{m} / \text{m}$ )	RMS Electric Power (mW)	Author
ANSYS	Girder with PZT-C64	75	387,97	31,41	[20]
SIMULINK DO MATLAB	Commercial Device Q220-A4-503YB Piezo Systems Inc	68	—	1,3	[21]
ANSYS e LABVIEW	PZT Cylinder	285	—	2,5	[4]

Source: Own authorship, 2019.

Table 2- Power Generation Values Measured by Prototypes

Piezoelectric Materials (Un)	Pressure (kg)	Voltage (V)	Power (W)	Author
30 Discs of 35 mm PZT	92	6,82	1,52086	(22)
30 PZT-4 (Lead Zirconate Titanate) 35mm tablets	80	7,18	—	(23)
PVDF (Vinylidene Polyfluoride) LDT0-028k, MEAS, 25mm / 13mm	—	8,92	0,00074	(24)

Source: Own authorship, 2019.

From these authors it becomes evident that piezoelectric materials have the capacity to generate energy, arising from deformations in their structure. Therefore, it is undisputed that the application of these materials becomes very productive in relation to the production of alternative energy.

We sought to present an analysis of existing studies on the piezoelectric effect for power generation, showing the amount of energy generated according to the methodologies observed, being an effect widely used in the small-scale world, in relation to alternative energy. , bringing satisfactory results.

According to [20] it is clear that the beam with PZT is the most productive in relation to other materials, and it is also explicit the use of this study as a source for other research, such as the capture of piezoelectric energy by vibration from a rectangular metal beam (Figure 1), also known among the authors as "cantilever".

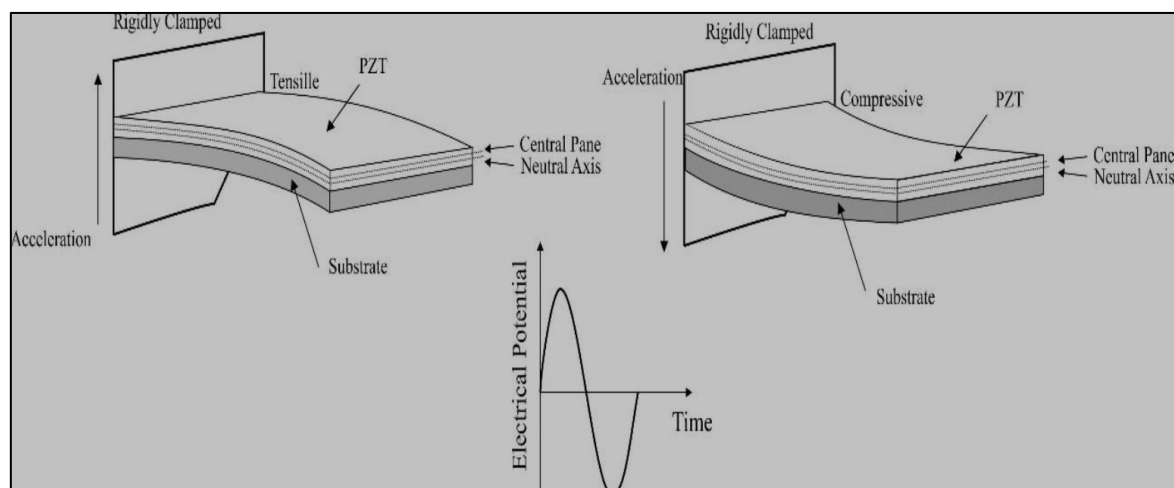


Figure 1: Basic configuration for energy capture through balance piezoelectric beams.

Source: Adaptation [12].

The best performance was observed in the use of 35 parallel interconnected 35 mm piezometric disks, with a positive pole of one ceramic with the positive pole of the other, where it is made with the negative pole, being the harvest by mechanical pressure. [22] There are other methods of linking the discs (Figure 2), which are used according to the purpose of each author, as topology has an influence on power generation.

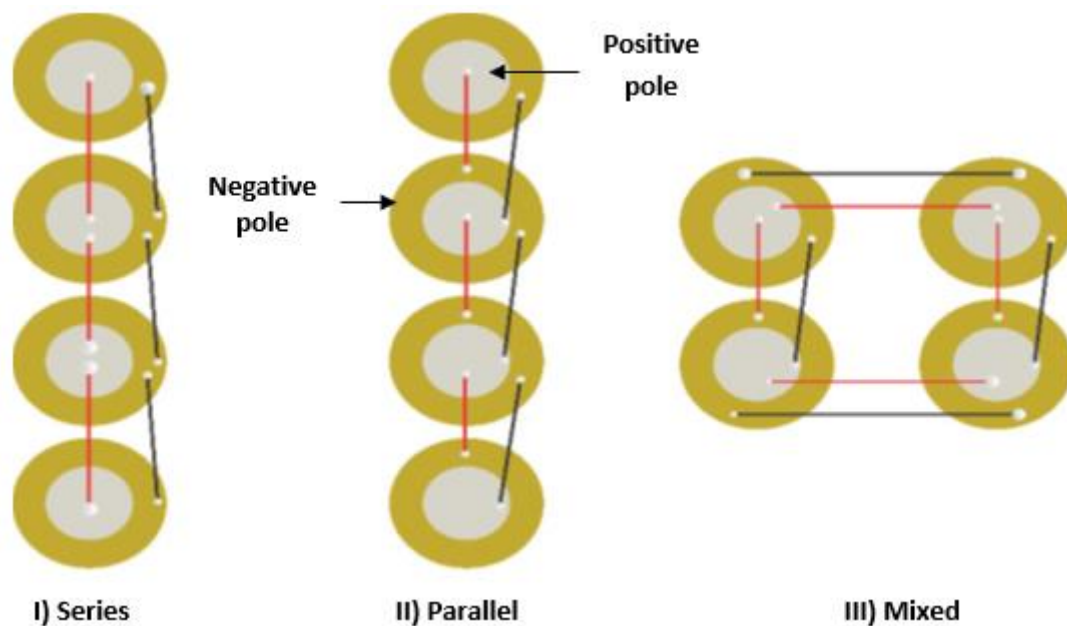


Figure 2: Electrical circuit topologies using piezoelectric

Source: Adaptation [25].

It is noteworthy that piezoelectric materials have limitations according to [26]: natural aging; property instability due to temperature variation and electrical and mechanical excitation limit. Knowing these limitations of properties and applications regarding commercial ceramics gives benefits in choosing the right material to use.

According to [27] relating the piezoelectricity generating sources to the main renewable energy sources, it is noted that the piezoelectric effect does not depend on climate or specific geographical area, such as solar energy and wind energy, besides can be installed in urban areas near points of greatest demand, seeking to minimize transmission costs, which would not be possible with hydropower.

Also in this context, for [28] the use of these materials for power generation, has been gaining more attention from different communities, given the fact that it is mandatory to increase the demand for energy and consequently the search for alternative sources, given the impact caused over-exploitation over time and the impact on resources needed to generate this product. Thus, even though Brazil is dependent on hydroelectric dams, it has a great reference in the use of renewable sources.



#### 4. Conclusion

Through the bibliographic review it was possible to analyze the contents about the use of the piezoelectric effect in the generation of clean electric energy, where when evaluating the different studies, still new within the research area, it was realized that there was a great potential regarding the diversification of the energy matrix.

Thus, it is concluded that piezoelectricity has evolved structurally and has several applicability in other areas, besides the production of electric energy, being exemplified its use in the areas of medicine, aerospace, electronics, etc.

In general, the application of this effect to energy generation can bring environmental benefits, without visual pollution, besides not using fossil fuels, considered a clean and alternative energy, which promises a promising source of energy generation. . In addition to being a sustainable solution, Energy Harvesting can be done anywhere that has a large flow of people as well as vehicles, reversing this condition into usable energy.

In this sense, the use of piezoelectric effect for energy harvesting through vibration or impact proved to be effective when analyzing the data from the sources in question. Attention is drawn to the fact that the study of these will be further studied and researched, since energy generation always aims at potentiality on a large scale.

Although feasible, further studies are needed on such properties of the materials used for piezoelectricity generation, which notes the existence of a difference in the generation potential.

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# Evaluation of Surface Water Quality of The Area of Influence of The Landfill of The City of Manaus/Am

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## ABSTRACT

*This work aimed to evaluate the quality of surface water around the Manaus Solid Waste Landfill (ARSM), in which it is located near important waterways in a growing urban expansion area. During the collection period, the parameters pH, T, fecal coliforms, OD, DBO5, nitrate, phosphate, turbidity and total solids were monitored, where these are the main parameters for performing water quality index calculations. The results analyzed indicate contamination in the streams near the perimeter of the Landfill, where the possible origins for non-conformities can be problems in draining the leached and waterproofing system of the landfill ponds. The recovery of the quality of these water resources is essential, since it is an area with flora and fauna that are heritage, not only of the residents who occupy their surroundings, but also the population of Manaus who in the past enjoyed bathing and fishing areas in the streams currently affected by the slurry produced in the landfill.*

**Keywords:** Water quality; Surface waters; Landfill

## INTRODUCTION

With the expansion of cities and population growth have generated many problems related to the disposal of solid waste. Today one of the world's biggest concerns has been the issue of excessive generation of solid waste and its final disposal, to which it poses risks to human health, biodiversity and water resources. For modern society it remains to face the great challenge of properly managing waste while there is a lack of areas of final environmentally appropriate disposition for these.

This fact has often led to the emergence of sites with inadequate management, and there is mostly the appropriate treatment for slurry thus causing contamination of soil and underground water sources through toxic waste. There are several places where waste is not adequately arranged, covering extensive areas, not observing legal limitations and disobeying the standards and techniques of proper management.

For Monteiro et al, (2001) the lack of support tools and professionals trained in the municipalities are factors that make decisions difficult to make about the sustainability of the waste management system of most municipalities in Brazil. According to Brollo e Silva (2001) what the issue of public health, urban waste, from a sanitary point of view, constitutes a means of transmission of diseases by the action of

vectors that are attracted to the places where garbage is disposed, feed and proliferate -if, indirectly being the cause of epidemiological diseases.

The term solid residue presents different definitions, made by several authors. For Hamada (2006), waste refers to things without utility or value, and can also be defined as remnants of human activity which physically contains the same materials that are found in their original products, which had value and Utility. Economic, social, geographic, educational, cultural, technological and legal factors affect the process of generating solid waste, both in relation to the quantity generated and its qualitative composition (ZANTA *et al.*, 2006).

Detailed knowledge of the damage that can be caused in water resources around areas of deposition of municipal solid waste (dumps or landfills) is fundamental for planning preventive and corrective actions. In view of the growth of the urban area towards the area of the Solid Waste Landfill of Manaus (ARSM) and the importance of surface waters (BRASIL 2002), especially in communities and neighborhoods present in the vicinity and do not enjoy public supply (BARRONCAS 1999), CPRM (Mineral Resources Research Company – Geological Survey of Brazil) has been monitoring the contamination of water resources around ARSM since 2006.

According to NBR 8419/92 of the Brazilian Association of Technical Standards (ABNT), landfill is the technique of disposal of municipal solid waste in the soil without causing damage to public health and its safety, minimizing environmental impacts, a method that uses engineering principles to confine solid waste in the smallest possible area and reduce them to the lowest permissible volume, covering them with a layer of land at the conclusion of each working day or at shorter intervals if necessary.

Landfill is recommended as the best way to make up the final layout of urban waste. This technique basically consists of the compaction of waste in the soil, with them in layers that are periodically covered with land or other inert material, forming cells in order to have an alternation between waste and cover material.

Until 2005, the city of Manaus presented as a form of final destination of municipal solid waste a controlled landfill, where the deposited waste was scattered, compacted and arranged in layers, interspersed with clay soil removed from the near the site forming cells. Solid waste from households, hospitals, industries, fairs, markets and complementary services were received on site (weeding, sweeping, gardening and cleaning of streams) were received. As well as, remains of tree pruning and waste from fairs and markets that were moving towards composting (OLIVEIRA, 2007).

The Municipal landfill of Manaus was designed to hold an average daily production of up to 980 tons/day, which would allow a useful life of about 20 years (BARRONCAS, 1999). Exceptionally until 2005, the landfill received more than double the maximum waste capacity provided for in its initial project (SEMULSP, 2006).

The landfill studied in this work has its solid waste collection and transport services executed, in almost its entirety, by two concessionaires and are subdivided, according to concession contract, in five modalities: Home Collection, Mechanical Removal, Manual Removal, Pruning Collection and Selective Collection. A smaller portion of the garbage collected in Manaus comes from third parties, that is, companies providing services, such as disk debris, construction companies, industries, among others, which request authorization to dispose of waste in landfill.

The Solid Waste Landfill of Manaus is the main final destination complex of the city's municipal solid waste. It is located at km 19 of the AM-010 highway, spatially positioned through the geographical coordinates S02°57'23.86" and W60°00'47.62. The complex has an environmental license of operation provided by the Environmental Protection Institute of the State of Amazonas - IPAAM. The estimated area is 66 hectares.

This work aims to analyze possible contamination surface and groundwater around the landfill. The water quality was monitored in wells and streams in the area of influence of the Manaus landfill. The parameters of water quality measured were dissolved oxygen, fecal coliforms, pH, biochemical oxygen demand, nitrate, phosphate, temperature, turbidity and total solids.

## MATERIAL AND METHOD

### Characterization of Study

The Solid Waste Landfill of Manaus (ARSM), is located at km 19 of the am-010 state highway, at the expansion limits of the urban area, and currently occupies an approximate area of 66 hectares (Figure 1). It is inserted in the Matrinxã creek basin, a tributary of the Acará creek, which joins with the creek of Santa Etelvina to form the creek of Bolivia. Arsm is bordered to the east and north by the Matrinxã creek valley; to the south by a small tributary of this same creek, and to the west by the AM-010 highway. A small portion of the land, closer to the highway, is drained by an arm of the Aracu creek, a tributary of Bolivia's creek.



*Figure 1: Satellite image indicating the location around the red line, the landfill of solid waste in the city of Manaus/Am (Google Earth Pro -2019).*

### Sample Collection

Technical visits were made to the Manaus landfill during the month of May when it was possible to obtain information from the study area. Preceding the in-situ data collection activities, the landfill area

was recognized and around it. The aim of the recognition was to analyze the aspects related to the following stops such as: facilities for access to data collection sites (roads and extensions); details of the distribution of the surface drainage network; existing localities (communities, villages, farms, sites, changing rooms, etc.); water supply systems for human consumption; location of the slurry extravasation points and landfill operating conditions. For a more detailed analysis of the site, a topographic map of the Manaus Landfill was elaborated, in order to verify the hydrodynamic behavior around the ARSM (Figure 2).

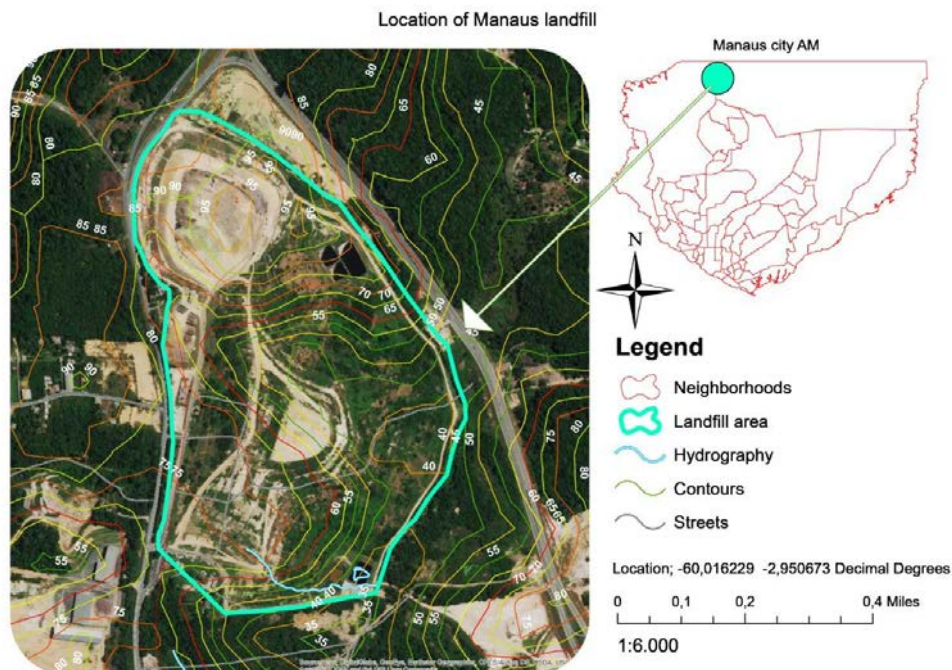


Figure 2: ASRM topographic map.

### Surface water monitoring

For the development of the work, three sampling points located in the Matrinxâ igarapé hydrographic basin, near ARSM, were selected. Surface water samples were collected and analyzed during September 2019 to assess the quality of the basin. The first sampling point is situated 1,300 feet from the landfill. The second point is in the same tributary, but there is a kilometer from the first, in the extension of Avenida Governador José Lindoso. And finally, the third point which was approximately 750 meters from the second point.

The results of bacteriological and physicochemical examinations of surface waters in the area of influence of the landfill were compared with maximum values recommended by CONAMA Resolution No. 5/357, Art. 15 – from the sweet waters. The resolution presents the classification of water bodies and environmental guidelines for their framework, in addition to establishing the conditions and patterns of effluent launches.

The collection and analysis of surface water samples were based on the conditions proposed by Rodger (2017). Furthermore, the samples of surface water for physicochemical analyses were performed using one liter vials. On the other hand, bacteriological collection of sterilized 250 mL bottles and



laboratory preparations were used. To perform the analyses of BOD5, total solids, pH, turbidity and nitrate nitrogen, 1L sample analyses were collected.



Figure 3: Collection and monitoring of surface water temperature.

Preceding the surface water sampling activities, on-site measurements of three physicochemical parameters were performed: pH, dissolved oxygen (OD) and temperature, made through a digital device kit. These parameters serve to reveal, in preliminary, evidence of possible chemical contamination in the water bodies sampled.

## 2.4 Characterization of the Water Quality Index

In the characterization of the Water Quality Index, he used some parameters that represent its physicochemical and biological characteristics. These parameters were established by the National Sanitation Foundation (NSF) in the United States, through opinion research with various environmental experts, for the development of an index that indicated water quality.

Thus, nine parameters were considered more representative: dissolved oxygen, fecal coliforms, pH, biochemical oxygen demand, nitrate, total phosphate, water temperature, turbidity and total solids. Each parameter was assigned a weight, listed in Table 1, according to its relative importance in the calculation of the WQI/NSF.

**Table 1** - Weight of WQI parameters.

Parameter	Peso (wi) NSF-WQI
Dissolved Oxygen	0,17
Fecal Coliforms (NMP/100 mL)	0,15
PH	0,12
DBO5 (mg/L)	0,10
Nitrates (mg/L NO <sub>3</sub> )	0,10
Phosphates (mg/L PO <sub>4</sub> )	0,10
Temperature (°C)	0,10
Turbidity (UNT)	0,08
Total Solids (mg/L)	0,08
<b>TOTAL</b>	<b>1,00</b>



Then the WQI is calculated by the weighted production of water qualities corresponding to the parameters according to equation:

$$WQI = \prod_{i=0}^9 q_i^{w_i}$$

Where: WQI, water quality index, a number from 0 to 100;  $q_i$ = quality of parameter  $i$  obtained through the average quality;  $w_i$ = weight attributed to the parameter, depending on its importance in quality, between 0 and 1. Index values range from 0 to 100, as specified in Table 2, as follows:

Table 2 - WQI Quality Level.

Description (NSF)	FAIXA	Description (CETESB)	TRACK
Poor quality	0 – 25	Poor quality	0 - 19
Bad quality	20 – 36	Bad	20- 36
Medium quality	37 – 51	Regular	37-51
Good quality	52 – 79	Good	52-79
Excellent quality	91 – 100	Excellent	80-100

Source: CETESB (2007)

Thus defined, the WQI/NSF reflects the interference by leaching and other organic materials, nutrients and solids in the quality of water resources.

## RESULTS AND DISCUSSIONS

The evaluation of the results of the physicochemical parameters of the surface waters of the Matrinxã-Acará Basin was performed comparing the values obtained in each stage, as well as using reference values existing in RESOLUTION CONAMA No. 357/2005. The results obtained are presented in the following tables:

Table 3: Results of The Dot samples P – 01.

Parameters	Unit	Sample result	VMP
Fecal coliforms	NMP/100mL	$17 \times 10^3$	1.000
DBO <sub>5</sub>	mg O <sub>2</sub> /L	24,0	5
Phosphate	mg PO <sub>4</sub> /L	5,8	NA
Nitrate	mg N/L	1,9	10,0
Dissolved Oxygen	mg O <sub>2</sub> /L	6,4	Não inferior a 5
pH	-	7,80	6,0 a 9,0
Total Solids	mg /L	76,0	NA
Temperature	°C	21,5	Inferior a 40°
Turbidity	UNT	12,5	100

VMP: Maximum values allowed by Resolution CONAMA n.º 357/05.

*NA: Not applicable*

The results obtained through the analyzed sample presented values above the maximum value established by CONAMA Resolution No. 357/05, for fecal coliforms and DBO<sub>5</sub> parameters. The point analyzed is far about 400 m from the perimeter of the landfill and downstream of the release of the treated effluent that does not present a good efficiency in the removal of pathogenic bacteria and organic load, not meeting environmental standards (LATORRACA, 2007).

The launch of this effluent directly reflects on the quality of the Matrinxã igarapé, where the signs of pollution are visible in the color and odor of water, confirmed in the results of the parameters of DBO<sub>5</sub> and fecal coliforms. These results agree with those obtained in the Cleto (2003) study, where the author verified that the studied area presents variations in the parameters analyzed in different rainfall periods, which at a certain time of year cause dilutions of their water bodies. Thus, natural changes in the physical and chemical properties of the waters of the landfill region are quite common.

Table 4: Results of The Dot samples P – 02.

Parameters	Unit	Sample result	VMP
<b>Coliforms</b>	NMP/100mL	22x10 <sup>3</sup>	1.000
<b>DBO<sub>5</sub></b>	mg O <sub>2</sub> /L	26,0	5
<b>Phosphate</b>	mg PO <sub>4</sub> /L	6,0	NA
<b>Nitrate</b>	mg N/L	1,5	10,0
<b>Dissolved Oxygen</b>	mg O <sub>2</sub> /L	6,3	Not less than 5
<b>pH</b>	-	6,9	6,0 a 9,0
<b>Total solids</b>	mg /L	79	NA
<b>Temperature</b>	°C	22	Less than 40°
<b>Turbidity</b>	UNT	14	100

*VMP: Maximum values allowed by Resolution CONAMA n°. 357/05.*

*NA: Not applicable*

Point P-02 is 100 m from the perimeter of the landfill, the values of DBO<sub>5</sub> and fecal coliforms presented values above the maximum limits recommended by CONAMA no. 357/05. Probably these results are due to the inefficiency of waste cover and rainwater drainage system, rainwater washes and percolate waste increasing leaching production and flows towards the analyzed point. In a similar study, Jordan and Pessoa (2005) showed that during the rainy season domestic wastewater, presented dark coloration and odor.

It is verified that in point P- 02 the results presented a contamination greater than point P-01, however both points suggest that it is linked to the release of the effluent treated by the sewage treatment system of the landfill. It is observed that the concentrations of organic matter (DBO<sub>5</sub>) coliforms and turbidity in point P- 01 decreases towards downstream P-02. This decrease may be due to the phenomenon of self-purification or dilution in the spring, since there is a distance between the points of approximately 750 m. However, both points show indicative of contamination.

Table 5: Results of The Dot samples P–03:

Parameters	Unit	Sample result	VMP
Coliforms	NMP/100mL	40x10 <sup>3</sup>	1.000
DBO <sub>5</sub>	mg O <sub>2</sub> /L	4,5	5
Phosphate	mg PO <sub>4</sub> /L	0,09	NA
Nitrate	mg N/L	0,05	10,0
Dissolved Oxygen	mg O <sub>2</sub> /L	5,9	Not less than 5
pH	-	7,20	6,0 a 9,0
Total solids	mg /L	51	NA
Temperature	°C	21,50	Less than 40°
Turbidity	UNT	7,00	100

VMP: Maximum values allowed by Resolution CONAMA n°. 357/05.

NA: Not applicable

Point P-03 showed no evidence of slurry contamination, being the only sampling point that presented BOD<sub>5</sub> with a result lower than the maximum value allowed by CONAMA Resolution No. 357/05. This result may be due to the distance from the perimeter point of the ARSM, as the sampling point is located approximately 1 km away from the landfill. However, the results of coliforms presented values higher than the standards established by CONAMA Resolution No. 5/357, possibly related to the anthropic occupation on the banks of this stretch of the creek. Water resources may present contamination related to anthropic occupations devoid of sewage system, a fact that contributes greatly to the degradation of this resource (BARRONCAS, 1999).

For the dissolved oxygen parameter, it was observed that at all monitoring points the concentrations remained within the minimum limit of 5mg/L established for class 2 rivers, as recommended by CONAMA Resolution No. 357/05. With regard to samples for microbiological analyses all samples, they are at odds with the bacteriological standards for class 2 waters of CONAMA Resolution 357/2005, with values above 1,000/100 mL of thermotolerant coliforms (fecals).

With regard to the results of the samples for pH, it is necessary to make a caveat with respect to the value range (6.0 – 9.0), used as a reference in CONAMA 357/2005, since in it no specificity of the Amazon Region was taken into account, that is, the natural acidity of black waters, caused by excess humic acids dissolved.

With regard to the results of the samples for pH, it is necessary to make a caveat with respect to the value range (6.0 – 9.0), used as a reference in CONAMA 357/2005, since in it no specificity of the Amazon Region was taken into account, namely, the natural acidity of black waters, caused by excess dissolved humic acids. Santos (2001) found in this course of water, just downstream of ARSM, at different times of the year, pH values ranging from 5.8 to 6.1 and dissolved oxygen from 1.5 to 4.0 mg/L. Such data, compared with those obtained for this study, suggest that contamination intensified sharply.

Thus, it is important to emphasize that the results based on a single sampling campaign, such as that carried out for this study, cannot be considered as a definitive reference, requiring a program to monitor water quality affected by ARSM, so that a picture of variations in diagnostic parameters is obtained throughout hydrological cycles.

### Surface water quality index (WQI)

The Figure 4 shows the location of collection points and surface water quality index according to WQI/NSF ranges.



*Figure 4: Classification of surface WQI in the area of influence of the ARSM.*

The Iq of surface water of point P-03 presented a value of 70, considered good. The results for sampling points P-01 and P-02 presented A Poor Surface Water Quality Index with values of 33 and 31, respectively, probably influenced by the landfill. Points P-01 and P-02 are located on the east bank of the landfill area, where there are indications of slurry contamination, because it presents anomalous values of the main physicochemical parameters, such as pH and DBO5, and the considerable increase in nitrate concentrations, when compared to the sample results of the farthest point and with less influence of ARSM.

Thus, the values of these parameters were very high in relation to the reference values for class 2 waters of CONAMA Resolution 357/2005. It is important to mention that both points are very close to slurry launch sites and during the monitoring stages, the launch of slurry was observed directly on the bed of the Matrinxã creek, coming from the underground drainage pipes of the Landfill.

### CONCLUSION

The data produced from the analyzed samples show that slurry from ARSM compromises the quality of the waters of the Matrinxã stream, as can be observed by the comparison between the results obtained for point P-03 (upstream of the landfill), free of contamination, and points P-1 to P-02 (downstream of landfill), with contamination statements.

The slurry produced by the Manaus Municipal Landfill is considered the main source of water pollution identified in this region. Several activities carried out near the Landfill can also contribute to changes in water quality, such as: areas occupied by waste tanks from septic tanks and leisure properties such as clubs, changing rooms and Ranches. As observed in the samples for microbiological analyses all samples, they are at odds with the bacteriological standards for class 2 waters of CONAMA Resolution

357/2005, with values above 1,000/100 ml of thermotolerant coliforms (fecals), even if one of the points is not directly connected to the landfill area of influence. However, the consequences caused by the activities carried out in the Landfill are more aggravating, mainly due to the constant fractures in the layers of waste cover, leaving them exposed.

The AQI of surface water in the area of influence of the landfill for points P- 01 and P - 02 presented values of 33 and 31, therefore considered, poor, and is probably directly associated with the poor efficiency of the effluent treatment system of the landfill, highlighting the large amount of coliform organic matter analyzed in the samples. The surface water from the farthest point of landfill P-03 presented the value of 70, considered good, thus does not directly suffer influence of the landfill due to topography and distance.

Therefore, to mitigate the reported situation, it is recommended that the interruption of the slurry to the bed of the Matrinxã stream is carried out as soon as possible, diverting all the slurry generated to the stabilization ponds already existing in ARSM. This measure is essential to initiate the process of environmental recovery of the Matrinxã Stream and, without it, there is no way to think about mitigating the degradation observed a long time ago. There should be greater control in the waterproofing and closure of cells, as well as in the construction and maintenance of the drainage system so that all leached produced is in fact referred to the treatment ponds.

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## Health Care Assistance for Trans People

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### Abstract

*Transgender people (trans people) are those who don't identify with the gender assigned at birth, regardless the will to align their physical appearance to their gender identity by clinical ou surgical procedures. Historically, they are presented with interaction difficulties with health care professionals, leading to barriers to care and potential risks for health issues. This study results come from an integrative review from the literature aiming to know actions and practices of health care for trans people and the existance of protocols of care for assistance to trans people health demands. The following descriptors were chosen in the virtual health library site (DeCS search): transgender people; transsexualism; protocol; health services; care ambulatory; health services for transgender people and their equivalents in portuguese. The literature search was undertaken in the CAPES, Science Direct, MEDLINE, LILACS and SciELO databases. Entry criteria were: 1) studies that described the health assistance for trans people; 2) studies published from January 2009 to May 2009 and; 3) studies published in English, Spanish or Portuguese. The research methodology included using software Mendeley and checklist PRISMA, recommended for systematic reviwis and meta-analysis. The initial sample was of 471 articles. After applying entry and exclusion criteria, six articles remained for analysis. The categories that emerged from reading the articles were: surgical and hormonal interventions importance; civil name change and respect of the social name; negative health outcomes; barriers of health care. Nonetheless, the results allowed to identify some difficulties in this field, such as health system infrastructure, different sociocultural contexts, inexpressive number of health care professionals specialized or even prepared for this assistance, and lack of protocols of trans people health care applied in a consistant way. It's proposed health education, in which work is done multidisciplinarilly, developing protocols for trans people health care that respect the chosen name and guaranty the disponibility of hormonal therapy, working health promotion actions aiming to reduce the negative outcomes.*

**Keywords:** transgender people; health services; care ambulatory

### 1. Introduction

Transgender people (trans people) are those who don't identify with the anatomic sex, that is, the gender assigned at birth. It's a wide spectrum term, since it englobes different definitions of trans people – transsexuals, travestis and transgender. This means that any person who doesn't recognize itself in the social role previously stablished for its inate identification, regardless the will for aligning its physical appearance to its gender identity by clinical or surgical procedures.<sup>1</sup>

Trans men and women may require for their health a body transformation, aiming a final objeotive with

different meanings – since belonging to a desired gender perspective, happiness and beauty, to financial gains to those who are sex professionals.<sup>1</sup> Different strategies to this end are demanded by trans people, such as hormonal therapy, industrial silicone applications, surgical procedures, which will be chosen mediating their wills and their access conditions to these services, besides HIV and other sexually transmitted infections (STI), needing routine health care as well as the proper health issues for these people.<sup>1,2</sup>

Against these health demands resolvability, trans people historically are presented with interaction difficulties with health care professionals, leading to barriers of care and risks for a wide range of health problems. It means that not everyone will have their rights met in the actual structured model of health care.<sup>2</sup> In this sense, trans people ask public policies and health services for differential treatment. The issues that affect this population are partly the same as for other individuals, but some situations are related to their vulnerability and risk of exposure to STI. It demands specialized assistance that comprehend their health needs.<sup>3</sup>

The search for health services was intensified by trans people especially from the HIV/AIDS epidemics in the 80's. Most of the recognition that Brazilian HIV policies receive had origin in the crucial role played by non-governmental organizations in this confrontation, overall in the defense of key populations, as trans people. Over three decades later, trans people have amplified their possibilities for health care access through public policies which allow them, among others, the right to transsexualization process by the Brazilian health unique system – especially for the sexual redesignation surgery. This regulation aims to achieve the same principles and directives for this population, overall in the context of specialized assistance.<sup>3</sup>

Trans people have always been in the spearhead of prejudices and discriminations in Brazil with the LGBT people – gathering Lesbians, Gays, Bisexuals and Trans people. Data presented reinforce that trans people are even further apart from health care. It happens mostly because specific mechanisms that should ease these people's health care are absent.<sup>4</sup> Nay, stigma, discrimination and lack of legal identity restrict economic opportunities for these people, what may induce the search for sexual work. Prostitution, in its turn, may lead to more violence, even lower rates of condom use and augmented index of STI. In this scenario, the lack of social support is related to mental health issues, including anxiety, depression, violence, suicide and substance abuse.<sup>5</sup>

Adding up to these people's health risks that elevate barriers for health care, there's a lack of connection between primary care and other levels of health assistance. To achieve specialized services, the Brazilian health system user must necessarily be referred by any entry gates of the system – primary care, overall.<sup>6</sup> This means that the existence of public policies isn't a guarantee that human and sexual rights of trans people will be achieved. The absence of an adequate network for their demands' resolvability is revealed in the finding of public health institutions in which the most of the professionals are unprepared, there's inadequate ambience and desintegrated workflows for health care.<sup>5</sup>

Facing the above, this study is about an integrative literature review that had as goal to know actions and practices for trans people's health care and the existence of protocols for attending these people's health demands. It's expected that the results may support health care professionals to achieve integral health care for this population.



## 2. Methods

This research is an integrative literature review of studies published between the years of 2009 and 2019 about the aspects related to trans people's health. To develop this study, the following stages, which compose the elaboration of an integrative review, have been performed: definition of the research question; literature search; studies categorization; studies evaluation; results interpretation; and knowledge synthesis.<sup>7</sup>

The guiding question of this research was: "What are the forms of health care assistance to trans people?". To answer such a question, databases indexed on the Virtual Library of Health (VLH) were visited using the following descriptors in Health Sciences (<http://decs.bvs.br/>): "transgender people"; "transsexualism"; "protocol"; "health services"; "care ambulatory"; "health care for transgender people". These descriptors were used in both Portuguese and English languages, checked with Boolean operators AND and OR. The databases included were CAPES, Science Direct, MEDLINE, LILACS and SciELO. The encountered articles were grouped on the Mendeley software for material organization and deletion of duplicate. The criteria used to select the articles were: 1) scientific articles fully available online; 2) studies that described health care to trans people; 3) studies published from January 1<sup>st</sup> 2009 to May 29<sup>th</sup> 2019 (including); 4) studies published in English, Spanish or Portuguese. The exclusion criteria were: 1) studies published before 2009; 2) studies focused on non-trans people; 3) studies focused on specialties, such as psychology or speech therapy; 4) studies focused on sexual satisfaction and life quality according to therapeutic outcomes; 5) studies focused on gender affirmation; 6) studies that approached lesbians, gays, bisexuals and trans (LGBT) or men who have sex with men (MSM), but didn't address gender identity specifically.

In order to analyze the studies, a selection flow chart has been created according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The total of found articles was 471. After the exclusion by year, 177 were left. When the Mendeley software excluded the duplicated, there were 169 articles left. Reading the articles titles permitted the exclusion of those that didn't match the established criteria, excluding thus 85 articles. Then, the abstracts were read and those that didn't fulfill the established criteria were excluded, which eliminated 73 articles. At least, the thorough reading of the files led to the selection of six articles, that have been analyzed in the present study. The analyzes of the selected articles went through a judge.

The flow chart below outlines the literature survey adopted by the researchers for the elaboration of this research (Figure 1).

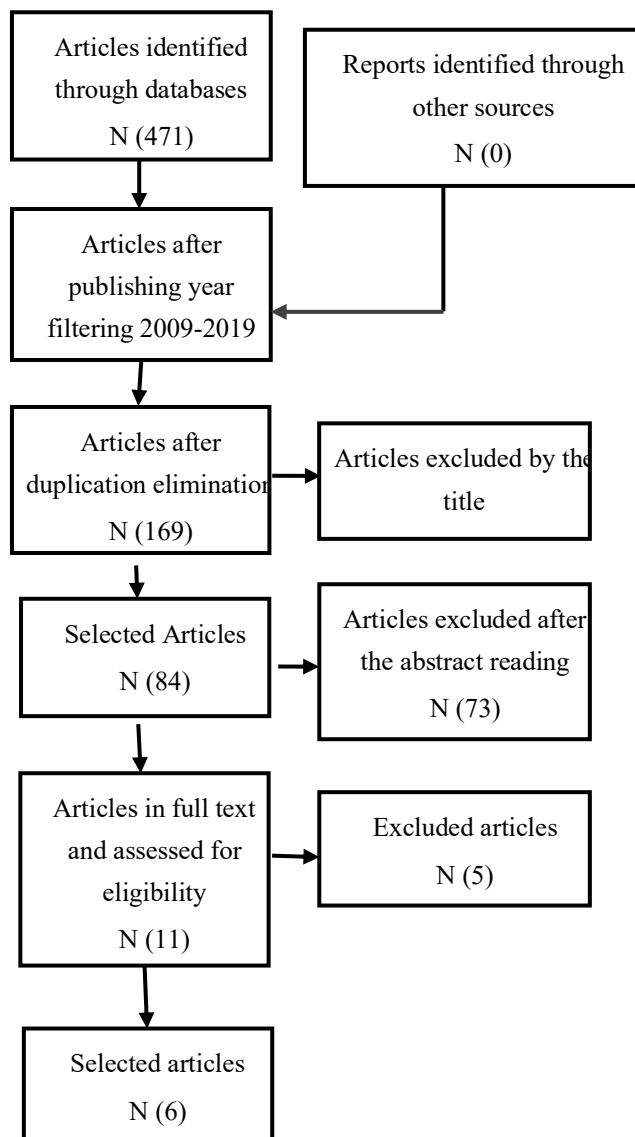


Figure 1. Flow Chart of the studies selection according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)

### 3. Results

Six scientific articles published in Brazilian and international journals and that were related to health care assistance to trans people were analyzed. In order to analyze the selected material, after fully reading the articles, a table that contemplated the information regarding the publishing year, title, journal name, purpose and form of study was elaborated, as shown in Table 1.

Table 1: Article distribution according to publishing year, title, journal name and purpose

Authors	Title	Journal	Purpose	Study form
Sampaio L, Coelho M (2012) <sup>8</sup>	Transexualidade: Aspectos psicológicos e novas demandas ao setor saúde	Interface	Investigate the transsexualiser process of four people, from their own perspectives.	Quantitative and exploratory research
Reisner S, Poteat T, Keatley J, Cabral M, Mothopeng T, Dunham E, et al (2016) <sup>9</sup>	Global health burden and needs of transgender populations: a review	Lancet	Identify the global health burden and the needs of transgender people.	Literature review
Mendelez R, Pinto R (2009) <sup>10</sup>	HIV Prevention and Primary Care for Transgender Women in a Community-Based Clinic	J Assoc Nurses AIDS Care	To obtain information about good practices that improve HIV prevention services and primary health care to transgender women.	Qualitative and exploratory research
Markwick L (2016) <sup>11</sup>	Male, Female, Other: Transgender and the Impact in Primary Care	The Journal for Nurse Practitioners	To discuss the transgender patient and outline basic care and question that might emerge on primary attention.	Theoretical article
Wylie K, Knudson G, Khan S, Bonierbale M, Watanyusakul S, Baral S (2016) <sup>12</sup>	Serving transgender people: clinical care considerations and service delivery models in transgender health	Lancet	To review the role of the mental health professional, models of effective health services and surgical interventions available for transgender people.	Literature review
Gridley S, Crouch S, Evans Y, Eng W, Antoon E, Lyapustina M, et al (2016) <sup>13</sup>	Youth and Caregiver Perspectives on Barriers to Gender-Affirming Health Care for Transgender Youth	Journal of Adolescent Health	To understand the barriers that young transgenders and their caregivers face when accessing gender-affirming health care.	Qualitative and exploratory research

The performed review allowed the selection of six articles, one published in 2009, one in 2012 e the other four in 2016. Only one of those was published on a Brazilian journal. The articles were classified according to methodology: three were qualitative and exploratory researches and three were theoretical studies. All of the selected articles have in common the trans people care, each one with a specific point of view: investigation of the transsexualising process; global charge and health needs of trans people;

good practices on primary care; basic care on primary attention; service templates; and barriers of access to young trans people.

The qualitative researches were conducted by different perspectives. One of them interviewed 65 participants, being 15 young trans peoples and 50 caregivers; another one interviewed 20 trans women; and the last one interviewed 2 trans men and 2 trans women.

Both literature reviews are focused on previous studies that enlighten the adverse health outcome in trans people, discussing factors that lead to health risks and health professionals' education. The theoretical article focuses on primary care to address their health issues.

Four categories emerged after reading the selected articles: 1) importance of hormonal and surgical interventions; 2) change of the civil name and respect towards the social name; 3) negative health outcomes; and 4) barriers of access to health care. The articles were grouped into more than one category, according to the approached thematic.

### ***3.1 The importance of surgical and hormonal interventions***

The first category – the importance of surgical and hormonal interventions – is characterized in the studies as a need to insertion in the society, regarding labor market, as well as a feeling of belonging to the desired gender.

Marckwick's study shows that hormonal therapy can help achieve the appearance desired by each individual. It may take from 3 to 6 months to observe any physical effect from the hormones, lasting up to maximum effects in 5 years. The referred study's results indicate that the hormonal treatment from female to male (FTM) aims to reduce female secondary sexual characteristics, such as menstrual cycles, and to induce male secondary sexual characteristics. On the other hand, male to female hormonal treatment (MTF) seeks to reduce the male secondary sexual characteristics and induce female secondary sexual characteristics.<sup>11</sup>

The hormonal therapy emerged as an important subtheme for health care assistance, specially about the care of people who live with HIV, according to the study of Mendelez and Pinto.<sup>10</sup> In order to develop a feminine appearance, most trans women used estrogen. All of the study participants wanted feminizing effects that were related to their physical appearance; however, many of them pointed to the importance of hormonal therapy for their physical safety regarding other people. On the absence of the hormone, facial hair growth and body muscle are frequent, which can be devastating to some people, especially those whose social networks don't know their trans person condition.<sup>10</sup>

In the study of Wylie et al<sup>12</sup>, hormonal therapy appears as a fundamental need for most transition patients. Such study brought to light that even before socially adopting the chosen gender, hormonal therapy can be applied, which can emotionally favor the individual who doesn't intend to submit to surgery. As shown by the authors, the assisting team must provide a perspective in which the treatment limitations are clarified. Different intentions lead trans people to search surgical procedures as part of their transitions, with not only personal meanings, but also for social representation. It is fundamental to assure those who have been submitted to a sexual reassignment a long term follow up, aiming to reduce the risks of cardiovascular disease and suicide, which are greater in comparison to the general population.<sup>12</sup>

Many participants on the Grindley and collaborators study<sup>13</sup> have noticed the lack of protocols for care

transition, especially for younger patients, which includes puberal blockers prescription. It was recommended that protocols based on clear evidences must be developed for assistance, once many providers don't have specialized training in young trans health and therefore are unaware of the long term collateral damages. The access age to treatment of 16 years was also pointed as a restricting factor, considered too high and associated to emotional consequences. It's relevant to understand, on the other hand, that receiving puberal blockers without access to hormonal therapy would be even worse.<sup>13</sup>

The transsexualization, required by the participants of Sampaio and Coelho's study<sup>8</sup>, was considered a process in which the person is not free from prejudice and social discrimination, even after undertaking surgery and hormonal treatment. The interviewees made clear that even if their condition may be a cause of suffering, when a trans person doesn't submit to transsexualization procedures, that does not exclude transsexuality. Thus, it is reinforced that body changes produce a distinction between the sexes, in a way that trans people claim for a physical transformation in order to fit the social ruling on sex and gender.<sup>8</sup> It's clear that, despite different medical possibilities, trans people still face a long way to achieve the required access to surgical and hormonal interventions.

### ***3.2 Civil name changes and respect to the social name***

The second category shows the civil name change and respect to the social name as dignity precepts, as recognition of identity.

Marckwick's study<sup>11</sup> describes that health care professional's attention to gender identity is fundamental to provide care in a way that recognizes the appropriated measures to their specific conditions. Every trans person must be identified by their social or preferred name and pronoun, it mustn't be made only by a note in the charts. This is the right start for a person centered care, which improves every outcome. The study recommends the following: be respectful – if you're not sure about how a person wants to be called, ask; never assume that a reassignment sex surgery is the goal for every trans person; always remember that gender identity doesn't define sexual orientation; keep every patient privacy; and always use pronouns chosen by your patient.<sup>11</sup>

The participants of the study conducted by Mendelez and Pinto<sup>10</sup> have reported that the clinic was a safe environment, highlighting the receptive attitude of the entire team regarding trans people. The staff was trained to use each trans person's preferred name, and the team was enabled to attend their social and health needs, through appropriated services. The identity emerged as an important consideration to the access to health care for trans woman. It's interesting to notice that trans woman prefer not to be attended at LGBT clinics, in favor of the segregation of some trans women from the umbrella term LGBT, specially in gay communities.<sup>10</sup>

As a social determinant in trans people's health, Reisner and colleagues<sup>9</sup> consider that the gender affirmation presents four central facets: social (name, pronoun), psychological (internal), medical (hormonal treatment, surgical interventions), and legal (legal markers, change of the civil name). The authors still discuss that the gender affirmation depends on a number of factors, including the cultural and social context, accessibility to hormonal treatment, criminalization of sexual minorities, legal barriers for change and acknowledge of identity. There is not a single way to achieve gender affirmation, no common way to describe how a trans person affirms and embodies his/hers gender.<sup>9</sup>

The participants on the study of Gridley et al<sup>13</sup> related situations in which their name or pronoun of birth were used on health care services, even after corrected by the patient or his companion. Even though most of it was perceived as not intentional, some participants have noticed malicious situations. Many teenagers described relief or joy when their name and pronoun of choice were used, and thus recommended the health professionals to ask the patients name and pronoun of choice, making this information clear on the medical chart.<sup>13</sup>

Sampaio and Coelho<sup>8</sup> reinforce in their study that the balance between body and mind of a trans person is achieved, also, by the adequacy between sex and pronoun. The respect to identity is anchored on the right to one's own body and the right to health.<sup>8</sup>

What trans people ask doesn't differ from any other patient: the right to be respectfully treated. Every name and pronoun must be used according to the patient who's asking for care.

### **3.3 Negative health outcomes**

The third category covers the negative health outcomes. The article selection allows to perceive that the health damages appear predominantly on the studies represented by HIV infection and other ISTs, psychic suffering/mental disorder and drug use/abuse.

Markwick's article<sup>11</sup> describes that trans people face harms on health care related to social stigma, discrimination and denial of human rights. All of this results on higher rates of HIV/IST, victimization, substance abuse and psychiatric disorders. Young trans are more likely to live on the streets and 2-3 times more likely to attempt suicide.<sup>11</sup>

HIV infection was reported by several researchers as been greater in trans women, according to Mendelez and Pinto<sup>10</sup>, with emphasis on the meta-analysis that reported a prevalence of 27,7% of HIV infection on trans women. Furthermore, it has been observed an inferior treatment adherence rate to antiretroviral treatment among trans women HIV infected. Such data is justified, at least partially, by the triad: mental health; violence; and substance abuse. The study concludes that only comprehensive care in the health care of transgender people can change such outcome.<sup>10</sup>

The 116 studies analyzed by Reisner and collaborators<sup>9</sup> allow to infer that trans people face a high charge of negative health outcomes, which have been grouped into six categories: mental health; sexual and reproductive health; substance use; violence and victimization; stigma and discrimination; and general health. The authors conclude that mental health is the more studied health area regarding trans people, focused on mood disorders, suicide and self-afflicted injuries and anxiety disorders, consistently demonstrating that adult trans suffer from psychic disorders.<sup>9</sup>

Likewise, following the listed categories of the study<sup>9</sup>, sexual and reproductive health was the second more studied area, identifying that trans women are disproportionately affected by HIV and other IST. Other subjects regarding sexual and reproductive health still receive little attention from studies, for example, about fertility and gestation. Substance use was the third more studied category, with outcomes, though heterogeneous, capable of assuming that such use is associated with stress coping.<sup>9</sup>

Thereto, the study<sup>9</sup> shows that violence and victimization among trans people create a high charge of suffering on this population. The forms of violence or victimization most pointed were sexual (34%), physical (17%) and psychological or emotional (7%). Stigma and discrimination as health outcomes have

been cited on only 14 articles, most of which conducted on North America, and a bit more than half of them specifically directs to stigma and discrimination on health care, including the refusal to care due to stigma, thus making clear the need of more studies in order to enhance health care.

Moreover, the study of Reisner et al<sup>9</sup> expresses that general health of trans people is the least studied aspect on the global disease burden of the population, with notes to outcomes such as mortality, diabetes, hormone use, metabolic syndrome and cancer. Most of the studies only show statistic data that are not adjusted to trans population.<sup>9</sup>

Facing such adverse outcomes is sadly easy to understand. Stigma and discrimination are general rules for trans people, who are presented as vulnerable as they might be.

### **3.4 Barriers to health care access**

The fourth category are the barriers to health care access, presented on studies as a multifaceted and that restricts the resolubility of trans people's health demands.

Marckwick's study<sup>11</sup> describes that barriers to health care access for trans people are centered around four main questions: reluctance to reveal one's identity, from the doctor to other health professionals, such as pharmacists and laboratory technicians; lack of staff and specialized resources in the trans people care; financial barriers – most of them don't have private health insurance and, when they do, there's no coverage for specific assistance; and structural barriers, inadequate ambience, expressed by the absence of unisex restrooms and gender segregated hospitalization, besides lack of documents on electronic records and variations of appropriate reference on lab systems. The author also points that doctors and nurses graduation curriculum abstain from trans patients care, which difficults the access to a culturally competent quality care.<sup>11</sup>

The participants of the study conducted by Melendez and Pinto<sup>10</sup> described that having a variety of health needs met at a single location and a holistic approach were favorable. Many of the HIV infection prevention practices resulted initially from the attraction to primary care. The factors that directed trans women to medical care were: possibility of personal identification as a woman, not as a trans; access to hormonal therapy; and the staff attitude that created a culturally congruent atmosphere towards health care.<sup>10</sup>

Reisner and collaborators' study<sup>9</sup> demonstrates that health care barriers have been met, partially, by laws and public policies. Some countries start articulating the required transformations through gender identity laws, legislation about gender affirmation care and protective and antidiscrimination measures. For example, according to the authors, in 2012, the Argentine Senate approved the first gender identity law on the world, which authorizes the trans person to change her legal gender markers through a simple administrative procedure, with enhanced access to hormonal treatments or surgical procedures and under state coverage. It's required an evaluation of such legal changes effect and improvement on trans people's health.<sup>9</sup>

On Gridley et al's study<sup>13</sup> it came clear that many factors related to the professional health system have an impact on the access to interventions. The lack of training on health care to gender affirmation may lead to insufficient knowledge of specific health issues of trans people, and thus inadequate knowledge to prescribe treatment. The authors highlight that few studies focus on young people experiences and their

caregivers. Participants cite the lack of a structured care as a barrier; the care has been seen by some as disorganized, underneath a layer of team work.<sup>13</sup>

Many participants of this study<sup>13</sup> have seen mental health professionals as hormonal therapy guardians, frequently describing a frustration feeling because they should wait for this professional's approval in order to transition; most of the participants wishes the therapy could be integrated to care, not a pre-requisite. Negative experiences with mental health professionals have been described. Meanwhile some young people also cited as a barrier the need of the responsible adult's authorization for treatment, some caregivers reported difficulties accepting the body alterations.<sup>13</sup>

It's expected from trans people an adequate access to health care, which means care from ambieny to prescription.

#### **4. Discussion**

There is much to observe about health care assistance for trans people. It's important that there's a differentiated look, expressed by a competent and culturally sensible care. The lack of a formative curriculum focused on trans patient care on medical and nursing schools, as well as the absence of available resources for the caregiver, extend trans people's vulnerability through a great disparity in access to quality care.<sup>11</sup>

Studies consistently show the importance of early introduction of transgender health modules on medical education. Evaluations of those curricula suggest that even a short training can substantially increase the comfort with trans people's attention. The reality is that most students, even those studying in higher income institutions, still complete their training with limited display of trans people's needs. The training necessity is clear in view of the importance of acknowledge by health professionals of expressions beyond gender binary and also the potential presence of specific violence affecting trans people.<sup>12</sup>

The health inequalities are hypothesized for being born from a systematical exposure to multiple stressors factors, including legal and structural factors that result from being part of a socially marginalized group. Social and economical exclusion are, thus, considered casual pathways of negative outcomes in health. As cultural diversity and gender fluidity get more attention, it's expected that standard care and services for trans people become available in most countries on the human rights structure. It's understood that general health and well-being of trans people should be attended on the primary care context, with no differentiation on services offered to cisgender people on physical, psychological and sexual health.<sup>12</sup>

Specific attention to gender transition is also possible on primary care. To establish a gender dysphoria diagnosis and to adapt a care model may allow the start of hormonal therapy on primary attention. All health unit professionals must receive basic training aiming to adopt a cultural humility combined with clinical abilities, acknowledging the diversity of required training for different staff members.<sup>12</sup>

The offer of a diversity of health services on the same unit has the potential to increase the user adhesion and favor the integral care. To promote hormonal therapy is a way of not only retaining trans people on the service, but also to promote health, prevent HIV infection and retaining antiretroviral therapy. It is notorious that trans women need to maintain a feminine appearance for their psychological well being, as well as to avoid abuse and violence, understanding a context of poverty underlying transgender people



and sex associated incentives in exchange of drugs or money. The high rates of HIV infection and other IST among trans women outlines the importance of HIV and IST testing in all trans people.<sup>10</sup>

Some barriers pointed out by young trans overlap those cited by adult trans people, including cost, limited access to friendly trans professionals with knowledge on the field, limited access to hormones, gender confusion experiences and not coordinated and without retention care.<sup>13</sup>

People's and society's expectation towards health care of trans people are evolving; thus, the evolution of care patterns allows a flexible path of support from professionals that promote care during the transition. Even though, the fundamental change stays in how the care patterns are going to be negotiated, approved and implemented by public and private health authorities in many countries, in the context of broad socio-religious and sociopolitical issues, within the normative of heterosexism.<sup>12</sup>

## 5. Conclusion

The goal for this integrative literature review was to acknowledge actions and practices for trans people health care and protocols attending these people health demands. From the six studies selected, it's clear to see there's a long way to go to achieve adequate care that improves their demands' resolubility.

The product presented by this review results from many difficulties: health system infrastructure; different sociocultural contexts; inexpressive number of specialized or capable professionals; and lack of protocols consistently applied. This set leads to a care not coordinated and without retention, restricted access to hormonal therapy and a scenary of specialized attention more prepared in contrast to primary care, which should be able to offer whole care.

We propose therefore improvement in health education, where a multidisciplinary team must work together, developping health care protocols for trans people which respect name and pronoun of choice use and guaranty hormonal therapy availability, enduring health promotion actions aiming to reduce the negative health outcomes.

The limits of this study are the chosen database and health science descriptors. We suggest that further studies amplify the database range.

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## **Mentoring: A Faith Based Relational Leadership Approach in Preventing and Countering Violent Extremism in Kenya.**

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### **Abstract**

*The article examines the role that mentoring, a critical relational leadership process would have in preventing and countering violent extremism by first examining the contexts of radicalization into violent extremism and past violent extremist attacks. Youths and adolescents in Kenya have been radicalized into violent extremism with resultant acts of terror that have resulted in; mass fatalities, casualties, destruction of facilities, disruption of livelihoods and business, and creation of immense fear within the public. The first major attack that seemed to have opened this cycle of al Qaeda and al Shabaab-led Jihadist attacks was the August, 1998 twin-bombing of the USA embassies in Kenya and Tanzania. Since then, we have had the advent of; al Qaeda, its affiliate al Shabaab, and ISIS attacks rising within the African continent with heavy impacts of death trails, casualties, and destruction. This year, Kenya has suffered a number of attacks targeting both soft and hard targets. Among the soft targets was the attack targeting Dusit Hotel in the upmarket 14 Riverside Complex, which left 21 Kenyans and foreigners dead. By extension there have been a number of IED attacks targeting the security services of Kenya many fatalities and casualties. All these attacks have been executed by violent extremists among who are Kenyan youth who have been recruited and radicalized into violent extremism as an ideology that is leveraged on the Islam religion. This ideology of Jihadism is skewed but uses narratives that easily appeal to those targeted for radicalization. Consequently there is an urgent need to have in place relevant mentoring leadership practice to enhance worldviews and perspectives among youth and adolescents which are in tandem with what a sane world subscribes to. It then becomes imperative to have a faith-based mentoring approach that is devoid of extremism and which gives the pool of those targeted a leadership component. This deliver a countering and preventive relational leadership model enhancing resilience of individuals and communities, while countering narratives and propaganda inherent in the recruitment and radicalization to violent extremism. Following literature review and conceptualization of the variables, this article concludes that preventive and countering violent extremism measures are best deployed first amongst the youth, who form the largest and most vulnerable pool of those targeted for radicalization due to; their crave for an identity, promises of a utopian caliphate on earth and life upon death, poverty, joblessness, presence of ungoverned spaces such as the complex cyber space, and dysfunctional social systems including families.*

**Keywords:** Leadership, mentoring, youths, radicalization, adolescents, faith based organizations, women, collaboration, violent extremism, terrorism, Jihadism.

## **Introduction**

Terrorism has been one of the most dehumanizing, fear-instilling, disruptive, sadistic, destructive, and exploitive manifestation of violent extremism based on skewed irrational Islamic worldviews of Jihadist leaders and their followers (Goepner, 2016; Haki Kenya, 2014). Kenya has borne the full blunt of both AQ and its affiliate Al Shabaab's terror attacks as witnessed in the attacks on; US embassy, West Gate, Garissa university, churches, bus stages, buses on transit, Mandera quarry workers who were Christians, Safaricom Masts, dispensaries, foreign workers, and IED attacks targeting security services (Akwiri, 2014; Mohamed, 2014; Njoku et al., 2018).

Following the 9/11 debilitating attacks by Al Qaeda on America, a number of strategic interventions involving collaboration across; agencies in nations, regions, and global actors of security have been initiated, with successful implementation (Goepner, 2016; Goodrich, 2002). Within the implementation frameworks has been the formulation of coalitions focusing on dynamic approaches towards the global war on terror (GWOt) as witnessed in; Somalia, Mali, Iraq, and Syria. By extension nations have formulated national strategies on countering violent extremism (NSCVE) as seen in Kenya, under the National Counter Terrorism Centre (NCTC), and the National Strategy for Counterterrorism of USA (NSCT-USA, 2018).

In spite of the many counter terrorism (CT) knowledge packages developed through a wide spectrum of researchers and other actors, as seen in the outcomes under; criminology, sociology, communication, anthropologists, and economists, there has been minimal footprints of leadership researchers in regard to; terrorism, counter terrorism, preventing and countering violent extremism (Braddock, 2017). Further research vacuum is in the leadership role of faith based organizations in CT and PCVE, besides the glaring gaps of the same organizations for they lack proactive participation in research towards understanding their leadership roles in the GWOt.

It is further observed by the authors that the role of leadership has not been singled out by the many researchers including (Alkaff & Siyech, 2017; Finn & Hafez, 2016; Goepner, 2016, Nyaga, 2018), who have to the contrary, only focused on the rhymes of the different contextual push and pull factors into radicalization. Empirical evidence makes the scenario more complex by showing that religious beliefs and practices have not been integrated into the managing and mitigating disasters (Gianisa & De, 2018). This is despite the fact that terrorism delivers disasters in different faith based contexts as observed in incidents such as the atrocious bomb attacks on churches during Easter festivities in April 21<sup>st</sup>, 2019 in Sri Lanka. Every terror attack negatively affects; civil, business, and national continuity with an inherent need for the Faith Based Organizations (FBOs) to understand this and hence have in place resilience strategies. Such strategies should include business continuity plans.

The major demographic pools targeted for recruitment and consequent radicalization into violent extremism in Kenya, one of the countries heavily affected by terror activities, are adolescents and youth (Nyaga, 2018), including girls and women. The research further cites dysfunctional families characterized by abdication of parents and politicians from their duties, with suggestions for government, parents, and society to play their critical roles of enhancing the psychological wellbeing of adolescents and youth.

Psychological fortification of children, adolescents, and youth is a pivotal facet in the creation of resilience against violent extremism approaches and strategies.

There are far reaching ramifications on demographic dividends core towards community and national growth emanating from radicalization and consequent violent extremism. Among these ramifications are the; fatalities, casualties, trauma, destruction, and disruption of livelihoods caused by the attacks, untold suffering to the families of such youth, definite loss of life for such youths. There is use of a substantial amount of the national resources towards the GWOt to the tune of 13% of the gross domestic product (GDP) which would have been used for the much needed national growth activities (Mark, 2015).

This then places an inescapable role on the shoulders of leadership researchers into coming up with methodologies of enhancing the PCVE leadership practices and processes. This should permeate across the many youth and adolescents, who are the main targets across demographics and various spaces. Such a leadership-based strategy is a definite intervention resonating with the PCVE approaches as anticipated within the ambit of national countering violent extremism strategies as seen in the NSCVE of Kenyan whose pillars of; religion and ideology, psychosocial, education, legislation and policy, and security resonate with leadership-based approaches.

Captured at the node of faith based organizations it then becomes an important inclusive leadership model core towards involving families, FBOs, adolescent, and youth in charting thought processes and engagements that are not only rational but of utmost significance; thoughts, worldviews, and engagements devoid of extremism ideologies. By extension it cultivates a culture of collaborative leadership through bringing on board; linkages among; FBOs, families, adolescents, youth, leadership researchers, and governments. No wonder then that after the attack on Dusit in Kenya a number of religious leaders called on all faiths to ensure that they develop the practice of accounting for their youth (Nzwili, 2019).

## **Terrorism**

Since the advent of Al Qaeda as a Jihadist group, there have been many terror attacks on both soft and hard targets targeting a plethora of states and nations having relationships with the West, premised on the ideology of al Qaeda as well as its affiliates on one hand. On the other hand, other emerging twenty-first century Jihadist groups such as the Islamic State in Iraq and Syria (ISIS) together with a number of its affiliates, who have pledged allegiance to ISIS leadership, have left a heavy trail of; fatalities, casualties, destruction, disruption, and fear across the; facilities, communities, and nations that they have attacked.

Despite the long-awaited killing of Osama Bin Laden, the elusive AQ leader who authored the deadly 9/11 attack on US, AQ showed unique; survival, agility, and flexibility abilities after his death. This resilience had not been factored into the counterterrorism strategies by the actors of the global war on terror (GWOt). Instead, the main leadership of the GWOt was majorly focusing on the emerging and extremely violent major Jihadist group, ISIS, following the announcement of its caliphate, United States Institute of Peace, (USIP, 2017). This blindsiding of the actors of GWOt led to the unprecedented global proliferation of AQ, and complex mutation of Jihadism, resulting in a new form of complexity in the GWOt.

Among the camouflage, win-win strategies and diversionary techniques deployed by AQ includes capitalising on spaces that were either ungoverned or under-governed. This is achieved by; supplying essential needs for locals such as governance models, health services, food, forging strategic alliance with local militias, and withdrawal from some of their operational areas (Alkaff & Siyech, 2017; Finn & Hafez, 2016). In Syria, Nusra Front an AQ affiliate rebranded into Jabhat Fateh al-Sham in 2016, as a strategic move towards acceptance and avoidance of inter-Jihadist conflicts (USIP, 2017).

For Jihadist groups to maintain their murderous activities, presence and essence, they use elaborate contextual methods towards targeting vulnerable members of communities and in particular the; youth, women, adolescents, and children upon which such groups are recruited and then radicalized through skewed radical ideological propaganda. Fertile grounds for recruitment include unstable states and nations as seen in the ecosystem provided by the current Yemen conflict which resulted in the formation of the al Qaeda in the Arabian Peninsula (AQAP), an affiliate of AQ (The Soufan Group, 2016). Within the unstable states and nations are the spaces across the informal sectors, while for stable states the spaces are within the formal public spaces including; family, learning, religious, business, and cyber spaces.

## **Al Shabaab**

In Africa, AQ has affiliates that include the al Shabaab whose base, Somalia, is yet another ecosystem characterized by both under- and un-governed spaces and territories, with a characteristic trend of waging its Jihadism towards having an AS –led Somali government. Al Shabaab pledged its allegiance to AQ in 2008 and has been the greatest terror threat to East African region and in particular to Somalia and Kenya (Warner & Chapin, 2018).

Another Al Qaeda affiliate Jihadist group in Africa is Jama'at Nasr al-Islam wal Muslimi (JNIM) of Mali, an affiliate of Al Qaeda in Maghreb (AQIM), whose estimated number of fighters by April, 2018 was 800 (Warner & Hulme, 2018). Mali has borne the full blunt of the different Jihadist groups that are within its boundaries where some have bases in the Wagadou woodlands ecosystem, and those from the surrounding nations that include; Boko Haram who have pledged allegiance to ISIS, those from Niger and Southern Libya, and AQIM (USIP, 2017).

Within the ranks of Al-Shabaab are hundreds of foreign Jihadists, its transnational signature, including; Kenyan youths, Americans, Yemenis, Syrian–Americans, Saudi–Arabians, Pakistanis, and Sudanese, playing critical strategic roles such as; funding, recruitment, training, and cyber terrorism by preparing and disseminating online; propaganda, training, sourcing for funding and attack materials (ICG, 2010; Michael, 2017; Weber, 2015).

## **ISIS**

Following the announcement of the ISIS physical caliphate on June 30<sup>th</sup>, 2014, there was an array of activities across the globe from three main fronts; actors of GWOt, al Qaeda, and thousands of ISIS followers from across over 100 countries. This strategic statement by ISIS created a global complexity that saw mass movement involving; families, professionals, girls and boys, youths, former members of other Jihadist groups, to Syria through a firm belief in the utopian caliphate nature that was promised

(USIP, 2017). During a Wajir county focus group discussion on radicalization, a critical CVE exercise in Kenya, a participant narrated how the son got radicalized and finally joined ISIS, one of the many indicators of ISIS presence in Kenya (United Nations Development Program, UNDP, 2017).

A major bioterror attack targeting mass fatalities organized by Mohammed Abdi Ali, a Kenyan medical intern and a member of ISIS was thwarted in 2016 (Mwangi, 2016 May 14; Zadock, 2016 May 3). Ali belonged to an affiliate group of ISIS known as Jabha East Africa which is part of the ISIS presence in the East Africa region with other affiliate groups being; Islamic State of Somalia (ISS), and Islamic State in Somalia Kenya, Tanzania, and Uganda (Warner & Hulme, 2018). The instruction to ISIS fighters and sympathizers in December 2017 to hunt Christians and kill them further shows the threat ISIS, its affiliates, and supporters pose to the region and in particular to targeted non-Muslims.

### **Radicalization**

Radicalization is a process that involves indoctrination of an individual through the use of skewed Islamic based beliefs and values, into violent extremism and terrorism with such individuals either becoming operatives of violent extremism in terror attacks or playing other roles in terrorism such as; recruitment, financing, radicalization, intelligence gathering, and assembling of IEDs (Rahimullah, Larmar, & Abdalla, 2013). The social space that is part of the radicalization spectrum, in which individuals are recruited and radicalised into violent extremism, is highly complex with continuous change. Some of its parameters are; narratives on national wealth and its skewed distribution, social exclusion relationships in a diffuse society, cultural diversity, and normative perspectives (Cooney & Bigman, 2015).

The drivers towards one becoming radicalized then vary in line with the many contexts that an individual is exposed to within different environments which include; family, faith, organizational, cyber, legal, political, and socio-economic ecosystems. Among these drivers include the need for a national identity in the youth (USIP, 2016), and particularly for those who lack exposure to relevant dialogues that capture their worldviews as well as those of others.

Wanderlust serves as another driver towards radicalization of the youth (USIP, 2016), together with readily available online Jihadist propaganda captured through the cyber radicalization platforms (Hamm & Spaaj, 2017). It is worth noting that some youth want to be celebrities, wanderlust, and thus join violent extremists with that motive in mind.

By extension research has shown that religion can be a key factor towards radicalization into violent extremism with some cultural components including beliefs that are fatalistic, adding to violent behaviors in the radicalized (Schmid, 2014). Radical Muslim figures with prominent justifications for Jihad premised on well thought out misinterpretation of Islam, as witnessed in the utterances of radicalization and Jihad by bin Laden and al al-Awlaki (Rahimullah et al., 2013), have played a major (mis-)leadership role in shaping tragic misguided global Jihadism. No wonder then some mosques and their firebrand clerics have been involved in the recruitment and consequent radicalization of Muslim youth as witnessed in the case of Sheikh Aboud Rogo in Kenya (Ndzovu, 2014).

## **Radicalization and use of children**

As observed by Bloom, Horgan, & Winter, (2018), between 2015 and 2016 Jihadist groups such as ISIS had normalized the use of children and youth in serving the same roles as adult operatives. On May 13<sup>th</sup>, 2018, in Surabaya, Indonesia, a family within which were two teenagers and two children, simultaneously attacked three churches through suicide bombing resulting in 13 fatalities and 41 casualties (Schulze, 2018). These family borne attacks were a response from an extremist ideology calling for the targeted attack of idolaters, unbelievers, and those showing deviance to the words of Allah (Schulze, 2018).

Recruitment and consequent radicalization of children has been on the rise with the United Nation verifying 274 cases in 2015, involving the Islamic State in Iraq and the Levant, with other children being recruited in Kenya and Somalia by AS, a case repeated by Jihadists in Mali, Nigeria, and Philippines (UNODC, 2017). The report further outlines that, such children pose future threats to humanity not just from the lens of terrorism but also from those of plausible war crimes as well as crimes against humanity such as genocide.

## **Radicalization in Kenya**

In Kenya, radicalization has focused on social exclusion narratives citing; marginalization based on lack of provision of basic services by government, mistreatment by security services including alleged extra judicial killings, negative ethnicity, perceived historical injustices and supremacy of Islam religion (BoC, 2017; Ndzovu, 2014). Other skewed and irrational cards played by the Jihadist groups include the entry of the Kenya Defence Forces into Somalia with alleged accusations of atrocities committed against the Muslims in Somalia (Haki Kenya, 2014; Ndzovu, 2014), statements bitterly used by attackers during the brutal terror attacks on West Gate and 14 Riverside Dusit. Recently al Shabaab leader, Ahmed Diriye, expressed al Shabaab's anger on Kenya in regard to the on-going maritime conflict between Kenya and Somalia defining it as a Christian hostility against Muslims (Daily Nation, 2019, September, 20).

Such comments and worldviews in an ecosystem of on-going AMISOM operations in Somalia which Kenya is a member have a possibility of being used as grounds for narratives on radicalization into violent extremism by AS. The card of religion needs to be viewed from the context of having relevant cultures of resilience within targeted groups through the nexus between faith-based organizations and resilience against radicalization of the society.

In January, 2019, two students from Narok County, aged 16 years, were arrested in Narok on their way for training in Somalia, with their recruiter escaping from being arrested (Kirui, 2019 January 24). In September, 2019, police officers in Transmara arrested a motor bike owner, aged 34 years and therefore a youth, who had gone to claim his bike while having fake bandages on his face. He had presented a letter from the national police headquarters for assistance in releasing the motor bike only for the police to realize that he was wanted for terrorism activities as well as other criminal acts (Kirui, 2019 September 22).

Youth are radicalized in; institutions of learning, work places, social places, religious places, cyber spaces, prisons, and gangster spaces. Particular youth targeted for radicalization by Jihadist groups in



Kenya include; those with low levels of education, jobless, slum dwellers, criminal gangs, girls as well as children from target rich families, college and university students (Hellsten, 2016). Among the planners and executors of the terror attack on Garissa University was a former student of the University of Nairobi, who had attended one of the private secondary schools in Nairobi City County.

By extension one of the leaders of Al Shabaab in Mogadishu, Ahmad Iman Al, who has been declared by US as a specially designated global terrorist, was an engineering graduate of Jomo Kenyatta University of Agriculture and Technology (The East African, 2019, March, 27). He was involved in the; recruitment of youth from poor areas of Nairobi City County and universities, operating stalls in Gikomba, besides operating across the borders of the East African countries including; Burundi, Tanzania, Democratic Republic of Congo and Mozambique.

In the same breadth, the alarming trend of recruitment of university students by AS has been identified (West, 2016, January, 7), with evidence including Abdirahim Mohammad Abdullahi, a former law student at the University of Nairobi, who was involved in the planning and attack of Garissa University, and Abdul Hajira, a bachelor of commerce graduate and a banker who was killed in an attempted terror attack on a police station. Mohamed Abdi the medical intern involved in the planning of a thwarted bioterror attack adds to the statistics of learned Kenyan youth recruited and radicalized, who even went ahead to also recruit and radicalize other students into violent extremism.

## **Women and girls' operatives**

There has been a skewed focus on women as victim of conflict and violence thus blurring the need for elaborate CVE approaches targeting women in terrorism (Bigio & Vogelstein, 2019). Women have been used as tools for intimidation through sexual violence besides serving as wives, and in emerging traders as strategic actors in VE (Bigio & Vogelstein, 2019). Involvement of women in terrorism has seen the use of women as planners, couriers, and even suicide bombers owing to the less suspicion that women are treated with by security officers in facilities, spaces, and events (Ramachandran, 2019). In the ISIS, the use of women operatives was given a priority guideline through its newsletter, Al-Naba, calling upon women to join the Jihad when duty calls, a call that saw a woman carrying an infant a decoy, detonate herself against Iraq soldiers in July 2017 (Schulze, 2018). This was to be followed by a directive by ISIS for women to arm themselves and carry out terror attacks (Dearden, 2017).

During the attack on Dusit D2, in Nairobi, Kenya, in January, 2019, among the accomplices of the attackers was Veronica Kemunto, a former student in Journalism at Masinde Muliro University and an alleged wife of the master minder, Ali Salim Gichung'e. The wordings "Al Shabaab bride" on her Facebook page went ahead to indicate her daring nature, deep engagement and commitment to Al Shabaab. By extension a Kenyan woman by name, Halima Adan Ali, has been identified as an; Al Shabaab recruiter, ISIS facilitator, and fundraiser for both AS and ISIS by both the US and Kenyan governments (The East African, 2019).

Suffice it to say that in Kenya radicalization has exploited for maximum terrorism-based violent extremism the whole pool of diversity in relation to; gender, social status, age, level and type of education, ethnicity, race. This resonates with (Krueger, 2007; Vidino, 2011), assertions that the nature of

radicalization is complex with a focus on the diversity within existing demographics and geographical layouts to optimize on expected impact.

Unfortunately owing to the skewed lenses of the classical view of women as victims of conflict and violence leaving them either as unmapped or poorly mapped actors in the VE strands hence scuttling the efforts of NSCVE (Bigio & Vogelstein, 2019). Women have critical roles in nurturing families through the roles of enhancing family and community values, attitudes, perceptions and behaviors (de Leede, 2018). This role of women is leveraged on for indoctrination and nurturing of VE which places a critical strategic need of relooking the role of women in using their place and role in families and communities in the PCVE ecosystem. The role of women in mentoring women formerly in radicalization, and young girls who are vulnerable serve as critical nexus points with diverse NSCVE pillars although unexploited.

## Cyber radicalization

Cyber radicalization involves the adoption of innovative technologies to propagate jihadist related strategic activities including; recruitment, radicalization through online propaganda, sourcing for funds, planning and training on how to assemble IEDs and execution of different types of attacks (Avis, 2016). Of utmost attention and interest in cyber-radicalism is the large number of vulnerable youths who idle their time in the internet through a variety of cyber space activities, National Counter Terrorism Security Office, (NCTSO, 2015).

Cyber radicalization is seen as an efficient and effective ecosystem of radicalization owing to not only the large number of vulnerable youths accessing online spaces globally (Anne et al., 2017; NCTSO, 2015), but also to the decreased probabilities of detection and disruption (Ducol, 2015), due to assured anonymity through strategies such as use of encrypted messaging, Bureau of Counterterrorism (BoC, 2017).

Cyber Jihadists are systematic in identifying young social media users who are positively vocal towards Jihadist groups' deliberately drafted ideological narratives following which they guide such targeted users on how to use encrypted messaging via; Telegram, Kik, Whatsapp, and SureSpot. Some methodologies are involving use of identified diverse personalities (Meleagrou-Hitchens & Hughes, 2017), as a form of identity-driven radicalization as well as identity theft.

Jihadists have identified and consequently exploited the fact that radicalization is an antecedent to terrorism with increased use of social media adding to an exponentially increased number of those who are in the pool targeted for radicalization (Saltman & Smith, 2015). One mode of online radicalization is through the use of videos depicting extreme violence meted out, through beheading, on those who are deemed to be kaffirs by Jihadists, which triggers an emotional commitment from targeted recruits with a consequent worldview of the legitimacy of such Jihadist acts (Corcoba & Portilla, 2019).

The use of social media in recruitment has seen the leveling of the uneven ground where recruitment focused on males, with women being relegated to the secondary positions of; wives, mothers and daughters. Social media by Jihadists groups has seen women recruited and radicalized into *mujahidat*

(female fighters), a strategic step towards bridging the radicalization to violent extremism gender gap that existed (Winter & Margolin, 2017).

It is worth noting that the use of mobile money lenders in the Kenyan finance space has been flagged by Central Bank of Kenya as a plausible conduit and infrastructure for money laundering, with three credit-only digital money lenders namely; Tala, Branch, & Okash, being named as likely avenues (Burger, 2019; Mutai, 2019 July, 11). With Kenya being not only the leading nation in Africa on mobile banking, but also having the largest number of youth in Sub-Saharan Africa who are actively involved in gambling (Burger, 2019), lack of elaborate legislation towards regulating such credit-only lenders and gambling pose a serious threat and vulnerability. The consequent risk is particularly to the huge number of youths entrapped within the cyber spaces of accessing credit in which the loan services offered majorly target huge numbers of needy youth.

Part of the vulnerability would be towards elaborate credit-based terror networks geared towards cyber radicalization to violent extremism through the bait of quick riches in return for terror-related activities besides vulnerability of personal data. By extension emergent innovative financial technologies that have no legislative control and compliance such as cryptocurrency offer ungoverned cyberspaces. They offer spaces within which luring youths into violent extremism and financing of terrorism can be done discreetly (Irwin & Milad, 2016).

## **Violent Extremism**

Violent extremism is the violent behavior and activities exhibited by radicalized individual or individuals geared towards achieving skewed and irrational; social, political, or ideological goals (Living Safe Together, 2015). There are different types of violent extremism as seen in the attacks by a lone wolf, Anders Behring Breivik in Oslo, resulting in 77 fatalities (Hamm & Spaaj, 2017). Breivik had been a participant in an online platform of AQ extremists which made his extremist political perceptions of exclusion by the main ruling party reach a crescendo of his lone wolf murderous attacks.

Boko Haram, now the Islamic State in West African Province, has carried out hundreds of attacks on different types of both soft and hard targets with thousands of both fatalities and casualties coupled with destruction of facilities. Among these includes the atrocious attack of February 2014 on a Federal Government secondary school in Yobe state where they massacred 59 students who were asleep in their Hostels (Chiluwa & Obedunmi, 2016). Two months later in April, Boko Haram had another daring attack on a bus station in Abuja that resulted in 70 fatalities, and a day later they attacked a girls' school in Chibok kidnapping 276 school girls, while razing the school down (Chiluwa & Obedunmi, 2016).

The terror attacks on Garissa university that left 148 dead is one of the worst attacks targeting a Kenyan facility, and was executed by the al shabaab under the leadership of a former law student at the University of Nairobi. Other grisly and murderous attacks include those involving selective targeting of victims using a religious card in; Mpeketoni, Hindi, Mandera quarries, bus transport along Mandera to Nairobi and Malindi to Lamu routes (Akwiri, 2014; Mohamed, 2014; Njoku et al., 2018).

Lamu has hosted and facilitated the nationalization of Jihadists involved in major terror attacks such as; the US embassy attack Yemeni operative, Mohamed Sadiq Odeh who used the disguises of being a

fisherman and teacher, Fazul Mohamed whose camouflage for penetration was through philanthropy, with Aboud Rogo, an extremist Sheikh hailing from Siu island of Lamu County, worked with other terrorists in both planning and execution of terror attacks (Shauri, 2017). Among those radicalized by Sheikh Aboud Rogo and Abubakar Sharif Makaburi is Mahir Khalid Riziki, an al Shabaab who undertook the suicide bombing at Dusit D2 in January, 2019 (Olingo, 2019, September).

Al Shabaab has had an increased preference and therefore trend in the methodology of suicide attacks whose average number of fatalities per attack being 14.3 deaths per operation, a tactic focusing on efficacy of attack (Warner & Chapin, 2018). No wonder Kenya witnessed the first suicide bomber and hence suicide bombing attack during the attack in January, 2019, on Dusit D2 carried out by, Mahir Khalid Riziki, an al Shabaab of Kenyan origin, whose intent was to cause mass fatalities and damages.

It is worth noting that the multi-agency approach in countering terrorism in Kenya has had commendable success in detecting, disrupting and thus thwarting terror attacks. A case in point is a thwarted bioterror attack (BTA) targeting mass fatalities with *anthracis* by Mohammed Abdi Ali, a medical intern (Mwangi, 2016 May 14; Zadock, 2016 May 3). He was a member of ISIS under the affiliate group of Jabha East Africa (Warner & Hulme, 2018).

## Church Attacks

The terror attacks in Sri Lanka on Catholic Churches and hotels that left 256 dead was carried out by violent extremists who had allegiance to the ISIS (Ely, 2019). The methodology used was multiple modal and target approach focusing on an event based high risk targets. This involved strategic timing on April 21, 2019, when the churches had the highest number of members since it was during April Easter Christian festivities (Ely, 2019). Among the attackers was a family who included an expectant wife who undertook suicide bombing upon confrontation by police resulting in the death of her son, the unborn foetus, herself, and security forces.

The attack executed by a family of six targeting three churches in Surabaya, Indonesia, with a resultant fatality 13, and 41 casualties saw the advent of use of attacks uniquely characterized by; use of family members including women, and children, and suicide bombing (Schulze, 2018). It brought into fore trends that had not been well factored by analysts of the modus operandi of Jihadists; those involving familial ties, use of women, and children with the two sisters Fadhila Sari and Famela Rizqita being 12 and 9 years respectively. The other actors of the middle family class were; their father, Dita Oepriarto, their mother, and two brothers aged 18 and 15 years.

On the same Sunday, another family of six was preparing to carry out a similar attack near the same city, a move aborted by the accidental explosion of the explosive device which resulted in the injury of two of Anton Febrianto's children aged 11 and 10 years, with Febrianto, their father, being shot dead by police officers (Schulze, 2018).

On 29th April 2012, the first violent extremist attack on churches in Kenya took place in Nairobi City County, executed by Al Shabaab, targeting God's House Miracles Church congregation of 600, with a resultant fatality of one and many injuries from the grenade hurled into the church (Omayio, 2015). The second church to be attacked in Nairobi was St. Polycarp Anglican Church Juja Road Pangani

In December, 2017, ISIS called on its affiliated fighters in Somalia to hunt for non-believers over the Christmas festivities and murder them, an indicator of the violent extremism intent and targeting on Christians by ISIS sympathizers and fighters in Somalia (Shay, 2018). On 17<sup>th</sup> December, 2017, Bethel Memorial Methodist Church located in the a Pakistani city of Quetta, suffered from multiple modal attacks by ISIS using a suicide bomber and an active shooter, resulting in nine fatalities, and over fifty casualties (Hashim, A. 2017, December 17).

The Roman Catholic Cathedral of Our Lady of Mount Carmel in Philippines was attacked by violent extremists using bombs on January 27<sup>th</sup>, 2019 with twenty fatalities and 102 casualties with the November 13<sup>th</sup>, 2016 bombing of Samarinda Church in Indonesia, which targeted toddlers, causing the death of one toddler and casualties to a few others.

## **Mentoring**

A huge youth population can be viewed from the prisms of opportunities and/or challenges. It can provide a much-needed workforce for countries, continuity in various fields when engaged by different actors of the socio-economic value chain productively. On the other hand, when engaged by actors in the web of criminal world, the youth population can become not only destructive but as has been documented a threat to civil, business, and global continuity. Provision of meaningful sources; of income, career progression, mental health, and positive and socially acceptable identity, are just but a few critical issues of youth that require continuous strategic focus by the leadership of every society.

Part of these leadership processes should include mentoring, which Laiho and Brandt (2012) state is the transfer of tacit knowledge and experience from those who are older to younger colleagues, towards fostering their personnel development. Within a corporate setting, mentoring provides future potential deliverables that strengthens competences, self-esteem, self-concept, and enhancing of the organizational image.

For the youth, mentoring would provide direction, sound choices, and enable the youth to make the right choices for their lives. Young people, the authors note, may demand the use of social media alongside mentoring. With advancement in technology, further research could be carried out to find out how technology can be incorporated into mentoring without losing its relational aspects.

Mentoring has other diverse definitions, and a closer look at them enables us then to closely define what we really are referring to. Galbraith (2001) notes that mentoring is an activity by which older persons of higher rank, exceptional achievements and reputation instruct, counsel, guide and expedite the intellectual and personal development of persons who are identified as protégés. On the same breath, Merriam (1983) observes mentoring to be a powerful emotional interaction between an older and younger person in a relationship in which the older mentor is trusted, loving, and experienced in the guidance of the younger. Kram (1985) indicates that one who is a mentor needs to provide support, to guide, and counsel a younger adult as he or she accomplishes mastery of the adult world.

We also note the description given by Faure (2000) that mentoring reflects a relationship that meets a development need, that helps develop full potential, and benefits all partners; mentor, and mentee. In all these descriptions then, we note that there is a need for those who are older, to spend time imparting

values and correct ethics to younger adults. It is instructive to note that young people will always emulate those who are older, an indicator of the importance of showing them the way, a way that is not destructive to society or indoctrination that is harmful to themselves and the wider communities.

### **Appreciative inquiry as a supportive tool of mentoring**

FBOs have opportunities of interacting with not only the youth, children, and adolescents, but also with the key influencers of the same demographic categories. Among these actors of influencing the psychological, physical, intellectual, and social wellbeing of those targeted for radicalization include; mother and fathers as parents, learning institutions, employees, government, law enforcers, and civil society organizations. This then gives the FBOs a wider spectrum of applying a complex matrix of mentors by bringing on board relevant mentoring programs that have a shared leadership model.

The mentoring process that is adapted by FBOs must be one that looks at the whole spectrum of change, both personal and institutional. This is because the issues of radicalization and CVE are perceived to be both personal and institutional, with under-governed and ungoverned spaces pointing fingers at failed government. Mentoring in regard to such a specific context then, must then be seen to be holistic by appreciating the gaps which include social exclusion by government and even by other sectors of society. The Appreciative Inquiry (AI) is an approach to thinking that works from the propositions of affirmative action and visions of the possible, rather than problem solving, finding what is wrong and looking for difficulties (Cooperridder, 1998). The advantage of mentoring through Appreciative Inquiry is that it is based on dialogue, with initial steps being to collect opinions and observations of everyone involved through telling stories of what has been and is successful.

Within the context of CVE, the youth would begin from a point of narrating and appreciating the many strengths that they possess, skills that they know they are good in, as well as values that they wish to continue espousing. The method then progresses to the selection of the most important of these themes, which would then form a basis for building a series of provocative proposition that describes how the individual is. This guides the mentees and other participants towards relevant worldviews devoid of violent extremism.

By using successful examples in the past and present, Cooperrider (1998) indicates that we build a picture of the themes and ideas of what we know we can do, and that work. He also notes that we should develop an individual and collective mindset of what we are capable of, one that is grounded on realistic and authentic assessment of communities. He states that this is a significant shift from existing traditions of education, training, and institutions where the practice is focusing on diverse contexts of what is wrong.

It is worth mentioning that even cultural practices of dealing with issues of discipline or otherwise, stem from the angle of what is wrong that needs to be fixed. The author indicates that as we are dealing with AI and developing propositions and possibilities, AI envisages what might be (based on what is), and stimulates a dialogue on what should be, before finally focusing on what will be.

The AI format is divided into 4 stages that a mentor can use to adopt a mentoring process. Magruder and Cooperrider (1998) indicate that the Discover stage seeks to inquire into the best of the past and the present. We submit that the youth today, need to hear more of positive news than challenges and

weaknesses that may be around us. From the discovery stage, the authors observe that the dream is the second stage, which uses the findings of compelling authentic stories, to create memorable and ambitious picture of the desired future. And we posit that with global recession, minimal job opportunities, corrupt leaders, homicides, and suicides, the youth need encouragement that the future is still bright in spite of the current challenges.

In addition to these two stages, the authors name design as the third stage, that allows the mentor and mentee to agree on the rules that govern any action till the goals that have been set are realized. That should then be followed by the delivery stage, that makes commitment to what should happen next and who will do it.

By having innovative relational leadership approaches and practices FBOs can create dynamic mentoring programs that are characterized by shared leadership across the diverse members of any FBO. Within the echelons of FBOs leadership are members who have the; experiential narratives and encounters, skills and competences critical for effective mentoring. By extension within the membership are members who are willing to undertake mentoring as a patriotic duty as well as a duty of affiliation to the FBO.

Structuring mentoring as a relational leadership process for PCVE through the AI approach must focus on an FBO leadership that has a full understanding of the whole chain of; recruitment, radicalization, violent extremism and terrorism. The contexts identified for each FBO would then indicate the nature of mentoring approaches and even mentors core towards achieving a successful journey into the past, appreciating the current situations, and being courageous to dream and commit oneself to a great future. Due to the realization that mentoring the youth against radicalization and extreme violence is best achieved in FBOs, these stages can provide the safe environment that the youth need, to be affirmed, challenged, and appreciated as citizens of a country that means well and wants the best for them.

## **Discussions**

With the physical ISIS caliphate in Syria seemingly vanquished, comes the threat of regrouping of its members among them being the foreign terrorist fighters who came from across over 100 countries. These fighters are well trained and through the cyber space caliphate they become easy actors of terror activities through not only recruiting and radicalizing locals and particularly youths into violent extremism, but also undertaking attacks. FBOs are high risk targets of such attacks besides having their members being casualties and fatalities from attacks targeting different spaces and facilities.

FBOs then have a leadership responsibility of enhancing the safety of its members through innovative approaches with mentoring, a relational leadership practice, being critical. This is from both a proactive as well as a responsive leadership practice. Similarly their role in the adoption and practice of safety leadership values in collaboration with critical actors of safety against violent extremists beckons.

They have a critical responsibility which seems not to have been mapped and profiled by the main actors of the global war on terror within many countries. One of their critical roles is in joining hands to come up with joint relational leadership models of enhancing reintegration of returnees besides their critical role in the rehabilitation and reintegration of youth who have been in criminal gangs. Among the returnees are; young mothers who are still youth, young families, and former foreign terrorist fighters that

the communities and society would exclude from the norms and cultures with FBOs being part of the same.

This calls for close collaboration across; faith based organizations, other civil society organizations, county and national governments, and the private sector in order to have a whole of nation approach. Among the key sectors will be the departments directly in charge of the various youth agenda including the Youth Council at both national and county government levels, Ministry of Public Services Youth and Gender, and Youth Empowerment Centres.

An understanding of the nature of the families served by various faith based organizations through a family leadership model needs to be initiated across the faith based organizations, where none exist, in order to help in driving the key responsibilities, rights, and values that families should exemplify. Further to this the emerging trend of familial attacks in which whole families are radicalised and consequently undertake atrocious terror attacks should be a cue to the role of vibrant mentoring programs through FBOs.

Of utmost significance is the focus on the responsibilities and rights of youth across the spectrum of their ecosystem spaces of; home, education-formal and informal-, social, political, economic, legal, technological, environmental, and posterity. Mentoring that elicits a great desire within youths towards espousing values such as; patience and hence delayed gratification, resilience, self-leadership, fairness, justice, effective conflict management, national service, and authenticity is critical.

Similarly the trend of radicalizing children, adolescents, girls, and women needs to be well understood by the FBOs in order for them to have the relevant mentoring approaches which in this case include psychosocial approaches. This delivers the need for a firm nexus between the FBOs and other actors for the FBOs to have relevant knowledge on the contents, contexts, skills, knowledge, and competences needed to tackle such challenges either proactively or as a responsive activity.

Research by faith based organizations focusing on the challenges afflicting society that add to the; formation of criminal gangs, lack of positive national identity, erosion of national ethos, social exclusivity, addictions to destructive cyber space behaviors, drugs abuse, and dysfunctional families is needed. This is to serve as a diagnostic tool core towards an evidence-based informative basis for appreciative inquiry and other types of mentoring approaches.

Across all these activities is the opportunity of the FBOs to play their pivotal social continuity role of prevention and countering of violent extremism, through a strategic partnership leadership approach. This resonates well with the sustainable development goal on partnership and permeates into other goals including; reduced inequalities, peace and justice, and partnerships for the goals.

By serving across different divides of society and hence impacting positively on different aspects and levels of society the FBOs will become more relevant with fundamental justifications through positive worldviews across youths, families, and organizations. This is a unique turning point towards PCVE premised on a faith based relational leadership model.



## Conclusion

Relational practices right from; self, dyads, family, groups, teams, and organizations play a critical role in socializing members into accepting and practicing laid down norms, values, and beliefs. Similarly the same relational practices can play the opposite destructive role of socializing the same members into; vices, immoral behaviors, and unethical atrocious activities based on skewed worldviews. Such worldviews include those of violent extremism, and are ingrained through lack of relevant relational practices across the social places and spaces where individuals are socialized. With this understanding the faith based organizations have an inescapable role of having strategic and inclusive mentoring models whose outcomes will be youths, adolescents, and even adults, with acceptable worldviews, attitudes, perceptions, and behaviors. Such behaviors will be acceptable across different spectra of the human divide, a critical toolkit in the prevention and countering of the atrocious behavior of violent extremism.

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## From real to virtual eyes: a classification almost 4.0 tomatoes

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### Abstract

*The change in the color of the vegetables peel during the ripening process is the main criterion used by the consumer to define the fruit ripeness degree and for the producer to determine the best time of harvest. This relationship between bark coloration and different maturation stages allows the producer to establish harvest planning and extend shelf life. Students and faculty of the Biosystems Engineering course at São Paulo State University (UNESP), Tupã Campus, designed and developed a low-cost prototype of a fruit sorting belt, specifically for cherry group tomatoes. In the future, improvement in machinery with the insertion of new devices such as cameras, embedded system, combines sensor technology 3.0 with machine learning 4.0.*

**Keywords:** Agricultural machinery, sensing, technologies 3.0, CIELAB.

### 1. Introduction

The change in the color of the vegetables peel during the ripening process is the main criterion used by the consumer to define the fruit ripeness degree and for the producer to determine the best time of harvest. This relationship between bark coloration and different maturation stages allows the producer to establish harvest planning and extend shelf life.

Tomato is one of the most consumed vegetables in the world, with a production of over 182 million tons [7]. In Brazil, production was approximately 4.5 million tons in 2018, is the second most-produced vegetable [20]. In Brazil, the normative instruction No. 009 of 2002 says about the selection and classification of fruits and vegetables [1]. This one is a process that occurs according to size and shape, color, maturity point, and defects. What's more, a high-quality product will have a higher added value. Better quality and reduced product loss can be achieved through technology applied to product selection and classification. This process may be less subjective; the more direct contact is avoided. Thus, a process performed by machine vision and later for processing and analysis of images will have a closer response to a pattern among the selected products.

Stinco et. al. used tomato coloration to measure and quantify changes in chemical composition and physical attributes of fruits [4]. Thus, computer vision has been used to measure the color of different foods objectively. These provide an advantage when compared with the conventional colorimeter, such as the ability to analyze each pixel of the entire surface, quantifying surface characteristics, and defects [19; 3].

The application of sensors, processing techniques, and image analysis has been used to obtain qualitative and quantitative data regarding fruit selection and classification. Process automation allows standardization at speeds higher than those achieved by manual and/or mechanical processes.

## 2. Theory

### 2.1 The tomato

Different types of tomatoes are available on the market: Carmem, persimmon, Dutch, Italian, and cherry. Each for a different purpose and found both fresh and processed (sauce). In the vast majority of supermarkets, they sell these fruits in bulk and not in packaging that could increase their shelf time. This context leads to a devaluation of products and often leads to increased loss rates within the production chain [2].

Tomato is a fleshy and juicy berry with a different appearance, size, and weight, depending on the cultivar. Most fruits are bright red when ripe [6]. The choice of tomato fruit was due to maintaining their active metabolic activities in the post-harvest period. At this stage, physiological and biochemical transformations occur, causing physicochemical changes in the fruit [17].

According to Andreuccetti et al. [2], the absence of measurable quality standards and packaging improvement maximizes problems in the production chain. To ensure tomato supply throughout the year, wholesalers receive the product from various regions of the country under different conditions and times of the year. This diversity of product origin makes it difficult to standardize. However, current market demands such as better quality, appearance, texture, taste and aroma, nutritional value, and food safety make producers feel the need to implement standards for classification. The broad acceptance of the vegetables is due to their organoleptic characteristics. The color one of the leading and decisive at the time of purchase [5].

### 2.2 CIELAB and data clustering algorithm K-Means

Clustering data to describe them according to their homogeneity, characteristics, or organizing them into a set of categories is known as clusters. There are several techniques used for data grouping, and a measure of distance, correlation, or association must be defined so that it is possible to determine (dis)similarity between objects. Such (dis)similarity can be calculated in countless ways, but each type of measure addresses a perspective, and its application depends on the expected objective and the kind of data worked. It is called here a cluster (or a partition) is a set of groups [20].

Data grouping algorithms are based on obtaining  $k$  groups of similar objects according to some pre-established criteria. However, the value of  $k$  must be provided by the user, informing an inappropriate amount can create problems of interpretation of the partition obtained. One of the primary data clustering algorithms is K-means. Initially sets up how many clusters are being sought; this is the parameter  $k$ . Thus,  $k$  points are randomly chosen as cluster centers. The Euclidean distance metric is the distance of all elements belonging to the group to parameter  $k$ . Then, the average distance in each cluster is calculated and is defined as new core values for their respective clusters. The whole process is repeated with new cluster centers [10].

The iteration continues until the elements contained in each cluster no longer change. After the iteration stabilizes, each point is assigned to the nearest cluster center. They are minimizing the total squared distance of all points to their cluster centers. The k-means algorithm produces excellent results when there are no overlapping groups.

Pattern recognition in images goes through a process of translating the image into numerical values (Several Color Coordinate Systems can describe the color of an Object). RGB (red, green, and blue concentration) is the best-known system, accompanied by the CIE L\* a\* b\* (Commission Internationale de l'Eclairage's) [15]. Colors are represented in the CIELAB system described by the parameters L\*, a\*, and b\* or the use of cylindrical luminosity (L\*), hue (H\*), and chroma (C\*) coordinates that are related to the Munsell coordinate. The parameter a\* informs about the development of the red color of the fruit and its degree of ripeness [13]. Positive values of a\* indicate red color and negative to green color. The b\* coordinate refers to yellow if the value is positive and blue when negative. L\* indicates lightness (black-white) [11]. The H\* parameter indicates the color quality, referring to the hue. Chroma is the quality of color that allows contrast to be distinguished by relating to the amount of color that exists. The chroma is associated with saturation, intensity, vibrancy, purity, chromaticity, and depth [14].

L\* and H\* values decrease proportionally to fruit ripening. This decrease indicates browning of fruit due to changes in the level of pigment, change the green to red color, for example. Concomitantly with this process, the value of a\* and C\* increase with fruit ripening [4, 21]. Tomatoes are always classified when they are ripe, divided by the color group, which can be red, pink, orange, or yellow. This subgroup classification analyzes tomato ripening and determines the color change of its peel. However, it is a visual and subjective classification and given the number of variations found in this type of fruit. Further analysis is required both for determining harvest timing and producer compensation, as well as for follow-up on the production line and post-harvest life. Therefore, it is necessary to promote the application of new technologies for automated classification of vegetables by color so that there is any contact between the machine, product, and labor.

Image processing, which consists of capturing and processing them, of improving visual information for human interpretation, or improve it for automatic machine perception/interpretation. Another area is computer vision, which consists of extracting information from images, such as locating objects and identifying changes in the environment, making the robot "see" the work environment [18].

### **3. Material and Methods.**

#### **3.1 Fruit Sorting Conveyor Belt**

Figure 1 shows the layout of the machinery and instruments and devices that have integrated the system. Figure 1a presents the prototype designed in Inventor Professional 2017 software, Autodesk version Build 142.

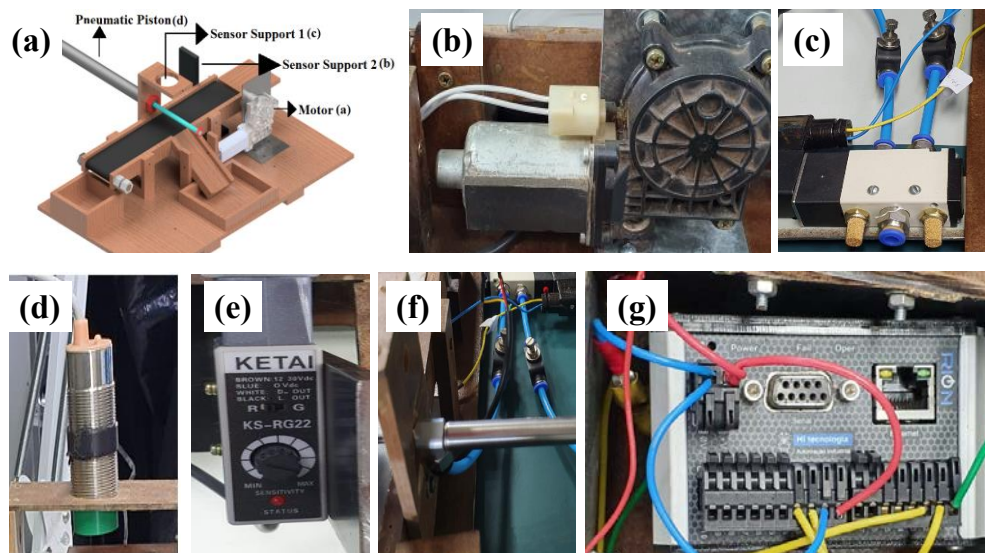


Figure 1. Prototypes and instruments used for the development of the fruit sorting belt: (a) Overview of the belt structure; (b) Bosch engine; (c) Color Sensor KS-W22; (d) Sensorbras Capacitive Sensor; (e) Air Cylinder CJ2; (f) Solenoid valves and (g) Programmable Logic Controller.

1. Simulations and theoretical calculations were performed, and the following set of sensors and actuators were defined for the prototype manufactured:
2. Bosch 12V electric motor. The device was salvaged from an automobile windshield cleaner, Fig. 1b;
3. High sensitivity color sensor, precision, and response time in the range 0.1-0.5 ms, KS-W22 KS-G22 KS-R22. This device detects the red and green colors, Fig. 1c;
4. Capacitive Proximity Sensor, 5 mm sensory distance, sensitivity adjustment, supply voltage 10 to 30 Vdc, Sensorbras - PNP, Fig. 1d;
5. Single-acting double-acting double-acting cylinder, 150 mm rod stroke, 16 mm bore, CDJ2B series, as shown in Fig. 1e.
6. Válvula solenoid with two-position five modes, supply voltage 12 Vcc, inputs, and outputs 1/4 inch, Fig. 1f;
7. Relay Programmable remote I/O HI Technology, Rion model (HIO115), supply voltage 10 to 30 Vdc, eight digital inputs, four digital outputs, three analog inputs, one encoder two fast counters and one PWM communication Ethernet or serial cable, as shown in Fig. 1g.

Additionally, a treadmill control was inserted with two commands: (i) to start the engine rotation and (ii) to stop the motor movement. The color sensor was allocated to a fixed support on the side of the conveyor, perpendicular to the direction of its; another support served to the capacitive coupling sensor, so as to leave the face perpendicular to the conveyor band; In this same support, a pneumatic piston was placed perpendicular to the direction of movement of its. The final conveyor is shown in Fig. 2a-b.



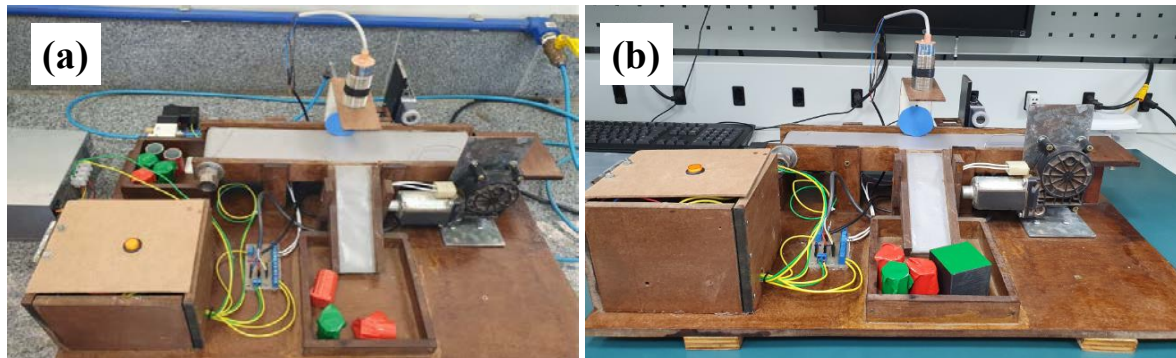


Figure 2. Final conveyor, top (a) and (b) front view.

After the equipment was built, the device was programmed through the programmable relay and remote I/O to automate the process. The developed program for the control conveyor consists of three steps:

1. Switching On/Off the conveyor motor via a holding button, i.e., the conveyor motor is On while the button is engaged;
2. Object color recognition. If the color chosen by the developer is green, then the answer is stored as a value of 1; otherwise, a value of 0 is stored.
3. Verification and implementation of the following procedure:
  - a) Object detection by Capacitive sensor. When an object is detected, it checks what value was stored by the color sensor;
  - b) If the color is red, stored the value 0, the pneumatic system starts to act, separating the object from the others;
  - c) Otherwise, green, the object continues its path until it reaches the container at the end of the conveyor.

The procedure described above was carried out using a ladder programming language, as described below. First created a button (I0) to turn On/Off the conveyor selector (O0). The input I1 has addressed the detection of the color sensor, and to assist the storage of the results of this sensor was used R0 addressing. After measuring the color sensor, the code analyzes the detection of the object by the photoelectric sensor, addressed by I2. If the photoelectric sensor and auxiliary R0 have a high level, the auxiliary variable R2 is left in Set mode, and R0 is reset. This will trigger the piston, and the R0 will be ready for a new color sensor detection. The piece of code representing such functions is shown in Fig 3a.

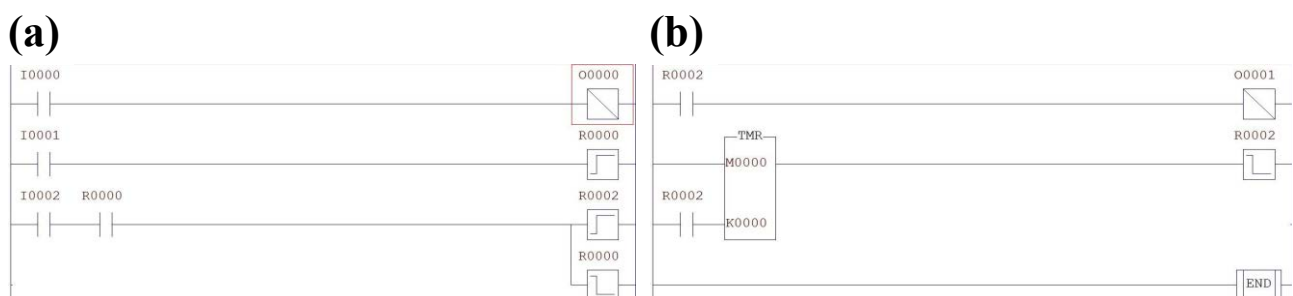


Figure 3. Programming code that control the conveyor, (a) First and (b) second part.



Finally, it can be stated that only when both sensors detect the object will the piston (O1) be driven, pushing the object off the belt. To monitor the response time between piston activation and movement, we have inserted a timer into the code. Code is presented in the Fig. 3b. Due to the distance between the color sensor and the pneumatic piston, it is not necessary to use a method if more than one object is detected before separation occurs. At this point, the actuator has already been triggered, even when inserted objects close together.

### 3.2 Recognition of red and green patterns

In order to differentiate the green fruit of red, it started the description of a standard image process, as seen in Fig. 4.



Figure 3. Standard imagem processo of Cherry Tomato

Due to the standard image composition, the CIELAB descriptor was chosen using 4-pixel sub-images. The result is a matrix with the color data of each of the pixels. Thus, using the k-means algorithm grouper, I have been able to image segmentation by separating into three different groups.

## 4. Results, Conclusions and Open Problems

The prototype calibration was done with different objects of red and green colors. A signal conditioning system is coupled to the device to circumvent the problem of the color sensor has a short-range. The piston speed, both in expansion and retraction, has been calibrated. Also, it has made adjustments in the photoelectric sensor so that the conveyor canvas did not interfere with the capture of data.

After the initial tests, they were replaced by cherry tomatoes. The results obtained were positive, presenting many imperfections due to several factors, such as close tones, inhomogeneity of color, rounded shapes, causing fruit-bearing and problems in its detection by color and photoelectric sensors. Next, there is a photo sequence of positive results for the selection of tomatoes.

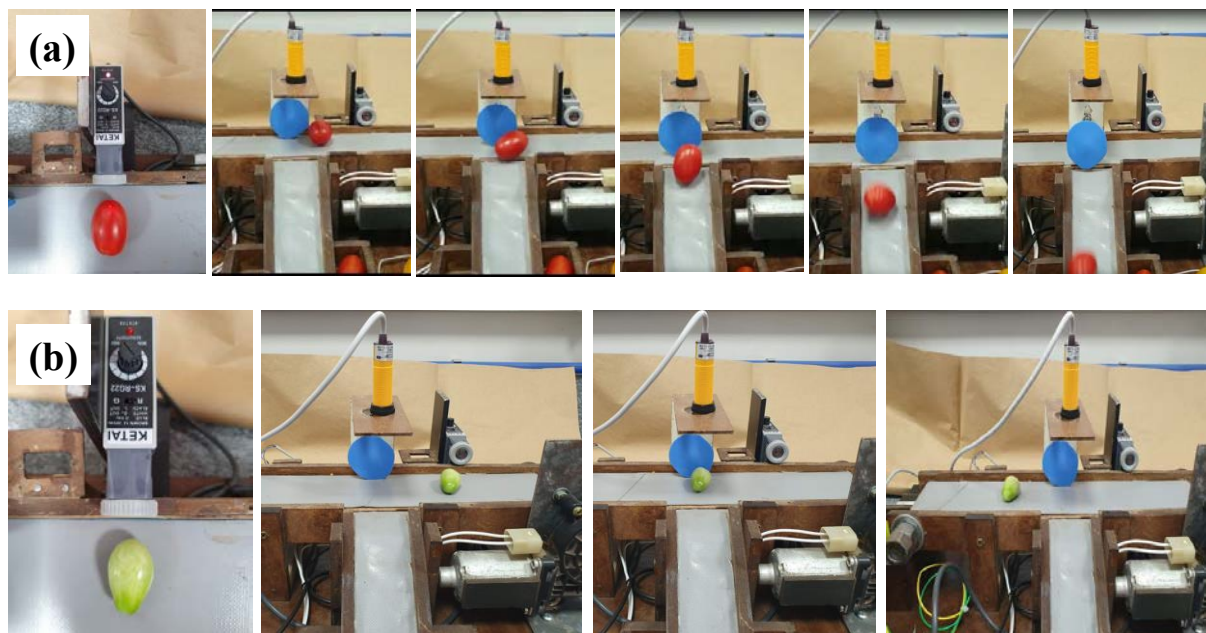


Figure 4. Sequence of the fruit selection process: (a) tomato red color detection, Photoelectric sensor detection, Start of piston drive, Push piston initial and End of ripe tomato separation process; (b) tomato green color detection and Photoelectric sensor detection and process continuity

In order to alleviate, and even remedy, the execution problems presented in the belt sensor set, we link to the mature green fruit recognition system through a pattern recognition algorithm, namely: K-means. The images were matrixed using the CIELAB, generating a database that was clustered by some predefined mathematical algorithm - such as Euclidean distance measurement. The results obtained were satisfactory as shown in Fig. 6a-b.

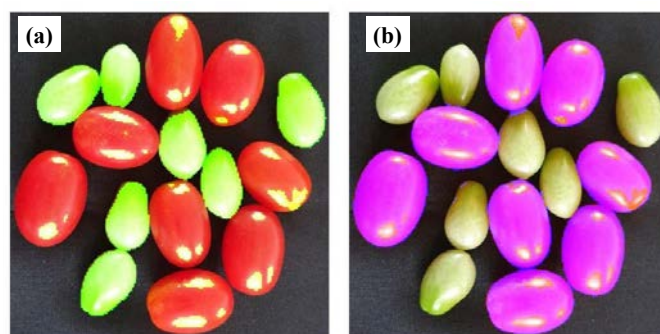


Figure 5. (a) Green pattern and (b) red pattern recognition.

The linking of the developed algorithm with the conveyor programming is in the execution phase. In a next step the programmable logic controller will be changed by the microcontroller MSP430FR5949. It is hoped that optimize and lower the machinery, in addition to embark developed artificial intelligence; inserting a model VGA 0V7670 camera into the conveyor so that sensor technology 3.0 brings us great results when added to machine learning 4.0.

## **6. Acknowledgement**

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# Construction of a low-cost mobile embedded system for computer numerical control and educational purpose

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## Abstract

*This article describes the construction of a low-cost, mobile, CNC (Computerized Numerical Command) mini machine, bringing as its objective the gain of experience in relation to machining knowledge, where the device executes a list of movements written in the programming language G. For the development of the project, the Arduino Nano embedded system, two CD / DVD players and two H bridges (L293D) were used. Afterward, the assembly, programming and results of the project in question are described.*

**Keywords:** CNC Machine, Arduino, L293D, Education, Embedded systems, G-code.

## 1. Introduction

Before becoming computerized, they were only numerical control machines, an electronic device that directly receives codified instructions through punched cards that had the function of interpreting the generated data to control the gears or pieces of equipment in order to press the designated images [1].

As it is stated on the book *Metal cutting theory and practice*, written by Stephenson and Agapiou [2], the first sample of a numerical control machine was constructed in 1952 in the Massachusetts Institute of Technology (MIT): it was a milling machine, creating continuous movement of tools utilizing aluminium.

New developments were created to promote this technology, the US air force bought many numerical control machines and rented them to corporations, for them to understand the application. In spite of those advancements, there was still the problem in input of instructions, in other words, each manufacturer created their own language solution to indicate the machining processes, generating a dispute among them. Afterwards, the G-code was created by MIT, a programming language developed to bring a certain pattern to the processes, it was quickly adopted by all corporations.

Only on the decade of the 1970s were the computer numerical control(CNC) actually created, as an application of microprocessors and ROM memory to the numerical controllers, increasing it's flexibility, precision and versatility.

Our project aims to report the process of the construction of a low cost, portable computer numerical control to acquire experience and knowledge about machining, related to the creation of complex development of aircrafts, spacecrafts and electronics. The purpose is for the results to be able to be reproduced on schools and educational institutes in order to maximize the learning of students of the area. The utilized embedded system is the Nano Arduino, for it's capacity in dealing with files that

executes the necessary commands to the functioning of the CNC.

## 2. Bibliographic review

The amount of contributions to this subject is vast, varying in the sense of forms of implementations, materials used and purpose. Following are a few projects that had been done in last few years that were taken as a basis to this project.

Moved by the imperfections of surfboard produced manually and the high cost of a milling machine CNC, which is the device that interprets the code for the equipment to work, the article presented by Gesser et al.[3], which has the objective of creating a low cost solution based on DeskCNC, a software used to determine the steps that the milling machine CNC should take.

The CNC is composed of steel tubes that are adapted to bolted unions, forming the 3 axis (X, Y, Z). That modular structure was assembled to create flexibility and agility on transport, adapting according to the size of the block that is about to be molded.

The software is based on Shape 3D, a program that generates the drawing that the CNC will create. The file is assembled and saved on G format, the programming language common for this kind of application, that the DeskCNC will execute, turning the processes of machining faster and more precise than manual manufacturing, meeting the expectations of the proposed project.

The work done by Dantas and Júnior [4] has the core idea of elaborating a tool to manufacture printed circuit boards to assist on students projects on automation and robotics laboratories situated on the Federal University of Rio Grande do Norte. The researched solution was the construction of a CNC machine that has the capability of executing such a task.

The project has a base constructed from wood, all structured to guarantee that the milling machine does not fall or tremble when the process happens. The movement control is done by a firmware called GRB1, installed on a Uno Arduino. This firmware is free and widely used on the development of CNCs, because of it's high performance on the precision of the machine. After the system is compiled on the microcontroller, it stays ready to receive code written on G language, that posteriorly the BCNC software will send to execute the instructions.

Among the many positives points reported on the development of the project, one to focus on are the tests that were made considering the time of execution of the instructions. There were used 2 different materials as methods of board production: the pen permanently has the time spent on the drawing for around 8 minutes and 47 seconds, however the corrosion time is high (32 minutes and 45 seconds) and because of that, a milling cutter being used is more advantageous, because it doesn't need of corrosion and the time drawing is on average of 17 minutes and 46 seconds.

The cost to realize the project varies at about 465,78 brazilian Reais, which is equivalent to a milling machine CNC distributed on the market, making the solution completely viable.

As it is stated on the article, the project has a few shortcomings in the sense of unevenness of the table and the rails are somewhat loosely, generating precision problems. However even with these, the work done proved it's worth with a good enough precision, reaching the goal designated, being capable of serving as base to articles to come.

The idea proposed by Macêdo et al. [5] is to construct a mobile low cost CNC to amplify the researches on the subject of machining. The base of the project is on the CAD software, which is capable of creating or importing images that were saved on the language G. Posteriorly, the file generated is interpreted by the BCNC software that sends the commands to generate the drawing to a Uno Arduino, who would control the stepper motors according to the pre established model from the code. The project had some problems in its fabrication, among them the levelling of the table that serves as support to the material that is being modeled and the factor of the electronic components in the sense of isolation and confection. Although it has these shortcomings, the results proved successful, the precision of the movements were good and it had good handling, maybe even doing more functions besides drawing, such as the example of marquings of certain components.

The total cost of construction of this project was equivalent to 500 Brazilian Reals, a very competitive price than a common real CNC. However the disadvantages like degradation of components and the requirement of constant recalibration, but if the objective is only for the creation and exposition on a versatile and playful way, it is possible to develop a machine to match the same results, with less failures and fewer resources.

Finally, the development of two very distinct CNCs, idealized by Lo Valvo [6], focused more on the education side. The first model uses a Raspberry Pi and the second one on a BeagleBone Black, making use of a free software called LinuxCNC that works on ARM architecture that composes the embedded system mentioned.

The price of each complete prototype is around 100 Euros, it's worth noting that each one were used different milling machines, one was acquired named RM Minimill and the other one modified by hobbyists that were used before on an Arduino system.

The Raspberry Pi model resulted in some problems because of the few pins it has for the application, generating the necessity of inclusion of extensors devices like the FRDM-KL5Z and put the Arduino CNC Shield on it. Even with the proposed being served, this prototype demonstrated difficulties because of incapacity of the Raspberry Pi with the AXIS graphical interface, massively explored by LinuxCNC, beyond that, the big amount of devices compromised the performance in the end.

The BeagleBone Black prototype was much better, having less devices attached to it, only an adapter for the RM Minimill called bbb\_parport. The performance was so impressive that is noted the capability of realizing more angles curves on more surfaces that are detailed.

Even with these findings, the article suffers from the lack of tables and graphic representation of the concrete results of performance, but it manages to reach the proposed idea of increasing the interest of students in the area.

### 3. Materials and methods

This section has the objective to describe the components and softwares selected for the development of the project, showing its functionalities. On Table 1 it is presented the inventory and the price of each material.



Table 1. Prices of equipment

ITEM	PRICE(USD)
Nano Arduino	\$ 8,35
2xL293D	\$ 4,29
Micro Servo 9g Sg90 TowerPro	\$ 2,86
Jumpers	\$ 2,39
Circuit Board	\$ 0,48
Fixing screws and hexagon nuts	\$ 1,91
Durepox	\$ 1,67
Total	\$ 21,95

### 3.1 Arduino

Created in 2005 by the Italian Massimo Banzi in conjunction with a specialized team, with them David Cuartielles, Tom Igoe and Gianluca Martino. The main objective was to bring a low cost free software platform to ease the realization of student's projects who have interest in the field [7].

There is multiple models of the platform to work with, however the one that was chosen for this project is the Nano Arduino, a small board based on ATmega328p, a microcontroller made by Atmel, a manufacturer of semiconductors funded in 1984. The reason for this choice is due to its capacity with dealing with files that executes the necessary commands for the functioning of the machine.

According to Ganssle and Barr [8], the Arduino is an embedded system, having a microprocessor that is totally dedicated to a certain assignment of a device or system that commands it. In other words, it's a system that after receiving a certain number of pre-defined functions, will do them if they're necessary. An example utilizing many times our daily activities is the calculator, it has pre-established requisitions that will only be executed if the user requests.

Through Arduino IDE, which start screen is shown on Figure 1 , where it is reunited the instructions that will be passed to the designated hardware. This software is a multi-platform application written in Java, being derivative of Processing and Wiring [9].

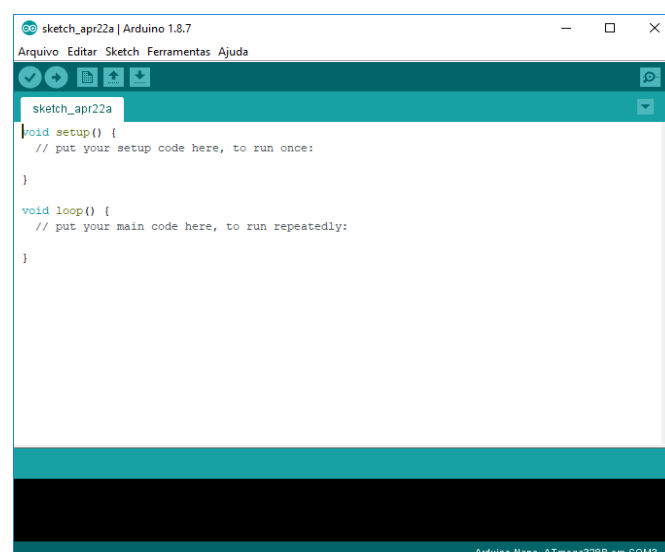


Figure 1. Arduino IDE

The firmware which was written in C will be compiled on the prototype board that was elaborated

by Adidax [10], where is contained the necessary instructions that the CNC should follow to do a complete interpretation of the G file.

### 3.2 H Bridge

It's a circuit that allows the inversion of the motor's polarity. By so, it is necessary a way to load the current on the motor in a direction and another that take to the opposite direction [11]. The H bridge utilized for the creation of the project is the L293D, a integrated circuit that can control motors up to 36 Volts on a constant current of 600mA up to 1.2A [12].

### 3.3 Motors

There are 2 types of motors that are going to be discussed on this section. The first is the stepper motor shown on Figure 2, a electromechanical device that transforms electric signal into torque, making it spin on a precise manner.

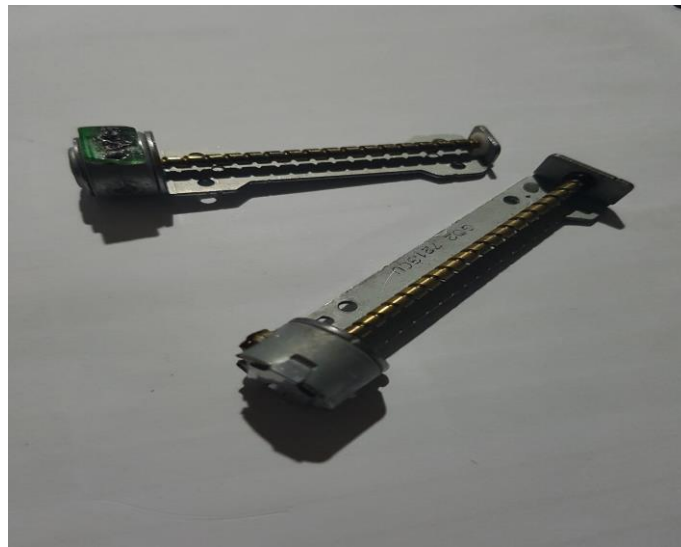


Figure 2. Stepper Motor

The selected stepper motors are contained on CD/DVD drivers, devices that interpret files stored on those formats and transmits their information to other determined device. Two of them were needed for the project, one for the X-axis and the other for the Y-axis. On Table 1 is not shown the price of those equipment's because they were taken from unused broken computers.

The next is a servomotor as displayed on Figure 3, similarly to the previous one is a electromechanical machine that is adjusted to the Z-axis. It works proportionally according to the required command, that is to say, after receiving a signal the servo should go to designated place on a certain speed.



Figure 3. Servomotor.

The model adopted was the Micro Servo 9g Sg90 TowerPro, as it's shown on Figure 3, because of its size and quality and compatibility with the Arduino platform on projects related to robotics. The supply voltage of the servo motor is relatively 5V, being capable of having a variation between 4,5V and 6V, consuming a high current of 200mA to 1A. Normally a servo has 3 ligations wires as it appears on Figure 4, which they are represented by the brown(or black) conductor that has as reference the 0V mass supply, the red being the power supply and the orange(or white) the one that inputs the data commands to the servo.

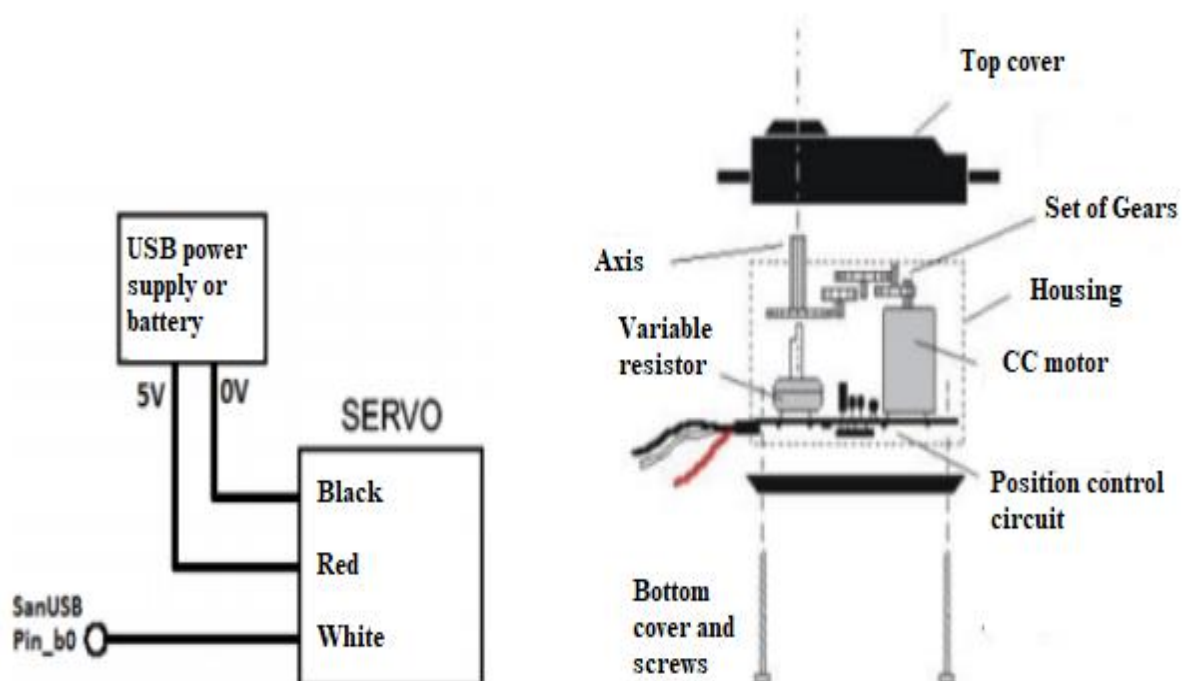


Figure 4. Internal visualization of the servo motor

### 3.3 Inkscape

Tool used for the construction of vectorial graphics. It has satisfactory portability, by having the capacity of working on different kinds of operational systems like Windows, Mac OS X and GNU/Linux, for example. Very efficient on the creation of illustrations, logotypes, maps and internet graphics (THE INKSCAPE TEAM, 2003) [13]. This software, whose main menu is displayed on Figure 8, will be used for the development of images that the mini CNC will write. Even with this array of utilities, this tool does not have the capacity to generate G files, for that it will be needed the installation of an extension who provides such feature. Created by McGuire [14], the MakerBot Unicorn G-code library meets these fundamental requirements, however the Inkscape should be on 48.5 version because this extension was not tested on future updates and could trigger some unexpected software bugs

### 3.4 Processing

Processing was elaborated by Reas and Fry [15], it's a free software language based on graphical functionalities of the Java programming language and has an integrated development environment, designed for the electronic and visual projects communities. It has as its main feature to proportionate basic notions of programming.

On it is executed gctrl, created by Mellis [16], a simple program, whose objective is to send a G format file to the Nano Arduino. As it is shown on Figure 5, this software has some functionalities that will be able to complete this task.

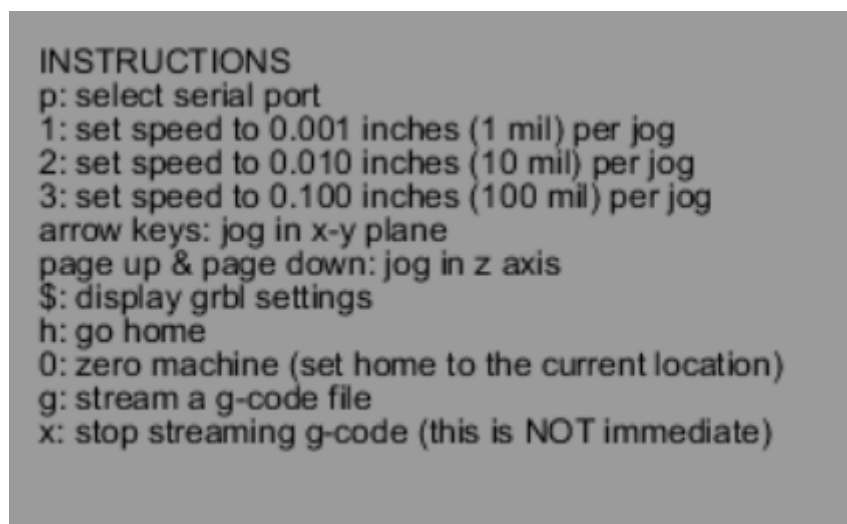


Figure 5. Gctrl program layout

The 2 main functions are executed when the “p” key is selected, which establishes the communication between the serial port with the Arduino and the “g” key that will search the image and then send it to the board.

### 3.5 Circuit and structure

The CNC circuit was constructed using as basis the diagram shown on Figure 6. The H bridges connect themselves to the step motors and the supply power of the Arduino, while the stepper motor

communicates only with the supply and the prototyping board.

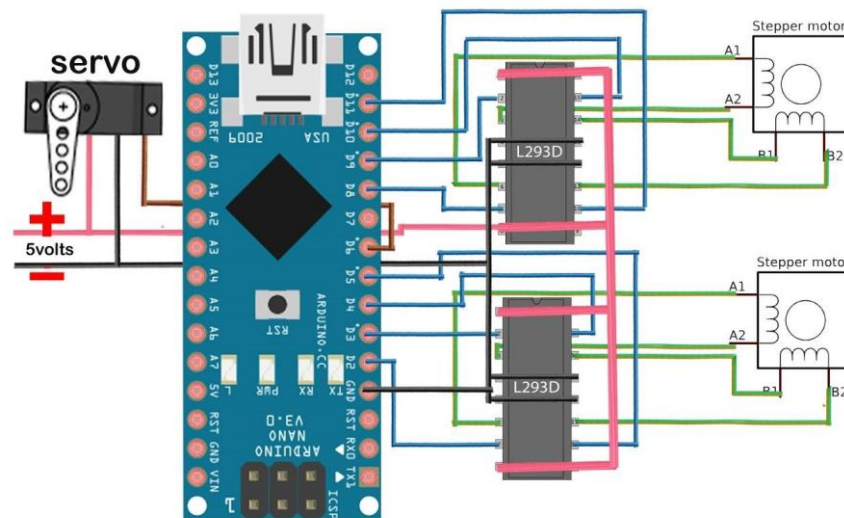


Figure 6. Circuit Diagram [17]

It was constructed on a printed circuit board displayed on Figure 7, where were organized the components according to the size of the board used.

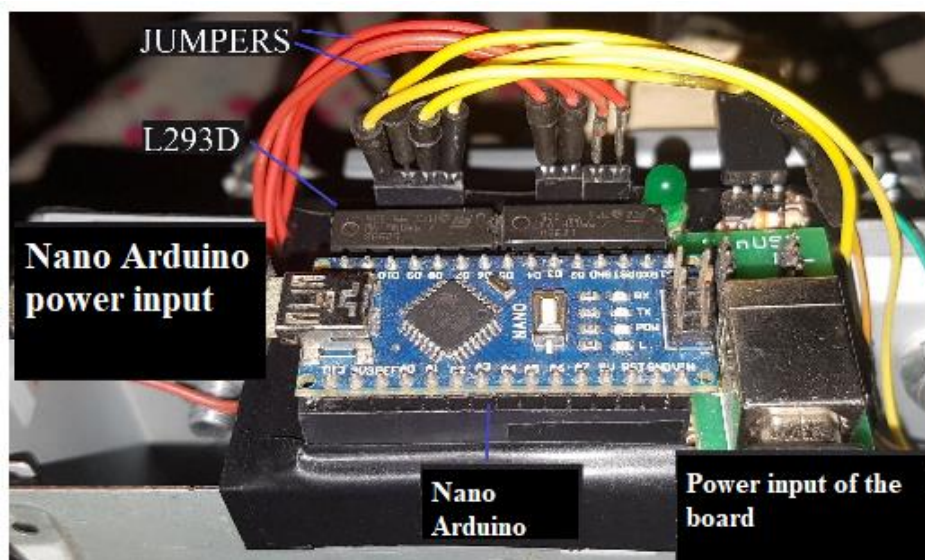


Figure 7. Constructed circuit

To build the base of the CNC, it was used the casings of CD/DVDs drivers, after their stepper motors were removed. As observed on Figure 8, the 2 drivers were placed on such way that formed something similar to the word “L”.



Figure 8. CNC skeleton

This type of form allow the fitting of the possible axis, for the alignment of them preventing failures. On figure 9, it is shown the concluded structure.

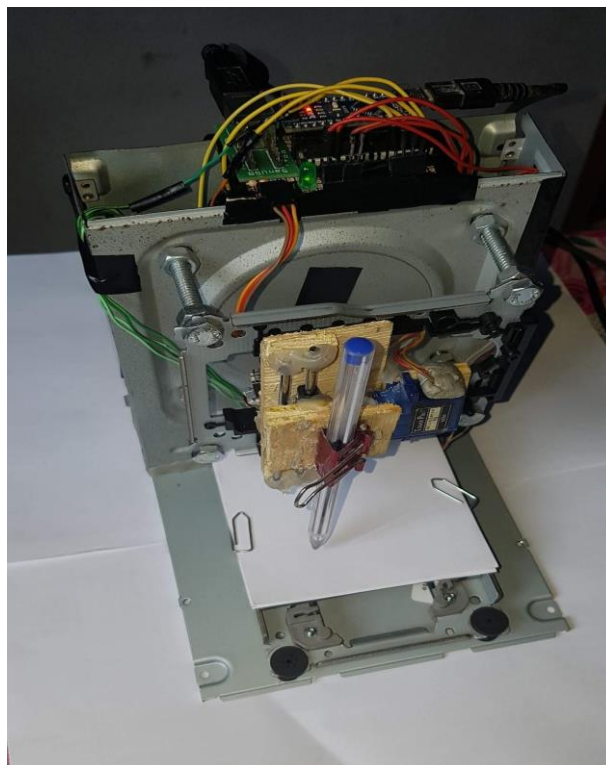


Figure 9. Concluded CNC

### ***3.4 Implemented software***

The CNC must follow the fluxogram displayed on Figure 10.



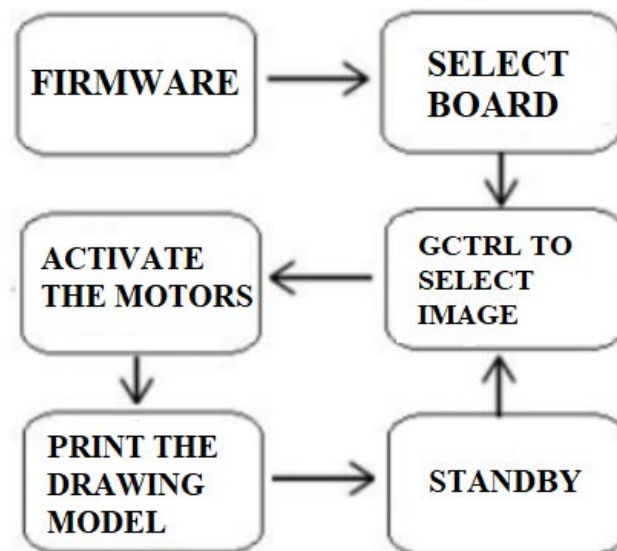


Figure 10. Steps of the process

The firmware is saved on the device, through Arduino IDE, then it is selected the determined image on G format, that the board posteriorly sends the necessary commands to activate the CNC's motors, to finally execute the designated task. After the activity is concluded, the software will be waiting for the user to provide a new image.

#### 4. Results

Multiple tests were made, utilizing a bic pen that had the goal of testing the precision and the time taken to realize either a complex or simple drawing. The first analysis was made on a simple drawing, represented on Figure 11, where possible to see the level of details of the results is presented.

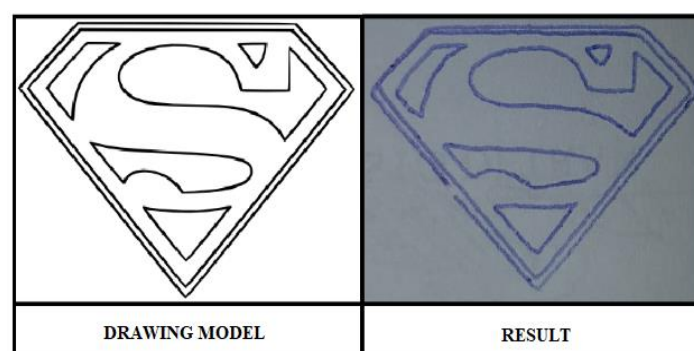


Figure 11. First test

The next test was made on a drawing that required a bigger degree of details and even with the bigger challenge, the efficiency of the CNC proved to be impressive as it is shown of Figure 12.

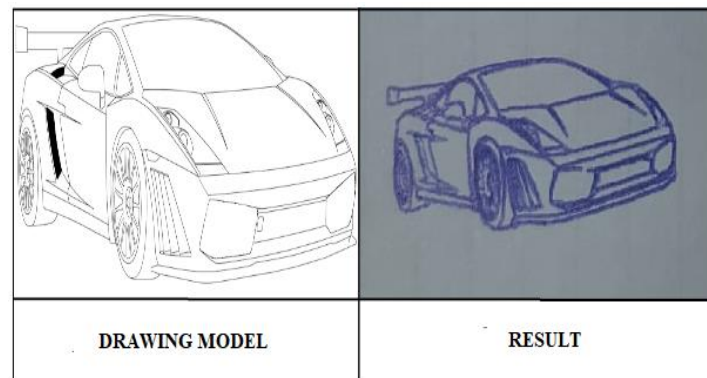


Figure 12. Second test

The third and final test verifies the capability of creating multiple circles. Even though it has some imperfections because of the chosen pen and the size of the drawing, the results displayed on Figure 13 are very satisfactory.

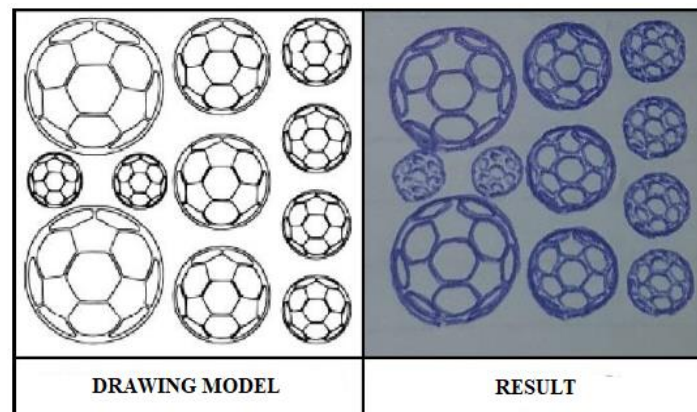


Figure 13. Third test

On Table 2 is organized the results in relation to time of execution.

Table 2. Results

TESTS	TIME
First	41 seconds
Second	5 minutes and 24 seconds
Third	8 minutes e 35 seconds

## 5. Conclusion

The core idea at the start was to construct a low cost mini CNC with the focus on learning of the processes of machining on a practical versatile way to be able to be reproduced on multiple education institutes in order the learn this subject. The objective was reached, displaying satisfactory results upon



the done executions.

The construction of the CNC lasted around a month, however because of the intricacies of the project and bibliographic review, the total time lasted 4 months. The biggest challenges were the care taken in the sense of compatibility of tools either on the hardware such as motors and microcontroller and on the software side, where each decision affects performance and production.

The total project cost was 21,95 US Dollars, a relatively low price in comparison to the knowledge acquired and performance of the machine. It leaves some improvements to be made by other students like the creation of CNCs that do the markings of pieces of equipments or boards of printed circuits through a more specific milling cutter.

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# The effect of Geographical Indications on Economic Development

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## Abstract

*The understanding of a Geographical Indication (GI), under an economic point of view, is connected to a strategy that aims at adding value to products or services whose characteristics are related to the territories in which they are inserted, with the premise of strengthening territorial economies, mainly in rural areas. GIs associated to agri-food products not only add value to these products, but also aim at providing easier access to either internal and/or external markets, promoting the inclusion of rural producers or disfavored regions in terms of commercial trade routes, besides contributing to the sustainable use of biodiversity and, consequently, of local genetic resources. Therefore, this work aims at providing an overview of the main scientific works regarding Geographical Indications (GIs) focused on the development of regional economies, especially in rural areas, considering in natura products. The methodology employed consisted of carrying out a systematic literature review on Scopus, Web of Science and Science Direct databases, based on a sequence of themes (Geographical Indication, Economic Development, Brazilian products in natura). Therefore, it was necessary to select the scientific articles corresponding to the combination of keywords, while also considering those works published in the last 10 years and with a score higher than 25 points, according to the criteria adopted in this work. The results of this research demonstrate the importance of GIs for promoting local economic development, through production and local services, adding value to the agri-food market and to its capacity in generating jobs and wealth.*

**Keywords:** *Geographical indication, local economic development, agri-food product.*

## 1. Introduction

Geographical indications (GIs), under an economic point of view, can be understood as a strategy aimed at adding greater value to products or services, whose characteristics are related to the territory in which they are inserted. Accordingly, GIs foster stronger territorial development, especially in rural areas, mainly those focused on the agri-food market, not only adding value to products but also promoting and providing easier access to either internal and/or external markets, contributing to the promotion and insertion of rural products or regions with less-favored markets, especially concerning the conservation of biodiversity and local genetic resources, contributing to environmental conservation [PELLIN and VIEIRA, 2015].

In the Brazilian context, GIs are established from the time certain characteristics, or certain aspects of quality or reputation can be associated to rural products, being mainly related to the geographical origin, being under legal protection, in terms of industrial property, against the use by third-parties [BRASIL, 1996, 2000; CERDAN, 2013].

The constitutional provision under Law no. 9.279, from 14 May 1996 establishes the rights and duties regarding industrial property, with articles 176 to 182 approaching the conditions of GI use, not only in terms of the indication of origin but also regarding the denomination of origin [BRASIL, 1996]. The National Institute of Industrial Property (INPI, in Portuguese), is the national entity responsible for establishing the criteria for obtaining a GI [BRASIL, 2000], which is described in Normative Instruction no. 95, from 28 December 2018 [BRASIL, 2019] on the conditions for granting Geographical Indications.

Therefore, GIs are considered a strategy for promoting and strengthening economic development, valuing territorial resources, consequently fostering niche markets, taking into account the intrinsic features for preserving biodiversity in rural environments [PELLIN and VIEIRA, 2015].

Accordingly, as pointed out by Pimentel [2013], GIs are based on the assumption of promoting regional growth and development. Through the national use of a system of intellectual property, this growth and development is enabled by the exploration of resources, such as economic assets, through which the analyses of indicators are essential to this subject, mainly when a GI can increase the sale price of regional products or contribute to the increase of regional income, fomenting regional economic development, as described by Faria, Bessi and Milanez [2014].

It is important to point out that the search for granting GIs, aimed at obtaining results which can promote economic development, depend on various circumstances and perspectives, especially in terms of who is in charge of a certain project, such as when a group of individuals settle in a region, seeking opportunities for realizing this innovation, analyzing capacity of local players in defining technical, political and economic criteria, including the perception of the market, its trends, as well as sources of support and partnership for carrying out a given project. Thus, it is noticeable that the team in charge of these projects can distinguish between the strong and weak points of the region, as well as its threats and opportunities [BRANDÃO and SANTOS, 2016].

Therefore, this work carried out a systematic review, as it is a potential tool that enables the analysis of scientific production of certain research themes. Thus, when applying quantitative and comparative methods, a systematic review can follow historical and scientific trends of research objects, identifying novelties, innovation or gaps in scientific knowledge [SACARDOS, HAYASHI, 2013].

With this in mind, this work is aimed at identifying publications with the following themes: geographical indication, economic development, focused on providing an overview of the effect of GIs of agricultural products *in natura*.

## **2. Theoretical Framework**

### **2.1 Geographical Indication (GI) and Economic Development**

The conception process of a GI consists in identifying a common product or service in a given territory, similar to a civil registration process, which aims at ensuring the civil rights that have been previously established in the Constitution [MAIORKI and DALLABRIDA, 2015].

Authors such as Gollo and Castro [2007] have defined a GI as a product originating from the territory whose characteristics are linked to its geographical origin, ensuring the civil rights of this product. However, a GI can be described as the exclusive right associated to industrial property, with collective nature and use, being linked to a certain region [FERREIRA et al., 2013]. In turn, Pimentel [2013] defined it as an industrial and collective-type intellectual property, being exclusive to certain local producers. These authors argue that the main GI goals comprise the economic development of the territory, due to the connection to the product, its quality and specificity in the territory in which it is produced.

For Santos [1998, p. 16], “territories are forms, but the territory used include objects and actions, which are synonyms of human and inhabited space (...) today a territory can be formed by contiguous localities and by network localities”. Regarding the reflections of a region, Santos [2006] states that concrete changes of a region arise from a geographical analysis. Nevertheless, regional reflections have always been influenced by the parameters of materialistic models of analysis, exclusively focused on an economic context, with no concern on issues of space, territory and regionality, which promote regional development from the production of products/services, mainly from small producers.

This context highlights the importance of Geographical Indications, which add value to territories, enabling local entrepreneurs to develop plans and actions that provide a competitive advantage to these territories in terms of local or external competitors [DULLIUS, 2009]. Moreover, as GIs are guided by cultural characteristics, they help preserving the local identity of citizens, promoting territorial development by fomenting the production of several products connected to the history, culture or tradition of these individuals, as well ensuring certain rights reserved to regional producers, besides promoting economic development.

## **2.2 Geographical Indication and Economic Development of Products in natura**

Regarding economic development, it is important to point out that this development is a result of economic growth associated to better life standards and to some essential factors in the economic and social structure of the population, which promotes a more balanced distribution of the wealth produced. Therefore, these factors control and determine territorial development, being conceived as economic, cultural and political factors which are inherent to biophysical and social characteristics, under the perception that the path organized and built by social actors must be present in the coordination of strategic local actions, in order to generate economic profitability [JEAN, 2010; SANDRONI, 1994].

In the Brazilian context, the discussion regarding a more sustainable territory through rural development, more specifically, through *in natura* rural development, has been intensified in several circumstances, innovating and fostering rural activities [ANDION, 2010]. In this perspective, in a rural environment, this development includes various programs that add value to issues on sustainability, with a clear preference verified towards products *in natura*, prioritizing regional products.

For this boost, growth and development of the rural environment in certain regions, mainly those which are deteriorated and require investment of some resources to explore the potential of local producers, GIs appear as a strategy for economic development, also promoting local territorial strengthening, especially in territories considered economically vulnerable. According to Vieira and Buainain [2011], GIs can provide new experiences with existing products, local natural resources, exploring local potential and promoting a better quality of life of producing communities, playing an important role in several sectors of the Brazilian economy.

Accordingly, GIs have been widely used in the agri-food business, mainly with products from local natural resources, aiming at protecting and adding value to these products. Furthermore, GIs enable the economic insertion of these products, according to their origin, with specific quality attributes, contributing to greater product value [ANDION, 2010].

### 3. Methodology

A systematic review of the scientific literature was carried out between the months of June and August 2019, using keywords correlated to the research subject (Table 1), according to the Systematic Review Flow Diagram Methodology [FERENHOF, FERNANDES, 2016]. The keywords used were “Geographical Indication”, “Brazilian products *in natura*”, being searched both in English and Portuguese, with the use of the Boolean operator “and”, as well as considering the synonyms presented in the Thesaurus (2019) website. Sequential searches were subsequently performed in the Web of Science, Scopus and Science Direct databases, being systematized in the search string, as shown in Table 1.

Table 1 – Systematic keywords and search string

Words in Portuguese	Words in English	Synonym	Database
Indicação Geográfica	Geographical Indication	Indexed	<i>Web of Science, Scopus e Science Direct</i>
Desenvolvimento Econômico	Economic Development	Indexed	
Produtos brasileiros <i>in natura</i>	Brazilian products <i>in natura</i>	Indexed	

Source: Authors (2019)

The *Web of Science* (WOS) website is considered one of the main multidisciplinary bibliographic platforms, providing access to trustworthy data, making use of citation metrics and including contents which are associated to various sources. Thus, it follows a strict assessment process, which presents information considered relevant and regarded as scientific research [BAKKALBASI et al., 2006].

As for the *Scopus* database, it is considered one of the largest abstracts and citations databases of peer-reviewed literatures, mainly due to its wide range of researches in the fields of science, technology, social sciences, medicine, arts and humanities, providing tools that are able to track and obtain significant research data [SCOPUS, 2019]. In turn, *Science Direct* gives access to approximately 2.500 scientific journals, including over 26.000 certified e-books through the Anglo Dutch editor Elsevier.

From the articles obtained as a result of the application of the combination of keywords, those which fulfilled the following inclusion and exclusion criteria were selected: scientific article, published in the past 10 years, full text, available in both languages (English and Portuguese), with a score higher than 25 points and research regarding GI and economic development, as well as works describing the opinion and methodology adopted for promoting GIs, being applied in the systematic review. The quality index was calculated taking into account the terms of interest in the title (5 points), the abstract (3 points) and the keywords (2 points). To identify the number of publications from these databases,  $n=$  (equal number) was considered.

The exclusion criteria included documents that did not obtain a score higher than 25 points, which is a value stipulated as the score range in this work, as well as those documents that did not include their full text and those not written in the pre-determined languages (English and Portuguese).

The analysis of the titles, abstracts and keywords of the articles selected was carried out when extracting the data, considering the inclusion and exclusion criteria aforementioned, as shown in Figure 1.

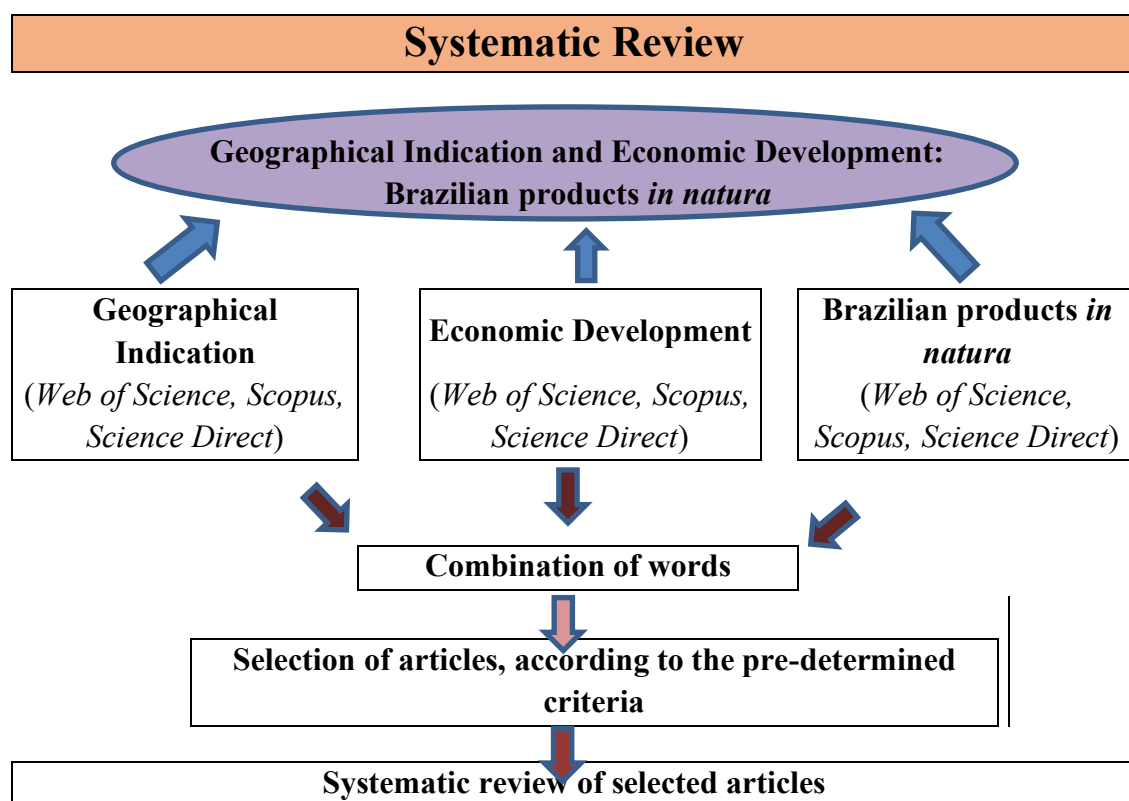


Figure 1. Research protocol

Source: Authors (2019)

## 4. Results and Discussion

### 4.1 Systematic Survey

Some keywords were selected for the systematic survey, as follows: Geographical Indication ( $n=1$ ); Economic Development ( $n=2$ ) and Brazilian Products *in natura* ( $n=3$ ). The term economic development was more prominent in *Science Direct*, with 76.563 publications, and *Scopus*, with 35.697. In turn, the term Geographical Indication was more frequent in *Science Direct*, with 1.805 publications, while the

search about Brazilian products *in natura* showed 1.075 publications. Both the combination of the keywords “Geographical Indication” and Economic Development (n=4), as well as “Geographical Indication” and Brazilian Products *in natura* (n=5) showed more frequent results in *Science Direct*, corresponding to 172 and 5 publications, respectively. The combination “Economic Development” and Brazilian products *in natura* (n=6) resulted in six articles, from which 5 were from *Science Direct* and 1 from *Scopus*, as presented in Table 2.

Finally, the combination of the three main keywords (n=7) resulted in no articles in the search, thus, no publications were published using the three terms combined. Therefore, this survey was able to demonstrate the novelty of the theme Geographical Indications in the perspective of economic development of Brazilian products *in natura*.

Table 2 – Overview of the scientific productions regarding GI and Economic Development of Brazilian Products *in natura*

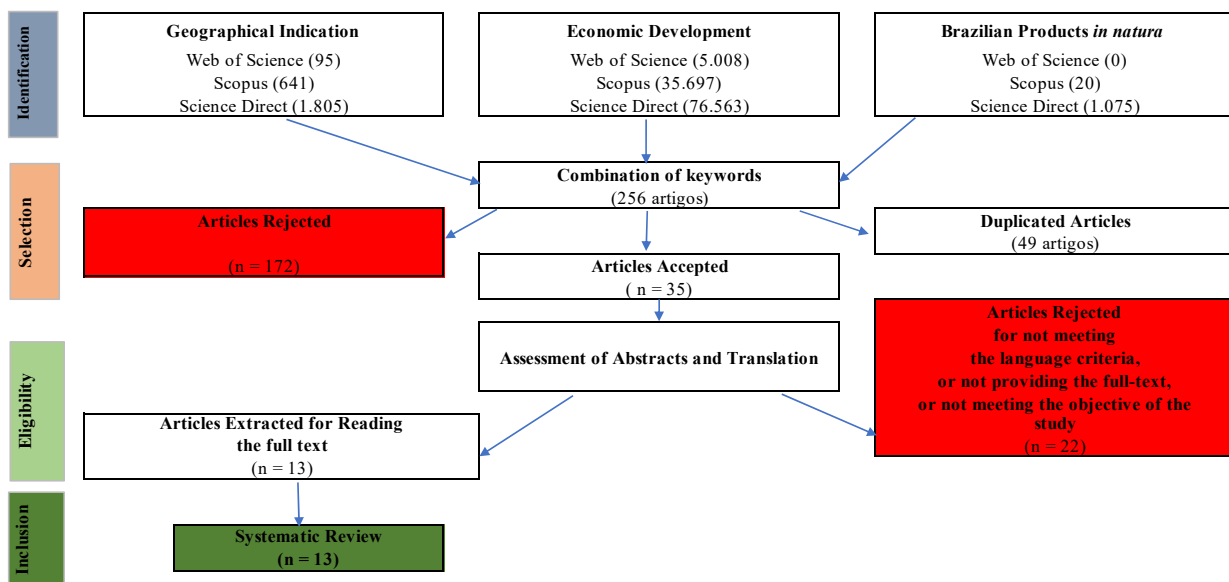
N	Keywords	Web of Science	Scopus	Science Direct	Total
1	“Geographical Indication”	95	641	1.805	2.541
2	“Economic Development”	5.008	35.697	76.563	117.268
3	“Brazilian products <i>in natura</i> ”	0	20	1.075	1.095
4	“Geographical Indication” and Economic Development	21	52	172	245
5	“Geographical Indication” and Brazilian products <i>in natura</i>	0	0	5	5
6	“Economic Development” and Brazilian products <i>in natura</i>	0	1	5	6
7	“Geographical Indication” and “Economic Development” and “Brazilian products <i>in natura</i> ”	0	0	0	0

Source: Authors (2019), from the databases *Web of Science*, *Scopus* and *Science Direct*.

#### 4.2 Systematic Review

Taking into account the inexistence of publications simultaneously including the themes Geographical Indication, Economic Development and Brazilian Products *in natura*, the systematic review was carried out with the articles identified from the combination of the three keywords (Table 2). Therefore, 256 articles were extracted for analysis, with 182 from *Science Direct*, 53 from *Scopus* and 21 articles from *Web of Science* (Figure 2). Only 13% of the articles selected obtained a score higher than 25 points, according to the inclusion criteria. Following this step, an analysis of the titles and abstracts of the articles selected for systematic review was carried out, having verified that only 13 scientific articles addressed the search terms considered in this work. Most articles presented the assumptions described, such as technical standards for GIs, territorial strengthening, economic development of products *in natura*, strategies of regional production in agriculture and economic assessment. These concepts enabled the analysis of the content related to the theme, as a result of the constant use of the keywords from the articles selected.



Figure 2. Geographical Indication and Economic Development of Brazilian Products *in natura*Source: Authors (2019), from the databases *Web of Science*, *Scopus* and *Science Direct*.

Following the systematic review, 13 articles were identified within the period from 2009 to 2019, with most journals selected being associated to GI and Economic Development (Table 3).

Table 3. List of Articles Analyzed in the Systematic Review regarding GI and Economic Development of Brazilian products *in natura*

	Title	Authors	Year	Journal
	Geographical indication as a market orientation strategy: An analysis of producers of high-quality wines in Southern Brazil	Fagundes P.M., Padilha A.C.M, Sluszz T. et al.	2012	Database Marketing & Customer Strategy Management
	An Overview of Geographical Indications in Brazil	Ramos B.D., Fernandes L.R.R de M.V., Souza, C.G. de	2012	Journal of Intellectual Property Rights
	Geographical indications in Brazilian food markets: Quality conventions, institutionalization and path dependence	Niederle P.A., Gelain J.	2013	Journal of Rural Social Science
	Trademarks, Geographical Indications and Environmental Labelling to Promote Biodiversity: The Case of Agroforestry Coffee in India	Marie-Vivien D., Garcia, C.A. Kushalappa, C. G., Vaast. P.	2014	Development Policy Review
	Contributions of geographical indications for territorial strengthening in rural space: a case study in southern Brazil	Pellin V., Vieira A.C.P.	2015	Revista Espacios

	Rural Territorial Development with Social Management: the Case of Geographic Indication of Paraty's Cachaça	Almeida A.C.R.A., Alimonda H.A., Meirelles Júnior J.C., et al.	2 015	European Journal of Economics, Finance and Administrative Sciences
	Protected geographical indications: Institutional roles in food systems governance and rural development	Conneely R.; Mahon M.	2 015	Geoforum
	Geographical Indication Re-signifying Artisanal Production of Curd Cheese in Northeastern Brazil	Almeida S.L., Paiva Júnior F.G., Costa C. et al.	2 016	Revista de Administração Contemporânea
	Technical norms for Geographical Indications and their reflexes for the wine sector	Bruch K.L, Vieira A.C.P, Gaspar L.C.M., Silva, da C. F. e Araújo, M. V.	2 017	BIO Web of Conferences
0	Geographical Indications and "Origin" Products in Brazil – The Interplay of Institutions and Networks	Wilkinson J.; Cerdan C.; Dorigon C.	2 017	World Development
1	From Geographical Indications to Rural Development: A Review of the Economic Effects of European Union Policy	Cei, L.; Defrancesco, E.; Stefani, G.	2 018	Sustainability
2	Geographical indications and value capture in the Indonesia coffee sector	Neilson, J., Wright, J., Aklimawati, L.	2 018	Journal of Rural Studies
3	Geographical Indication as a Tool for Regional Development: An Opportunity for Small Farmers to Excel in the Market	Malacarne A, Nunes-Silva L, De-Bort R	2 019	International Journal of Social Science and Humanity

Source: Authors (2019), from the databases Web of Science, Scopus and Science Direct.

According to Fagundes, Padilha, Sluszz et al. (2012), the issue raised by the development of a GI in the region studied in their work – Vale do Vinhedo, Brazil – lies on meeting the current and future demands, considering not only national but also foreign markets, taking into account that Brazilian organizations need to be focused on the growth of this market. The objective of the study consisted in assessing the economic development of vineyards specialized in high-quality wines from Vale do Vinhedo, in the Brazilian State of Rio Grande do Sul, from which the GI is characterized as a focus strategy to this market, enabling to improve economic development, leading to greater commercial value of the rural property, as well as the increase of the rural production area, improvement of technological standards, higher flow of tourists and recognition of the designation of origin.

For Ramos, Fernandes and Souza (2012), GI is a certification which leads to greater competitive advantage and adds more value to the product and region of origin. In the Brazilian scenario, with the country being a great exporting country of agricultural products, there is a significant potential in

obtaining this protection, considering cultural diversity, ecosystems and the distinctive local gastronomy. However, GIs are not widely known and explored in the country, with the development of new studies being highly important for present actions to be implemented, taking into account the great potential of the country and aiming at protecting GIs.

Niederle and Gelain (2013) discussed the institutionalization of the GI system in Brazil, emphasizing the evaluative disputes underway in hybrid forums, where several actors seek to build compromises concerning production rules and standards, linking economic and market aspects, analyzing the different understandings of GIs as they emerge from the discourses and practices of actors involved in food qualification processes. The results demonstrated that GI projects have been developed without a stabilized institutional frame – which would enable to set targets for the medium and long term, thus leading to the reproduction of a variety of subsystems implemented within different territorial and sectoral contexts. In turn, this has created several obstacles to market development, taking into account that the publication of GIs was not integrated in more effective studies nor integrated as part of a network with other GIs.

In turn, the work developed by Marie-Vivien, Garcia, Kushalappa and Vaast (2014) demonstrated that the district of Kodagu, in the Western Ghats of India, is responsible for the production of 2% of the coffee in the world, with the expansion and intensification developed in the region leading to the reduction of the forest cover by more than 30% in 20 years. Therefore, the authors identified the need of implementing innovative strategies capable of linking economic development and biodiversity conservation. Thus, three important strategies add value to coffee from Kodagu and prevent further biodiversity erosion: registration of trademarks; geographical indications; and environmental certification, via eco-labels. Accordingly, GIs are described as a path for promoting economic development, especially for adding value and protection to the coffee produced in the region.

In the study carried out by Pellin and Vieira (2015), by identifying strengths and economic vocations of the experience from Goethe Grape Valleys, in the region of Urussanga – in the Brazilian state of Santa Catarina, it was possible to identify that GIs have promoted rural territorial development, also increasing the competitiveness of the region. The study showed that GIs could be catalysts for territorial development in rural locations, mainly in economic terms, with the increase of sales and access to new markets, besides having other advantages related to the development of complementary activities, such as wine tourism and local identity preservation. In economic regards, the quantitative data of the study demonstrated that after identifying the GI for the product, several important economic advantages were observed in the region, especially two years after granting registration, when vineyards observed an increase of 20% in the sale of Goethe wines and of almost 30% in the sale of sparkling wines. This economic increase, following the recognition of GI of the Goethe wine, also provided access to new markets, where producers could sell their products in important regional networks, preserving biodiversity, local genetic resources and contributing to the environment.

The article with the highest score was published by Almeida, Alimonda, Meirelles Júnior et al. (2015), aimed at evidencing how geographic indications may contribute to the territorial social management movement, from a study on the label of cachaça produced in Paraty, in the south of the Brazilian State of Rio de Janeiro, addressing GIs and their implications on local development, focusing on the development

notion and its transformations, as well as on concepts of social management. The article states that a GI can generate a positive effect in providing development and improvement in life quality, though it may also cause negative impacts, as the exclusion in logic is only focused in the market perspective.

The article published by Conneely and Mahon (2015) examines the importance of national-level institutional arrangements for promoting the EU's Protected Geographic Indication scheme (PGI). Taking the example of Ireland, for which PGI designations remain comparatively low, the authors explore whether the approach for providing institutional supports to the PGI scheme is influenced by top-down technocratic governance structures that pertain to food safety and quality certification. The findings point to the benefits to be gained from a more layered governance structure for PGI, which is to incentivize the formation of producer groups and prioritize mentoring and support for PGI concept development, as a clearer reflection of bottom-up rural sustainability policy.

Almeida S.L., Paiva Júnior F.G., Costa C. et al. (2016) showed that fierce market competition and growing consumer demand for quality have spurred organizations to seek certification as a way of differentiating their products and services from those of competitors. This study aimed to understand how the process of GI certification has conferred a new meaning to the artisanal production of curd cheese, as well as how GI adds value to the product, making it competitive and influencing the economic development of the region. The results revealed that GI certification-driven innovations have helped producers to re-signify their artisanal production, while providing a clear understanding of the material dimension of the product, with a commitment for providing safety and high-quality products.

In the perspective of BRUCH et al. (2017), a technical norm for the GI management system is necessary, which has not yet been developed. This is necessary as the actions drawn are regionalized, although these could be part of a publication network that would enable greater exchange of knowledge, especially for promoting local economic development through the sales of products in other locations. The research developed examined the technical standards from the Brazilian Association of Technical Norms (ABNT), with the objective of examining if these can help in the structuring, recognition and sustainable development of GIs in Brazil. According to the authors, the creation of these standards is of great importance, as it would promote sustainability in several other sectors. Nevertheless, even without this GI management system, stark impacts can be observed as a result of existing technical norms in the wine-growing GI, which generated effective financial gains for local producers.

In the article published by Wilkinson, Cerdan and Dorigon (2017), institutional and organizational factors which have influenced the development of policies and mobilizations around agricultural products in Brazil were analyzed, particularly focusing on the analysis of the role of networks. The authors identified the different actors involved in the defense and promotion of origin products situated within the broader politico-institutional context, namely artisan cheese, identifying two types of networks focused on the promotion of origin products. Finally, new and broader trends in Brazilian agriculture were related to the development of GI for artisan cheese.

In turn, Ceï, Defrancesco and Stefani (2018) discussed about one of the main functions of geographical indications (GI), which is to provide information and quality of products/services to consumers, generating benefits to producers and stimulating rural development processes. The research was aimed at understanding if the theorized effects of GIs on local economic development are supported by empirical

evidence. The review carried out outlined that the demand for quality products is an economic opportunity for producers and, despite the difficulties found in the production process due to the location and sale of the products, the rural producer must maintain a skilled workforce to offer products with greater quality. Therefore, GIs are capable of protecting and generating added value, especially at the consumer and retailer levels, while the effects on the economic performance of producers are more heterogeneous and depend on specific local conditions. Nevertheless, the results obtained draw conclusions regarding the need for GI policies that attest the origin of products in more disadvantaged areas, with policies to advertise the region and its products/services, promoting the economic development of producers.

In the article published by Neilson, Wright and Aklimawati (2018), the discussion includes the concepts of value capture and strategic coupling from the global production networks, being used to assess the impacts of the Indonesian coffee sector with the development of formally-registered GIs. The authors also verified that GIs can deliver intangible benefits for some stakeholders in terms of promoting a sense of regional pride or cultural identity, contributing to the regional economic development.

Finally, the study carried out by Malacarne, Nunes-Silva and De-Bort (2019) highlights that agribusiness engages in a form of production in which only the big producer benefits, while family farming suffers from a scarcity of opportunities. The authors also analyzed the food production network in Brazil, within each of its five geographic regions, described in the documents consulted in the databases from the Brazilian National Institute of Intellectual Property (INPI, in Portuguese). The results show that the data on food production in the five large Brazilian regions differs significantly – mainly in the case of the States of Rio Grande do Sul and Minas Gerais, which are leaders in the use of GIs, with 19% and 17%, respectively, besides interfering in the agrobusiness model, where only large landowners generate wealth, being considered harmful to small producers. The authors concluded that one of the solutions for these small producers in improving their benefits and generation of wealth consists in innovation, thereby giving their products added value, with the use of GIs helping to support these small producers in their efforts to thrive.

## 5. Final Remarks

The systematic review identified the importance of GIs in adding value to products and services, mainly by enabling opening more markets from the standardization of products, thus promoting commercial leverage and rural development, consequently associated to a combination of improvements of local economic and social structures.

The guidelines adopted verified the existence of some locations around the world which use GIs as a way of promoting regional development, under an economic perspective, such as in the case of Kodagu, in India, and Ireland, taking into account the direct relation with the local territorial agglomeration, with potentialities for developing certain products/services, being an enabler of development in the region. The database from *Science Direct* presented the greatest number of publications in journals involving geographical indications and economic development as research focus. It is worth pointing out that the term geographical indication is cited in all articles published within the scope of the systematic review,

showing the concern of scientists regarding the need of valuing products/services and preserving tradition as a way of ensuring the quality to consumers, leading to greater trust. The publications analyzed were highly relevant for identifying the main actors, objectives and methodologies used for scientific production, especially concerning Geographical Indications and Economic Development of Brazilian products *in natura*. Moreover, a lack of research in this field was noted.

The development of this methodology contributed to the understanding of the strategy adopted in terms of how a GI can influence the economic development of a certain territory, mainly in disfavored regions, promoting the sustainability of production systems of local agri-food products, which can represent generation of wealth, work and jobs to local communities, besides mitigating rural exodus and helping in valuing natural resources and traditional cultures.

Accordingly, it can be concluded that the effects of Geographical Indicators in the economic development of regions have a considerable impact on driving investments in the production area, adding value to properties, boosting tourism, improving technological standards and generating job offers. Therefore, despite the limited number of GIs registered in Brazil, as a result of the increasing bureaucratic demand for legal protection, GIs are still considered a great potential to increase the competitiveness of producers as well as to economic development. Moreover, GIs can promote a better quality of life between the producing populations, playing an important role in several sectors of the Brazilian economy.

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# Study of the implementation of SPDA (Atmospheric Discharge Protection System) in a school in Manaus city – AM

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## Abstract

*Brazil is a country with high incidences of atmospheric discharges and during the year, several people are killed by these discharges. The main known discharge protection measure is the SPDA (Atmospheric Discharge Protection System). In this sense, this work proposes to present the measurements of SPDA (atmospheric Discharge Protection System) in a school located in the city of Manaus and its role for local security, by measuring the variables of an SPDA system, demonstration of the technical conditions of the SPDA and arguments that point out the relevance of the correct procedure for the realization of this process and importance of spda. For this, bibliographic research and on-site field study of the entire spda installation process was carried out in the buildings, multi-sport court and school water box. According to the studies conducted, it was observed that as measurements of ohmic resistances measured were low, very close to 0 ohms. The stress measures were collected, which were also low. The installed SPDA went to the Cage of Faraday and Franklin. For the school under study, the implanted SPDA obeyed all the standards that regulate it. The college is an environment frequented by many people of different age groups, the installation of SPDA implanted and sized ensures the protection of heritage, as well as safety and protection to life, because in case of an atmospheric discharge, there is a system who will receive it and lead it there is a path designed for it. If there were no, the building would be fully exposed to this risk and so would people. Therefore, even if SPDA does not guarantee absolute protection, the protection range it meets is representative, thus ensuring in a certain way the safety of people and protection of building and people. It was also found that the maintenance of the SPDA should be done annually from the start date of the technical report, to ensure the effectiveness of the system.*

**Keywords:** atmospheric discharges, electric grounding, spda;

## 1. Introduction

Brazil is a country with high incidences of atmospheric discharges and during the year, several people are killed by these discharges [1]. To ensure the protection of certain types of buildings considered conducive to this risk, ABNT (Brazilian Association of Technical Standards) created ABNT NBR 5419 – Protection Against Atmospheric Discharges, which explains the protection parameters against these phenomena [2]. The main known protection measure is the SPDA (Atmospheric Discharge Protection System). In addition to ABNT NBR 5419, ABNT NBR 5410 (Low Voltage Electrical Installations) and NR 10 (Electricity Safety) also regulate on the importance of grounding, which is a mechanism used in SPDA to dissipate the electrical current captured by the electricity system capture [3.4].

The SPDA has methods that are used to protect buildings and comprises steps ranging from the capture subsystem, subsystem of descent to the grounding subsystem.

In the building under study, two methods of protection of the SPDA were used, which were considered more appropriate for the building due to some aspects that will be explained later. For the design and installation of SPDA, there are several items that must be taken into account. These items include: degree of risk of building, soil, area and height of the building, among others.

The choice of the appropriate type of captor is important in an SPDA project, since they are the ones who capture atmospheric discharges, as well as descents also play a fundamental role in transporting these discharges to the ground.

In view of this, this work aims to present the measurements of SPDA (Atmospheric Discharge Protection System) in a school located in the city of Manaus and its role for local security. The steps of description of the steps for measuring SPDA variables; demonstration of the technical conditions of the SPDA and arguments that point out the relevance of the correct procedure for the realization of this process and importance of SPDA (Atmospheric Discharge Protection system) for the school will be essential for the realization of this study.

## **2. Theoretical Framework**

### **2.2 The installation of SPDA**

SPDA - Protection system against atmospheric discharges, these systems serve to protect buildings, antennas, industrial facilities, tanks, pipes and people against atmospheric discharges and their effects. Atmospheric discharge protection systems (SPDA) are composed of devices installed at the highest points of installations and structures, they provide a path to land offering the lowest possible electrical resistance to this way, offer a path to current created by atmospheric discharge flow toward the ground, without damaging equipment or structures, in addition to protecting people within the facility [5].

#### **2.2.1 Electric grounding**

Electrical grounding is the safest means of intervention in the electric current to protect and ensure the proper functioning of the electrical installation, in addition to meeting the requirements of the standards for electrical installations [6]. The grounding of a building electrical installation and the connection of a phase conductor or a ground neutral conductor aims to reduce ground stress within the limits set by the standards[6]. Every electrical installation should have the appropriate grounding system according to each project to be performed, thus all electrical equipment and metal parts must be connected to the grounding mesh [7]. Grounding allows a control of the stresses developed in the ground (pitch, touch and transferred) when a phase-ground short circuit returns by the ground to the nearby source or when an atmospheric discharge occurs at the site [8].

#### **2.2.3 Brazilian Association of Technical Standards**

According to ABNT NBR 5410-2008, electrical grounding consists of placing the facilities and equipment at the same potential, so that the potential difference between the land and the equipment is as

small as possible [3]. The earth is the connector with a potential difference equal to zero, the difference between it and the neutral is that it does not change its value by means of pollution so on the contrary, through the earth these dirties are eliminated, which does not allow power leaks to stay on the surface electrical appliances. These dirtis misthers are eliminated to land, hence the name [3].

The protection system against atmospheric discharges-SPDA aims to protect structures, equipment and individuals from atmospheric discharges, in addition to reducing their effects. NBR 5419-2015 recognizes three methods for protecting atmospheric discharges: Electrogeometric Model, Franklin method and faraday cage method [2].

#### 2.2.4 Methods of Air Discharge Protection System

##### 2.2.4.1. *Franklin Method*

This method was conceived by the discovery of scientist Benjamin Franklin. This method uses a raised rod above the structure to which it wants to protect, thus minimizing the distance and thus to the dielectric rigidity of the air between the supply of electrical discharge (charged clouds) and soil [7].

##### 2.2.4.2. *Faraday cage method*

This method consists of covering the building as a metal cage where everything on the inside of the cage is not exposed to atmospheric discharge, the radius hits the chord and descends through the cables of the subsystem of descents and is discharged into the ground, but for this system to work the grid has to be very well grounded [7].

##### 2.2.4.3 *Method rolling spheres*

This method consists of rotating a fictitious sphere, with radius determined by the norm, in all directions and directions on the top and facades of the building [7].

#### 2.2.5. Ground resistance measurements

The grounding resistance meter is constructed in the form of a two-core broken pliers with dimensions to engage the drivers of the grounding system. [6].

### 3. Methodology

The methodology used for the construction of this article is based on field survey and study, since data collection is done on site and then analyze so [9] and bibliographic research, which is effective trying to solve a problem or acquire knowledge from the predominant use of graphic, sound and computerized material information [10].

The area under study consists of a private elementary and high school, located in the Cachoeirinha neighborhood in the city of Manaus, in the state of Amazonas. The establishment is attended by more than 2000 students. Its degree of risk is 2, described according to Chart 1 of NR 04 - Specialized Services in Safety Engineering and Occupational Medicine [11].

To perform the school's SPDA (Atmospheric Discharge Protection System) system, it was necessary to

analyze some aspects of the environment such as verifying the activity that works in the environment, measuring the height and area of the building under study for the elaboration of the SPDA project of the building, if the soil has space to carry out a grounding system and the type of roof. In the installation phase of the SPDA project, it was necessary to measure the pH (hydrogenonic potential) of the soil, make the pits and insert the covered rods 5/8" x 2.4 meters in the soil to make the grounding system, installation of PVC boxes and installation of SPDA methods.

For installation of the Faraday cage method, the insulator supports were first implanted, then the 50 mm<sup>2</sup> nude copper cable was launched, closing the Faraday cage. With the mesh system ready, the subsystem of descent was made, which were fixed the insulating brackets, then 1" PCV tubes were connected.

For the installation of the Franklin type captor method, a 6 m high mast was implanted, then simple guide clamps were placed to attach to the top of the water box, PVC electroduate pipe to support the 50 mm<sup>2</sup> nude copper cable for the two Descents. At the top of the mast, a Franklin captor was fixed four-pointed and 30 cm tall.

For measurements of the omnimic resistances and tension, we used Digital Terrometer Model Minipa MTR 1520D Calibration AM06523/17, resistance ranges:0-20 ohms;0-200 ohms.0/2000 and tensã:0-200 VCA scale as described in figure 01.



Figura 01 – Terrometer Minipa MTR 1520D.

With the terrmeter, measurements of resistance and tension of the building were measured in the inspection boxes. Nine descents from the descentsubsystems were made in buildings 1 and 2. Six descents were made on the multi-sport court. Two descents were made in the water box.

The soil resistance measurement with the terrmeter was made from the displacement of point A to point B 20 m away, from point B to point C, the electrode had a distance of 15 meters, from point C to the terrmeter was detected a distance of 5 meters s. The electrode was implanted at a depth of 1500 mm, according to figure 02 [12].

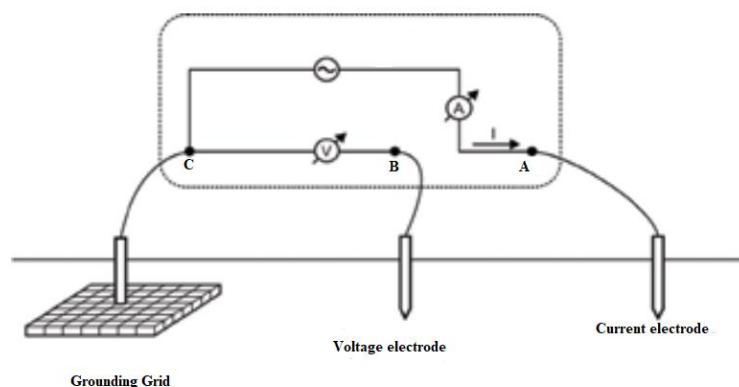


Figure 02 - Groundmeasurement.

The technical conditions of the site SPDA will be described in the results. The steps of arguing the relevance of the correct procedure of the SPDA and its importance to the school under study were achieved through knowledge derived from the direct observation of the process in partnership with bibliographic research on the subject.

#### 4. Analysis and Discussion of Results

According to the study conducted in locus for the installation of SPDA, the school has classrooms, library, multi-sports court, cafeteria, bathrooms, water box system and secretariat. The school consists of two buildings and a multi-sport court. In building 1, the high school works and in building 2, works the school of early childhood education, library, food court and secretariat. The building has 2,680m<sup>2</sup> of built area being, distributed as follows: building 1 is 40 m wide and 15 m long, totaling an area of 600 m<sup>2</sup> and 13 m high. Building 2 measures: 17 m wide and 40 m long, resulting in an area of 680 m<sup>2</sup> and 13 m high. The multi-sport court has measures 35 m x 40, with an area of 1400 m<sup>2</sup> and 15 meters high. The water box has a circumference of 4x4x6 with 20 meters high. Meeting the requirement of the Fireman's Body, a building with height above 15 meters vertically and area above 700 m<sup>2</sup> horizontal, is necessary for the installation of spda. When analyzing the building as a whole, it is observed that its area and height exceed these reference values, then it was necessary to install the SPDA.

After the analysis in square meters, it was identified that the soil presented the spacing necessary for the realization of the grounding with the triangle method.

In the installation phase of the project, after soil analysis, it was stated that it is of mixed type: sandy clay, with the following pH (hydrogenionic potential): the soil present near school building 1 is alkaline type and the other part the soil was confirmed to be acidic, which represents a soil to some point ideal for the implementation of the spda grounding, because for soils with these levels of pH the conductivity of the soil is good.

In the implantation of copperweld rods in 5/8" x 2.40 m copper welded steel, the cavas made were 25cm in diameter by 60 cm deep and for the cordoalha, the excavation was 25 cm wide by 50cm deep; at the connection points, the installed PCV boxes were 30 cm in diameter and 40 cm deep with galvanized iron slap. The grounding was made with the triangle method.

As for the roof, it was identified that the tiles of building 1 and 2 are of galvalume aluminum type with 5 mm<sup>2</sup> thickness. With this thickness, faraday cage method is necessary. On the other hand, the roof of the multi-sport court is zinc, 8 mm<sup>2</sup> thick serving as a captor. The SPDA methods installed were Faraday and Franklin cage methods. Faraday's cage method was used for the entire building of the buildings where the school operates, the multi-sport court used the roof as a captor. In the structure of the water box, the Franklin captor was used, because its height is greater than 15 meters vertically the circumference of the 4x4x6 water box, making it easy to place a mast to attach the lightning rod, obeying the requirement of the body's standards of Firemen.

The results of measurements of omnimic resistances performed in the grounding of each descent of the school are represented in figure 03. Ninety values were obtained for resistance measurements, because since the school building has 9 descent systems, measurements were carried out in the grounding of each.

These results are expressed by R1P, R2P, R3P, R4P, R5P, R6P, R7P, R8P and R9P.

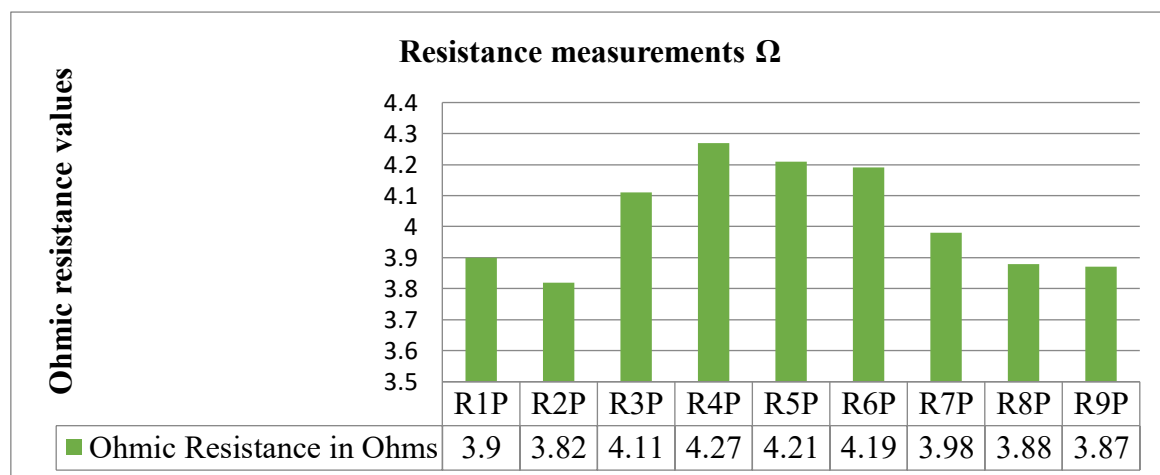


Figure 03 – Values of Omnimic Resistances of the grounding of building 1 and 2.

To perform the voltage measurement in V (Volts), where a voltage level up to 200 V was played, this voltage is discharged to the ground, the leakage of ground stress always vary between 0.00 and 0.12V, as shown in figure 04 carried out in building 1 and 2.

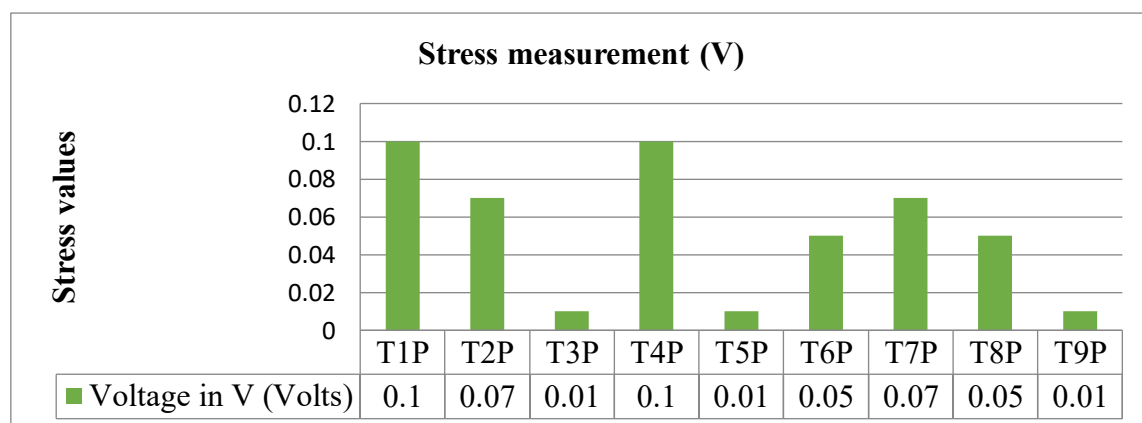


Figure 04 - Stress Values in building grounding 1 and 2.

It is observed that the values measured are very low, which configures a good SPDA system, because NBR 5410:2008 states that the lower the values of theethic resistance, the more effective the protection system. This applies to situations of electrical grounding, substation grounding and SPDA [3]. For the court, the values for resistances and stresses are described in figures 05 and 06, respectively:



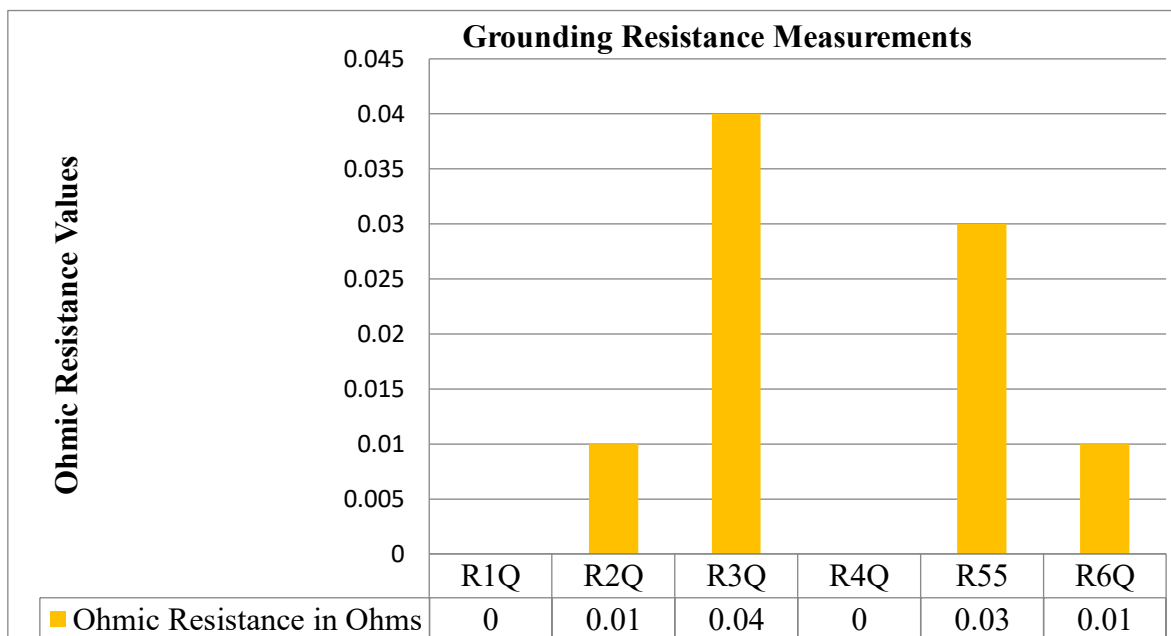


Figure 05 – Values of Ohmic Resistances of the grounding of the multi-sport court.

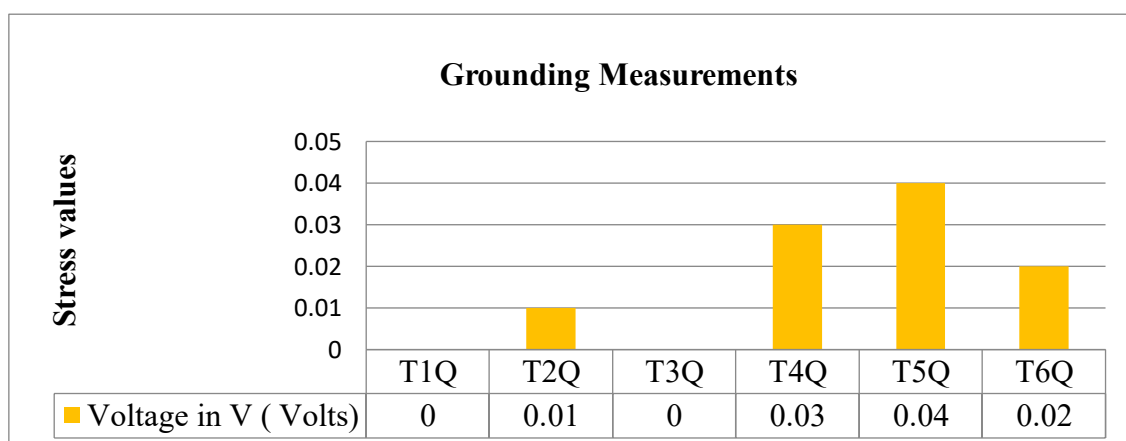


Figure 06 - Stress Values of the grounding of the multi-sport court.

The results show homogeneity and, consequently, electrical equipotentialization existing in the grounding mesh. The small variations are likely to stem from the various references adopted by the measuring instrument.

For measurements of ohmic resistance and tension in the water box, the following results were collected that illustrated by figures 07 and 08.

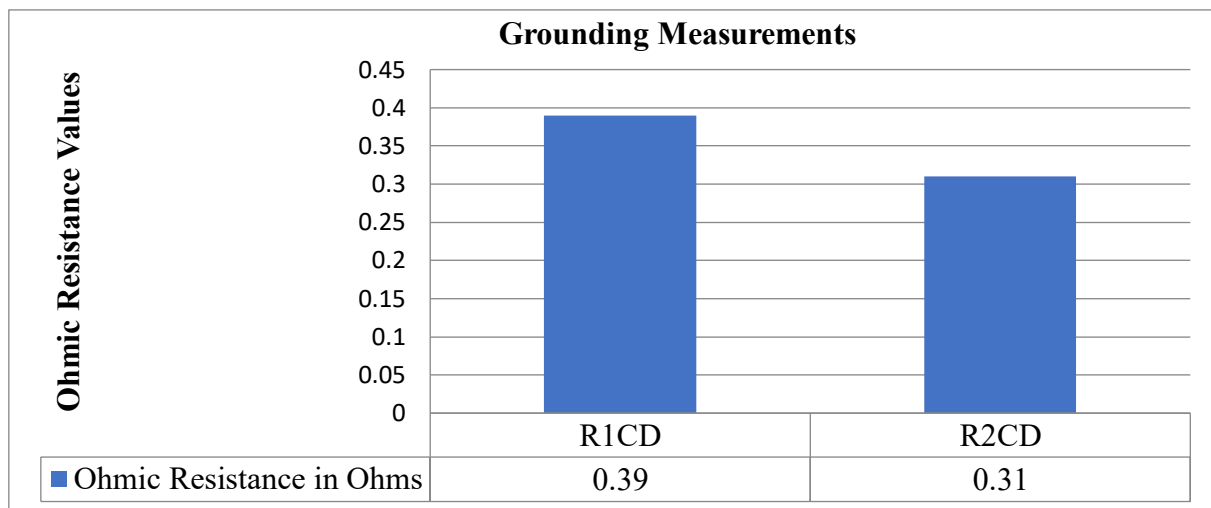


Figure 07 – Values of Ohmic Resistances of waterbox grounding.

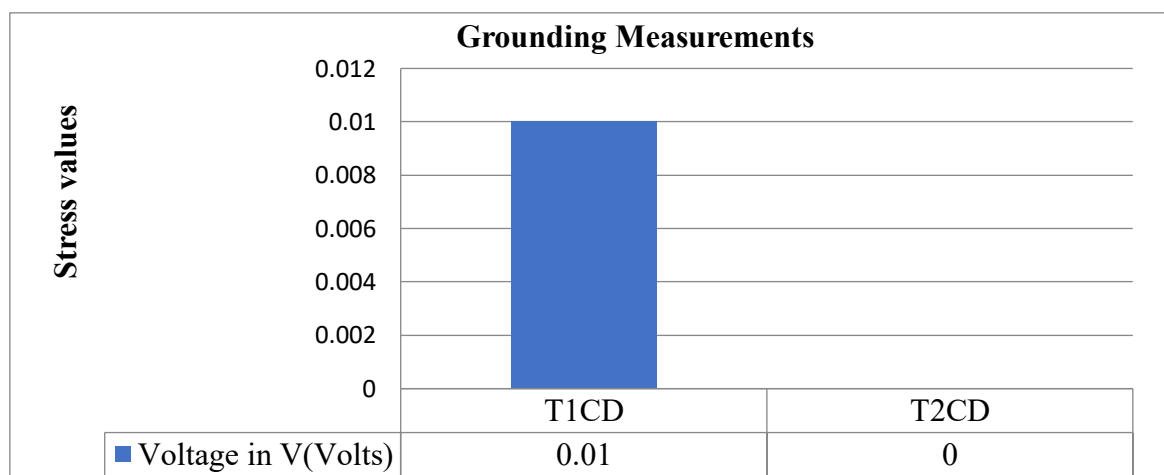


Figure 08 - Waterbox ground stress values.

It is important to highlight that all the ohmic resistance measured in the grounding system or school buildings, the multi-sport court or the water box presented very low values. Some values are very close to 0 ohms. This given is essential for a grounding system, especially SPDA, because the low ground resistance facilitates the dissipation of the electric current by it. A high ohmic resistance represents an obstruction to this dissipation of electric current, which is not a good condition for the installed protection system. Therefore, ABNT NBR 5410:2008 recommends that ground resistance be as low as possible.

In addition to being a requirement of the fireman's body, SPDA is a determination of ABNT NBR 5419, which determines all parameters for the configuration and installation of SPDA in Brazil. On the other hand, the ABNT NBR 5410 determines some conditions for grounding. NR 10 in turn determines that in addition to establishments with installed load greater than 75 kW constitute and maintain the Medical Records of Electrical Installations, they must have the documentation of inspections and measurements of the protection system against atmospheric discharges and electrical grounding [4].

The correct installation of SPDA is fundamental to the quality of the installed system. It is important that the system scales correctly, so that there are no future failures. In addition, you must comply with all the

requirements required by ABNT, NR and always observe whether there are municipal standards to be obeyed. For the school under study, the implanted SPDA obeyed all the standards that regulate it. The college is an environment frequented by many people of different age groups and a well-deployed and sized SPDA ensures the protection of heritage, as well as safety and protection to life, because in case of an atmospheric discharge, there is a system that will receive it and lead it there is a path designed for it. If there were no, the building would be exposed to this risk and so would people.

Because it is an environment frequented by people, the level of protection adopted for SPDA was level II that according to ABNT NBR 5419 is for buildings with high value goods or housing a large number of people [2].

The SPDA report of the building portrayed the good technical conditions of the SPDA, such as the resistance values already described, descent quantity, well-positioned captors, level of protection, calibration of the measuring equipment and validity of the SPDA which is one year, between Other.

## 5. Conclusion

Given the above, we reached the understanding of the importance of performing the SPDA for the school, as well as its level of protection and the technical conditions of such a system. It is important to emphasize that SPDA does not prevent atmospheric discharges from occurring, since they are a natural phenomenon. Although the system is a protective and safety measure, it does not ensure absolute building protection (80% to 95% - ABNT NBR 5419).

The school's grounding system has been installed and evaluated based on requirements and tested for compliance with the updated ABNT NBR 5419-2015, does not include protection of electrical and electronic equipment against electromagnetic interference caused by atmospheric discharges. Nor does it ensure the absolute protection of a structure, people and goods. Serves four protection points: capture conduction, absorption and equalization.

Therefore, even if an SPDA does not guarantee absolute protection, the protection range it meets is representative, thus ensuring in a certain way the safety of people and protection of building and people. It was also found that the maintenance of the SPDA system should be done annually from the start date of the technical report, to ensure the effectiveness of the system.

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## Social Presence and Video Conference in Professional Education

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### Abstract

*This qualitative and exploratory study aims to analyze the use of technology applied to vocational education from the theoretical review of the concept of social presence and the use of videoconference as an effective technological instrument in the consecration of social inclusion and interaction. In the face of worldwide globalization, need for qualification and professionalization of individuals is incorporated, with the modality of Distance Education being seen as an emerging strategy in the search for alternatives for this purpose. Within the results, two categories were listed and analyzed: professional education through videoconferences and social presence in the technological context. It is concluded that vocational education through videoconferences has been employed in order to face the demands of the labor market, qualifying workers and collaborating with the inclusion of those outside the productive process of the social system, with education being one of the main means for the realization of what we refer to as social inclusion. It is believed that cultural changes would be able to achieve a teaching method that should be seen as a social necessity, irrigated by the interaction of the subject through technologies and social presence, penetrating the entire social structure.*

**Keywords:** Pedagogical Formation; Continued Education; Vocational Education; Social Presence;

### 1 Introduction

Different authors conceptualize online education, also known as e-learning, as a particularity of distance education (Anderson, 2008; Elloumi, 2004; Ally, 2004). Online education refers to the use of the Internet as a medium for accessing didactic-pedagogical materials, conducting courses, interacting with content, teachers and peers, as well as for support during the learning process (Ally, 2004).

Vocational education, through videoconferences, has been employed to meet the demands of the labor market, qualifying workers and collaborating with the inclusion of those outside the productive process of the social system, with education being one of the main means for the realization of what we refer to as

social inclusion.

In this sense, videoconferencing is a form of remote and bidirectional communication that allows synchronized transmission of audio, video and data in real time. On this subject, Cruz and Barcia (2000, p. 4) state that, “of the technologies used in long-distance learning, videoconferencing is the one that most closely matches the standart situation of the classroom”.

The subject's involvement in an online learning environment alludes to the concept of social presence. According to Lowenthal (2010), the definitions of social presence in online education tend to involve the degree to which a person is perceived as being “real” and as “being there”.

In vocational courses conducted in part by videoconference, there is direct participation of the student, making it possible to reveal their ideas so that the teacher can determine their learning knowledge with a higher degree of interaction, yet with an expanded ability to communicate. However, how to maintain a sense of closeness in a communication context mediated by a computer? It is understood that the concept of presence, especially social presence, can subsidise this reflection.

Thus, this study aims to present a reflection on vocational education through videoconference, taking as a starting point the concept of social presence.

## 2 Social Presence and Videoconference Education

According to Obana and Tori (2010), the concept of presence is addressed in many researches and there are different definitions being applied, in which the most often found terms are: physical presence, social presence, co-presence and self-presence. According to definitions identified by the researchers, presence and physical presence have the same definition, with reference to the feeling of being in a real or virtual place. In this case, they can be known only as presence. On the other hand, social presence is a person's sense of being with another person or entity in a real or virtual environment.

In this context, Obana and Tori (2010) consider that social presence is of interest to all applications involving some kind of social interaction, whether for collaboration with remote human users, for virtual trials of representation or for public speaking practice with a virtual audience.

The Social Presence Theory elaborated by Short et al. (1976) apud Santos (2008), focuses on investigating how the media can successfully give users a sense of closeness and intimacy that is usually felt in physical presence. According to Bassani et al. (2011), social presence consists of interactions that enable the subject to recognize themselves and others in the environment, thus enhancing the feeling of trust and presence.

Some authors such as Whiteside (2007), for example, classify social presence into five categories. *Affective association* refers to emotional connections; *community cohesion* reproduces the way different subjects perceive the group as a community; *interaction intensity* refers to the level of interaction between participants; *knowledge and experience* entail on the sharing of additional experiences and resources; finally, the *investment of the instructor* refers to the involvement of the instructor in the establishing of the community.

For their part, Perry and Edwards (2010) highlight the importance of developing, implementing and evaluating different technologies to increase subject interaction in online education. From a Piagetian

perspective, Perret-Clermont (1978) apud Bassani et al. (2011, p. 109), it can be stated that “certain social interactions can modify an individual’s cognitive structure”. Still in this perspective, Perry and Edwards (2010) argue that the result of interactions in the online teaching-learning process can be understood as an enhancing of the experience of social presence within a virtual class, strengthening a “community culture”.

According to Bassani et al. (2011), based on conditions of interindividual coordination, the subject will elaborate their cognitive structures. As such, their cognitive processes will allow them to participate in new (more elaborate) social interactions that, in turn, will change their thought structuring. Thus, in this study, it is understood that social interaction is a condition for learning.

In the words of Carvalho and Ivano (2010), the use of digital technologies in educational practices is important for educators in a society which is increasingly connected to the internet. Commonly, technology has been used in long-distance education, seeing as besides promoting creativity and student participation in learning processes, it also promotes new ways of learning and teaching.

Online education refers not only to the use of technology in educational processes, but also to the inclusion of the internet in such proceedings, such as for the development of courses, as a means of access to teaching materials and as a means of interaction with the lesson’s content, with the teacher and classmates (Ally, 2004).

For the efficiency of classes taught through videoconferencing, there must be a subjective sense of being in an environment distinct from one’s physical environment. According to Albuquerque and Velho (2002, p. 01), in any communication mediated between remote users, the individual is physically in one place, but engaged and responding to a remote environment. “As the feeling of presence increases, the user becomes more aware and engaged in the remote environment and less aware of the environment in which they are physically located”.

When considering the theme interaction, intrinsic within social presence, we are talking about situations experienced by subjects, in which emotion and participatory cooperation of those involved prevail.

On the matter of technologies used in long-distance education, videoconferencing best achieves a standard classroom situation. Unlike teleconferencing, it enables conversation between student and educator, allowing the teaching process to take place in real time and to be interactive.

In the context of social presence, interaction is a fundamental requirement for vocational education processes made through videoconference. In this sense, Lowenthal (2010) points out that definitions of social presence in online education tend to involve the degree to which a person is perceived to be “real” or “being there”. Thus, technology modifies the interactions that subjects make with each other and with society.

Social Presence is considered to be the social and emotional projection of an individual in a virtual environment, namely, their involvement in the online learning environment. Moreover, it is a manifestation on the students’ part, and on the teachers’ part it is a perception of the interactivity of their subjects regarding themselves, their colleagues, their teacher and the environment (Bastos, 2012).

### ***2.1 Corporate education, new challenges in work education and continued vocational training***

A company is a learning space, and universities and schools can greatly contribute to the education of

professionals, as companies are trying to experiment with pedagogical practices stemming from the theories and methodologies of education. If companies seek to produce knowledge, add value and gain advantages over the competition, they will need to create and empower knowledge workers. With this, educational actions in companies are increasingly directed at the workers, as permanent and continuous learning is a competitive differential in today's market.

To teach content or to develop skills? We favor a fair, planned education focused on the students and their context; to develop their talents by valuing their experiences and practices, and to no longer focus efforts on whether or not they have memorized all they have learned. [...] as unfinished beings we can always evaluate and (re) evaluate, learn and learn [...]. (Ricardo, 2009, p. 91). In this sense, teacher training in this modality becomes essential, because technology can contribute to corporate education assisting in the advancement of Corporate Universities, and also as it is available to education for the purpose of facilitating learning. Innovative pedagogical practices promote reflective, questioning, revealing, critical and contextualized learning, and videoconferences and social presence are examples of these new pedagogical practices.

We agree with Senge (2004, p. 38) when he states that the organizations most likely to succeed in the future will be those that learn how to seed commitment in people and also the ability to learn within all ranks of the organization. This author emphasizes that companies must be committed to learning and developing the strategic competencies of their employees at all levels, even those less accessible by physical distance, and videoconferencing enables such access.

The scenario of globalization, according to Morin (2006), requires from Education a new outlook regarding the construction of knowledge, that is, a perspective able to respond to the challenges of the age of information through new ways of thinking and building knowledge. One of the great challenges of our century is knowing how to choose and handle information; To convert information into "pertinent knowledge", that is, that which is "capable of locating any information in its context", to exercise, learn and teach an "ecology of ideas and actions"; to understand ancient wisdoms, which are not yet gone, seeing as they still speak of the lingering essentials; to facilitate the emergence of new wisdoms; it is to seek complementarities in opposing knowledge (Morin, 2000).

It is, therefore, knowing how to make use of our "general intelligence" through compartmentalized knowledge and the culture of specialties. Therefore, the student must be encouraged to develop an investigative and autonomous spirit, ready to question the issues of a complex society, whose certainties are shaken by the speed that technologies of information and communication affect personal and professional daily life. Drucker (1989) complements this analysis by emphasizing that the future of companies depends on their ability to learn collectively and demonstrably from knowledge workers.

With this statement, it can be perceived that companies have many concerns that bring them to develop strategic competencies in their employees, that is, with investments in the development of human capital. There are innumerable efforts for facing an unstable and increasingly competitive market, and investing in knowledge, in learning how to learn, to do and to be, is essential and strategic. And as Geus (1999) states, the speed on which individuals and organizations learn can become the only sustainable competitive advantage for companies.

One of the alternatives used by companies is the implementation of Corporate Education, which unlike



training courses, is more focused on current and transient work situations, limited to a specific physical space and distant from learning proposals directed to problem solving and applicability in the workplace's daily tasks.

Meister (1999) distinguishes between corporate training and corporate education, stating that there are seven different points between these two modalities: the content, the methodology, the location, the target audience, the faculty, the frequency and the goal or expected result.

Corporate education can take place in any physical space, with the aim of working on subjects and actions that develop competencies suited to the strategies and business ventures of the company, with these being broad and global activities related to the whole business chain, with facilitators or teachers coming from the company itself or outsourced, such as university professors or outside consultants, thus contributing to the company's success, and particularly committed to worker performance. The author also reinforces that Corporate Education is a process which assists in the management of workers able to create and manage business opportunities, or even to enable them to be capable of facing the companies' internationalization processes (Meister, 1999).

The challenge lies in uniting business and education with a critical and reflective outlook on the pedagogical act and on the act of learning. In this sense, corporate education is an advance in relation to training programs that seek to develop competencies in line with the company's strategy. The focus is on the institution that understands and stimulates learning, with special regard to the company's core competencies, generating a development of people and, consequently, of organizations. (Bayma, 2004, p. 25).

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Éboli (2005, p. 53) states that the "Corporate Education System is a system of training and development of people based on competencies", and should aim to develop in employees the skills considered critical for the viabilization of business strategies, contributing for an active and permanent learning process, linked to the business' values, objectives and goals.

In this assertion, definitions lead us to understand that the process of corporate education is largely related to the notion of individual, organizational/collective and essential/critical competences, which stem from the strategic design of the organization. This development of competences must be based on learning processes, and structured with the purpose of being shared, so that they contribute to the critical/essential competences of organizations.

Within this context, companies with the Corporate Education model generally develop organizational learning strategies using long-distance education, live training and the exchange of experience combined with daily work practice, and the use of videoconferences is one of the tools which allows access to workers who would not have the possibility of continued education available in person.

### **3 Final Considerations**

When dealing with the topics of interaction, social presence and videoconference, it is understood that there is support for a social construction in which the manifestations of the culture of those involved would prevail. The subjects, when associated with emotion and cooperation, will be impregnated with cultural manifestations received through their socialization processes, since, from a Piagetian perspective, it can be stated that “certain social interactions can modify a subject's cognitive structure”. If nowadays we have a culture that pervades technologies, our actions are included in the cultural assertions of these days. By analyzing the interaction between the different actors and the environment in order to understand how social presence occurs, as well as inserting the instruments that assist the cooperative and collaborative learning process, we understand that there are subsidies for both the development of the learning strategies which will be employed as for the choice of the means to be used, whether they are informational or not.

Another interesting question regarding the use of technologies in vocational education concerns social presence, as the interaction of the subject being heard, the reception given to them, the interaction or even informal communication are all beneficial factors for the speaker. In this sense, according to Bassani et al. (2013), social presence is a fundamental condition for the cooperation between subjects to actually take place within collaborative environments, and the way the subjects present themselves in the social/virtual environment can be facilitated by the informational means and enhanced by the strategies of the subjects guiding the interaction.

When dealing with the theme of interaction, we are discussing the experiences in which what prevails are the cultural manifestations of those involved. In any virtual environment, participants will always be imbued with the manifestations earned in their socialization processes, resulting from the desire to strengthen friendship bonds at times when individuals begin attending certain environments more often, even more if they start perceiving it as a "place". Thus, for the learning to take place in online subjects, it is necessary for students and tutors to have access to an appropriate learning environment, to content designed for this particular purpose and to situations that provide interactions between student and teacher.

It must also be noted that this is a broad area of study which, evidently, allows for different interpretations. However, it is believed that some cultural changes would be able to achieve a teaching modality that should be seen as a social need, nurtured by the interaction of the subject through technologies and social presence, penetrating the whole social structure. Such experiences with digital technologies are part of a broader cultural transformation that is shaping education and providing a new medium for fostering creativity and student participation in teaching and learning processes. This is, therefore, a primary approach between considerations about videoconference before education and Social Presence, allowing an in-depth analysis to take place in future works, aiming to present other aspects related to the discussions that seek to situate the field of education studies and social presence.

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# **Proposal for Implementation of Post-Consumer Reverse Logistics in a Cosmetics Company in the Manaus Free Trade Area**

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## **Abstract**

*The objective of this study was to propose the implementation of post-consumer reverse logistics in a cosmetics company located in Manaus - AM (ZFM) Free Trade Area with the objective of optimizing the production processes in a sustainable way from the reuse of packaging waste, which will become raw materials in other production processes (feedback). It was adopted as a study method two types of research: bibliographic research and observational study. The Reuse Program will aim to promote the optimization of the production process of consciously and sustainably so that reverse logistics operation boosts the company's business. Investing in improving the logistics process of companies is critical to optimizing their processes and meeting the growing demand for quality services and products. B&B Cosmetics Company sought to invest in a re-logistics program. It is a post-consumer version to enhance its market actions and ensure competitive advantages.*

**Keywords:** Reverse logistic; Cosmetics; Manaus Free Trade Area - AM;

## **1. Introduction**

Society faces a major challenge in successfully moving socially responsible to an organization that is consistent with the natural system that supports it. This represents a significant challenge to the traditional way of thinking about social activities and the productive system. In this way, it faces the need to properly manage the entire product life cycle, seeking to improve both environmental, social and

economic performance.

For companies to remain competitive in the market, in addition to being in constant search for technological innovations, companies must also aim to contribute to sustainability in the end, the raw material is extracted from the natural resources that the environment generates, and due to population growth. This accelerated process generates a great need to take advantage of new technologies in order to meet the population need that consequently the extraction of raw material ends up being extracted in an unbalanced and unconscious way contributing to the imbalance of the ecosystem.

In the business sector there is a law that requires companies to manage their solid waste in an integrated manner and failure to comply with this law will be subject to the punishment of the Environmental Crimes Law - Law 9.605 / 98 (1998). These laws require companies to change their productive behavior towards a more conscious and sustainable production process. Companies' pursuit of sustainability is not only based on maintaining a positive image for their competitors, investors, customers and consumers, but on contributing to sustainability for the balance of the ecosystem as a means of preserving natural resources.

Incorrect disposal of waste generates numerous environmental damages that harm society: such as air pollution due to the emission of harmful gases; disposal of common waste in rain galleries causing flooding and flooding; improper waste disposal in environmental preservation areas that contaminate soil and groundwater; contributing in such a way to disease transmission, among others.

The objective of this study was to propose the implementation of post-consumer reverse logistics in a cosmetics company located in Manaus Free Trade Area (ZFM) in order to optimize the production processes in a sustainable way from the reuse of waste from packaging, which will become raw materials in other production processes (feedback). Therefore, the proposal will seek to: help improve business performance, increase material flows (reuse) and optimize the distribution center of the company's logistics chain.

## **2. Theoretical References**

### **2.1 Reverse Logistics**

According to [1], in the 70's, logistics began to occupy a space with the theme of politics and as a strategic alternative for business success. From that moment on, logistics followed a maturing path of understanding production with the flow integrated by the supply chain link and customer oriented.

This process of awareness, still underway, is closely in tune with the business context, characterized, since the 1970s, by changes in the world scenario, by managerial and technological innovations of social behavior [2].

Although the emphasis in this period was on direct logistics, the term "reverse logistics" was already present in the literature, especially in goods reprocessing studies. However, the maturity of organizations to deal strategically with logistics issues has not been exhausted at this stage of understanding. Today, successful business policies and strategic alternatives face a new challenge: reverse logistics as a way of adding value to business and society [3].

The path that has enshrined the importance of logistics for business performance is now undergoing

another stage of reflection, in which reverse logistics is included in the effective renewal of organizational strategies [1]. Amid a scenario focused on customer satisfaction with the objective of developing a management policy directed to the reuse of products based on sustainability, then came the reverse logistics which can be understood as a process that complements the traditional logistics, having as It is based on a differentiation in its process: it complements the product action cycle by bringing back the product used for consumption (total chain chaining).

Law No. 12,305 / 2010 defines reverse logistics: An instrument for economic and social development characterized by a set of actions, procedures and means to enable the collection and return of solid waste to the business sector, for reuse, in its cycle or in other productive cycles, or other environmentally appropriate final destination.

[4] notes that reverse logistics has a business point of view, whose chain of action is related to the planning, operation, control and flow of logistics information linked to the after-sales or after-use system of the product, adding a series of integrated tools to optimize the business of the company (Figure 1).

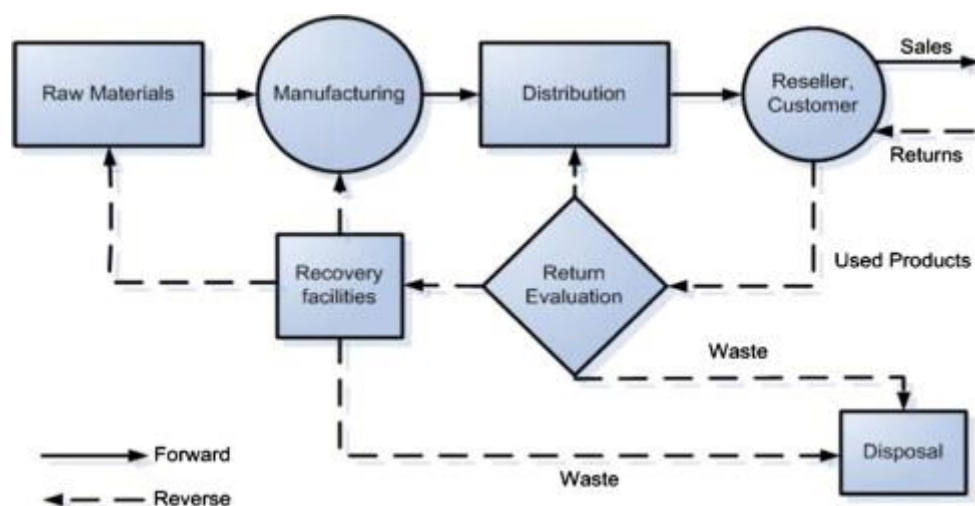


Figure 1: Reverse logistics;

Source: [5]

This reflection has enormous scope and should embark public and private organizations, all sectors of the economy and society. These are big and heavy demands on executives' behavior, because it's not just looking at reverse logistics as simply extending the scope of the logistics process [3].

## 2.2 Business Logistics: Direct and Reverse

Direct business logistics, considered as the focal point of the production chain, works closely with the supply chain management model. He focuses his study mainly on examining the flows of the direct supply chain [2].

Direct logistics is of fundamental importance in the process of collecting information about the process, based on the initiation of the process with the raw material until the final phase of production in order to serve the final consumer. This chain of actions represents, as noted [3] a logical operation of the relationship of the business-consumer process.

To achieve its business objective, direct business logistics has relied on business techniques and

philosophies that aim to increase the speed of response and customer service through the speed of logistics flow and the reduction of total operating costs, such as total quality, Just in time and logistics information technology [3].

It is noted that in direct logistics there is a unidirectionality and a linearity in the process, since the logical chain goes through the production, storage and distribution stages. However, organizations are optimizing their planning to increasingly serve the end consumer in the shortest possible time.

Both direct and reverse logistics, in their classic definition, are phases of business logistics. Thus, they tend to receive a strictly operational and economic focus, to the detriment of the environmental and social points of view. Although some environmental aspects are addressed as economic and / or operational factors of reverse logistics [6].

Pereira [6] notes that reverse flow process development has the ultimate goal of meeting customer demand needs. This factor of adding social and environmental responsibility to providing a more effective service to the end consumer is a primary characteristic of reverse logistics: reuse with improved distribution channels and information in the process.

### ***2.3 Post-Consumer Reverse Logistics***

Reverse post-consumer logistics is based on planning, control and final disposal with a focus on post-consumer goods, ie goods in final consumption phase [7]. The analysis of consumer goods in post-consumer reverse logistics takes into account the useful life of a given product, based on its final use characteristics, depending on the destination (recycling or reuse) in which the post-philosophy philosophy proposes. consumption and turns it into another consumer good.

[8] notes that post-consumer reverse logistics operates on a product return system to the production center in order to harness the resources and potential that it can still offer for an aftermarket stage. [6] analyzes that after-consumer goods, as well as after-sales goods, are elements that dissociate in some aspects: after-sales are products that have little use and demand of greater strategy for a new process of sale; Post-consumer products have a higher potential, as they have already been used and generally have a higher potential demand.

The post-consumer reverse logistics process develops through a logistic trigger that originates in the traditional supply and production process and returns in a reverse flow from the collection and reuse of these materials [7]. This chain consists of a series of activities that together articulate strategic actions to perform the reprocessing of the material used (Figure 2):

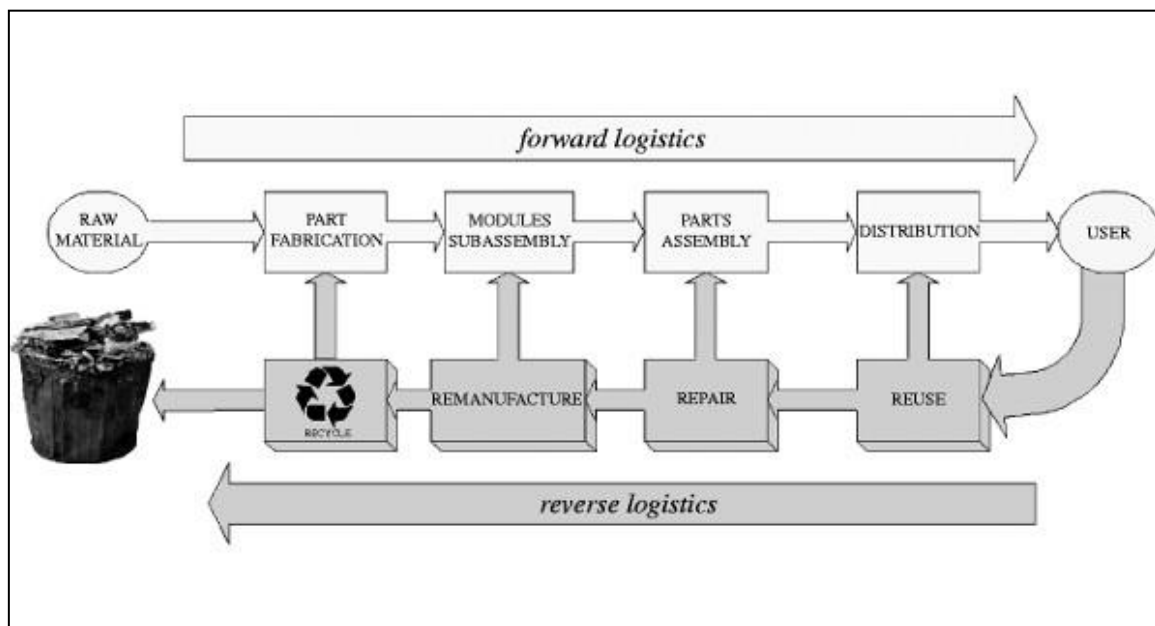


Figure: 2 Reverse logistics after consumption;

Phone: Adapted from [9]

[10] analyze that post-consumer reverse logistics is of fundamental importance to the process of organizational innovation. It generates a competitive factor from the proposal of ventures and actions arising from this type of logistics niche, which provides - in the long run - a more sustainable *modus operandi* with a focus on social and environmental responsibility.

[11] analyzes that post-consumer reverse logistics is part of the corporate logistics structure, whose key role is centered on the operationalization, management and decision-making of material goods after their sale and consumption process. The post-consumption phase, according to [10], is a step that goes beyond the organization's conventional production and demand process to strategic planning that involves systematization in the post-production chain.

#### **2.4 Distribution Chains in Post-Consumer Reverse Logistics**

Production life cycles are processes that have their origins in the manufacture of the product until the final customer service and delivery stage. [4] analyzes that the process of the production flow in a traditional logistics chain follows according to the production (origin) of the goods, passing through the stage of packaging, preparation, distribution and delivery. Reverse flow, on the other hand, is a process contrary to the traditional one, since it needs to work with a system of revaluation of goods through strategies of recycling, reuse and market replacement.

[11] analyzes that the main distribution channels in the post-consumer reverse logistics process are recycling and the reverse manufacturing channel. Recycling is a very important process for extracting consumer goods that have market value, that is, the product that has value after being consumed, which has market potential. The reverse channel of manufacture has the role of improving the recycled material, developing methods of reusing the physical state, replacing components and complementing product characteristics.

[10] state that in Brazil there is already a strong business branch in the process of recycling policies for



post-consumer reverse logistics. They mention that national and multinational companies are already developing actions aimed at optimizing their distribution channels throughout the country, especially in the recycling phase and in the preparation of the product in the manufacturing phase, in order to cheapen the process and leverage the reuse of the product. production.

### **2.5 Benchmarking**

According to [12] Benchmarking is a continuous and systematic process whose main purpose is linked to evaluations of services and products of organizations, recognized as relevant to a certain market niche, in order to serve as a parameter for improvement.

[13] note that Benchmarking within the industrial and corporate branch serves as a tool for parameterization of results and objectives achieved by the company, ie, it supports the evaluation of performance and continuous improvement methods to optimize services and products.

To apply Benchmarking as a market strategy it is necessary to know its types. [14] points out the main typologies as: Internal Benchmarking, Competitive Benchmarking and Functional Benchmarking. For the process of identifying competitor processes, services and products, competitive benchmarking has better functionality.

## **3. Tools and Methods**

The study used Benchmarking as a study application tool. Its objective was to analyze successful cases in the implementation of reverse logistics models and to adjust their strengths for the study.

Based on the analysis method, the Reuse Program - Post-Consumption Reverse Logistics application program - was presented as a research product for the optimization of the company's reverse logistics process.

## **4. Application of Study**

### **4.1 Characterization of The Company**

The company B&B Cosmetics is located in the city of Manaus-AM, in the Industrial Pole of Manaus Free Zone, and has been engaged in cosmetics in the Amazon region for over 10 years. Currently it has more than 23 (twenty three) direct and indirect customers from sales of its products, both to the local market and also outside the state of Amazonas.

However, in recent years, the company realized that it had been losing market due to not having within its strategic planning structure an action structure focused on Reverse Logistics. All outlets and distributions of its products are operated through Direct Logistics, without any planning focused on reuse and post-consumption.

After noting, by hiring a consulting firm specializing in business logistics, that the company was losing market share by failing to pursue a post-consumer reverse logistics strategy, the Operations and Logistics Board began the first studies on how to develop a strategic plan focused on the proposed reuse of its products.

## **4.2 Benchmarking Application**

The application of this study was aligned in 3 (three) steps:

### **I. Benchmarking application;**

The first step in the application of the study was the use of benchmarking as a tool to identify competitive practices to capture the positive points to be applied in the company's process. For this study, functional benchmarking and competitive benchmarking were applied, which was applied by consulting the successful cases within the reverse logistics sector in companies in the cosmetics and beautification segment.

After this thorough analysis were identified two (02) companies that had a successful case in the implementation of a business policy in reverse logistics: Natura and Boticário.

Boticário implemented its reverse logistics strategy from the implementation of the Packaging Recycling Program (PRE) with the proposal to apply the post-consumer reverse logistics of its beauty products. Since 2007.

Natura has been developing strategic planning actions directed to its post-consumer reverse logistics program, being considered one of the most efficient in the cosmetics business in Brazil and Latin America.

After the analysis process with Benchmarking, a survey of the optimization aspects of the logistics process of the companies that can be applied to the study was conducted.

### **II. Survey of aspects of logistics process optimization;**

Based on this analysis, it was observed:

- a) The structure of the Apothecary PRE
- b) Natura's strategic management
- c) The process vertical storage system with cooperative association

The proposal intends to use the same structure of the Boticário PRE as a form of reverse flow organization, prioritizing the waste treatment in a decentralized and cooperative manner, which tends to generate greater dynamism in the logistic chain process.

### **III. Reuse Program Development**

The proposal for the elaboration of the Reuse Program arose from the possibility of improving the reverse flow logistics aspects for the company through the logistics and distribution systems observed at Natura and Boticário. The choice of the name "Reuse" was due to the appeal of green marketing and the ease of communication on social media. In addition, the choice to implement it as a Program was made in order to make it a perennial activity in the company with long term execution.

## **4.3 Lifting and Aspects**

Regarding the strategy management process, we opted to incorporate the company's supply chain management method in accordance with Natura's logistics policy. The choice is due to the fact that Natura centralizes its logistics process according to demand, developing a Just in Time methodology based on product demand. B&B Cosmetics will aim to develop its strategic actions in the same way through the Reuse Program: combining storage and distribution by improving inventory management.

For the elaboration of the decision making process expansion structure, it was decided to use the storage

verticalization method through the agreements with associations of local waste collection cooperatives. This agreement will be based on the elaboration of collection and profit sharing goals with the preparation and sale of reused products.

Social accountability through strategic sustainability actions will promote the expansion of the company's activities through the reuse of product packaging waste. Closing according to the cooperatives - stakeholders - will enable the development of reuse focused on expanding niche markets.

## **5. Results and Discussions**

The Reuse Program has been aligned on three parameters for improving the process of implementing the B&B Cosmetics reverse logistics system:

I. Reverse Flow Thread Optimization

II. Expansion of Company Business Niche

III. Implementation of social accountability policy

The Reuse Program will aim to promote the optimization of the company's production process in a conscious and sustainable manner, so that the reverse logistics operation enhances the company's business. The program structure will proceed with the following phases:

1. Product life cycle mapping;
2. Monitoring of the reverse chain flow logistic chain;
3. Vertical screening in inventory management;
4. Closure of cooperation agreements with local cooperatives;
5. Structuring the social responsibility and green marketing action system

The Reuse Program implementation process is scheduled for 90 days. The proposal will be presented in the company through the offer of workshops and training and qualification of employees and managers.

## **6. Final Considerations**

Investing to improve the logistics process of companies is fundamental to optimize their processes and meet the growing demand for quality products and services. Today, companies are increasingly aligned with investing in stock innovation in their logistics process with the purpose of being able to serve their customers quickly and effectively.

B&B Cosmetics Company sought to invest in a post-consumer reverse logistics program to enhance its market actions and ensure competitive advantages. After observing that several competing companies were opting for this market niche, the company found that the feedback method of their production process could lead to market expansion and brand enhancement through social responsibility.

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## **Inclusion of Students with Down Syndrome in Brazilian Schools**

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### **ABSTRACT**

*Down syndrome, or chromosome 21 trisomy, is a genetic change that occurs at the time of conception of a child. People with Down syndrome have intellectual disabilities, this fact contributes to social exclusion, isolation and impairment in their development, since there is much social prejudice regarding this syndrome. Considering the need to include children with Down Syndrome In schools this research aimed to promote a reflection on the process of inclusion of these people in Brazilian schools through the assistive technologies used. This research is an integrative literature review where the search took place in databases of greater relevance to the subject. The exact descriptors of medical subject titles were used in English using "Mainstreaming (Education)", "Down Syndrome" and "Schools" and in Portuguese the exact descriptors in the health sciences "Educational Inclusion", "Down Syndrome" and Schools". The results showed that the insertion of the child is only physical and only due to the obligation promoted by the current national legislation. Social inclusion does not occur in such a way as to integrate students, teachers and technicians, and teachers are unprepared to drive inclusion due to limitations in their education, lack of incentive to qualification, school infrastructure and large numbers of students in the classroom. In accordance with this reality, this paper aims to promote a reflection on the inclusion of students with Down syndrome in Brazilian schools, through the discussion and development of appropriate assistive technologies for this process to occur effectively.*

**Keywords:** Down syndrome, Educational inclusion, Schools, Assistive Tecnology.

### **INTRODUCTION**

Langdon Down, an English physician who identified trisomy of chromosome 21 in syndromic patients in 1866, first described Down syndrome (Schwartzman, 2003). The trisomy of chromosome 21 causes intellectual disability, microcephaly and low implantation of the ears (Piato, 2009).

The frequency of occurrence of the syndrome is one for every 700 to 750 live births (Sherman *et al.*, 2007). Maternal age above 35 years is a risk factor (Gusmão, Tavares and Moreira, 2003). The person with Down Syndrome presents characteristics in different degrees, because it depends on the way they were stimulated in their development. Constant stimulation for development promote greater learning capacity and sociability (Santos and Santana, 2016).

The family and school play a key role in the child's learning. According to Abramowicz (1997) the school can welcome differences and teach through a pedagogy that is a new way of relating to knowledge, to students, to parents, to community, to failures and to their end whereas in this context, the concept of inclusion is interesting. For Aranha (2002) it is a process of affiliation, combination, comprehension, involvement, contenance, surrounding, that is, to invite those who are not inserted in a social context to enter and share knowledge, abilities and also difficulties, as companions and members. Inclusion is to promote the right to citizenship, to participate in society.

In the world context, the United Nations Organization advocated the inclusion of people with special needs through the Salamanca Declaration, which referred to social inclusion and participation as essential to human dignity and the exercise of human rights (UNESCO, 1994).

In Brazil the Federal Constitution, instituted in 1988, guarantees the process of inclusion of children with Down Syndrome and the right to education by Law Guidelines and Bases of National Education (LDBEN nº 9394/96) that establish those people with special needs have the right to education in Brazilian schools. This right is independent of physical, intellectual, social or emotional conditions, and should be free and started since Child Education and extend throughout life (Brazil, 2018).

The inclusion of the child with Down syndrome should not be only physically, but in the context of special education that according to Dellani and Moraes (2002) is a teaching modality that aims to promote the overall development of students with disabilities, respecting individual differences, and ensuring the exercise of citizens' rights.

In Brazil, more than 40 million people have special needs 1 million are enrolled in Brazilian schools according to data from the latest Brazilian sense of school (Brazil, 2019).

Taking into account the need to include students with Down Syndrome, the following guiding question guided this review: How are the inclusion of children with Down Syndrome in Brazilian schools? This question aimed to understand how this process occurs in Brazilian schools, whether it has effectiveness and what assistive technologies are used to include this population.

The purpose of this work is to promote a social reflection on the subject in order to favor the inclusion of children and students with Down Syndrome.

This study is an integrative literature review that aimed to understand and promote a reflection on the process of inclusion of these people in Brazilian schools, its effectiveness and assistive technologies used.

## **MATERIALS AND METHODS**

The integrative review is used in studies aiming to broaden the understanding about a certain subject. This integrative review utilized the five steps proposed by Whittemore and Knafl (2005) described below:

First stage - Identification of the problem: The problem was identified by variables of interest of the guiding question: "How are the inclusion of students with Down syndrome in Brazilian schools?"

Second stage - Literature search: The search in the literature was done through exact descriptions of Medical Subjects Headings (MeSH), in English, being used "Mainstreaming (Education)", "Down

Syndrome" and "Schools" and similarly in Portuguese, the Exact Descriptors in Health Sciences (DeCS) "Inclusão Educacional". "Síndrome de Down" and "Escolas". The search for the studies were through the combinations between the descriptors using the Boolean operators AND and OR.

The databases used were the most significant for the thematic, being: Latin American and Caribbean Literature in Health Sciences (LILACS), Eletronic Library Online (SciELO), Directory of Open Access Journals (DOAJ), PubMed and Web of Science.

Included in this review were articles that were complete and available online, written in Portuguese, English and Spanish, from January 2008 to May 2019. The articles should answer the guiding question of this study.

After search in the databases, the reading of the title, abstract and keywords was carried out to select the studies. The selected studies were read in their entirety, of which the respondents to the guiding question comprised the final sample of this study.

Third stage - Data evaluation: The authors formulated an instrument with the following variables: database, author(s) and article title, periodical and year of publication, type of study and educational institution, city and/or region of the Brazil to carry out the study, objective and main results.

Fourth stage: Data analysis: This step resulted in the following categorizations: Characterization of the sample; Evaluation of articles; Social inclusion and the school inclusion of the student with Down syndrome; The school, teachers and parents in the inclusive process.

Fifth stage: Presentation of the results through the elaboration of this article, which presents in a clear and concrete form the integrative review, putting all the elaborated stages, results and conclusions.

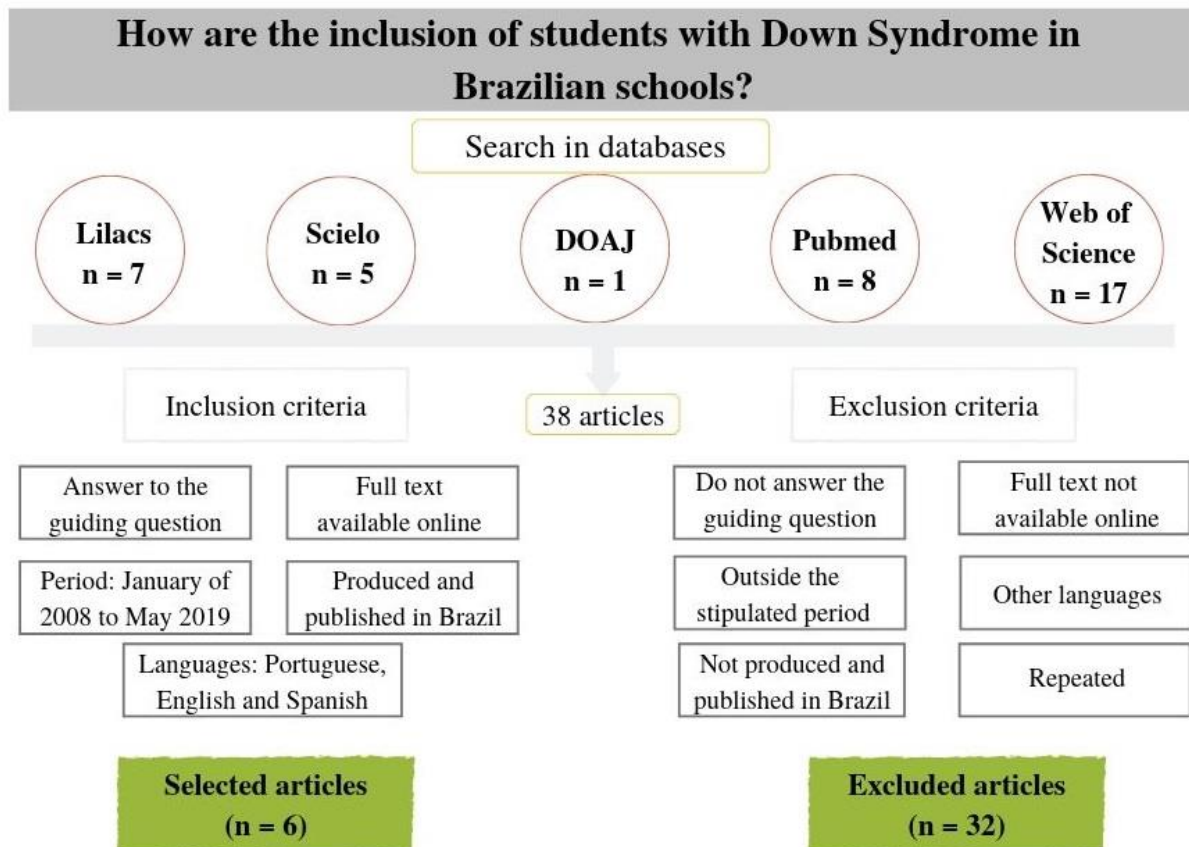
## **RESULTS AND DISCUSSION**

### **Characterization of the sample**

The search in the databases through the descriptors resulted in 38 articles. Of these 27 did not answer the guiding question of this study, remaining 11 studies, being that some of them did not meet the inclusion criteria and others were repeated in the databases, being excluded. Finally, 6 articles were selected that compose the final sample of this review.

When searching the databases with descriptors and Boolean connectors, we obtained: LILACS (7 articles), SciELO (5 articles), DOAJ (1 article), PubMed (8 articles) and Web of Science (17 articles), totaling 38 articles. LILACS and SciELO presented a higher number of articles corresponding to the interest of this study, however, the 4 articles selected in the SciELO database and the study in the DOAJ database were found in LILACS, excluding SciELO and DOAJ. PubMed and Web of Science databases did not result in final sample work. The figure (a) below shows the selection flowchart of the articles of this integrative review.

Figure a: Flowchart of the selection stage of the articles that make up the integrative review sample.



Source: Prepared by the authors (2019).

### 3.2 Evaluation of articles

The six articles that were part of this integrative review were evaluated according to the following variables: database; author (s) and title of the article; periodical and year of publication; type of study and nature of the educational institution; city and / or region of Brazil where the study was conducted; goal; and main results. This analysis is described in figure b.



Figure b: Evaluation Of the articles according to the selected variables

BASE	Author (s) and article title	Periodical and year of publication	Type of study and nature of the educational institution	City and/or region of Brazil where the study was conducted	Objective	Main results
LILACS	TEIXEIRA, F. C.; KUBO, O. M. Characteristics of the interactions between students with Down syndrome and their classmates in the regular system of education.	Brazilian Journal of Special Education, 2008.	– Cross-sectional qualitative study; – Private school.	– Medium-sized city not mentioned; – South region.	To characterize the interactions between students with Down Syndrome, inserted in the regular system of education, and their classmates.	– The greater the academic development and the degree of participation in the activities, the greater the possibility of the student with the syndrome to be considered friend; – The classmates are more recognized, both positively and negatively, and have a negative expectation about the possibility of the DS student doing a college.
LILACS	OLIVEIRA-MENEGOTTO, L. M.; MARTINI, F. O.; LIPP, L. K. Inclusion of students with Down Syndrome: teachers' discourses.	Fractal: Journal of Psychology, 2010.	– Qualitative, exploratory study; – Public and private school.	– Novo Hamburgo, RS; – South region.	To discuss the discourses of school teachers from the city of Novo Hamburgo / RS on the inclusion of students with Down Syndrome.	– They express feelings of helplessness, impotence and incompetence in the face of inclusion; – Lack of space for discussion and training on the subject.

Figure b: Evaluation of the articles according to the selected variables (continuation).

BASE	Author (s) and article title	Periodical and year of publication	Type of study and nature of the educational institution	City and/or region of Brazil where the study was conducted	Objective	Main results
LILACS	FERRAZ, C. R. A.; ARAÚJO, M. V.; CARREIRO, L. R. R. Inclusion of children with Down Syndrome and cerebral palsy in elementary school I: comparison of the reports of mothers and teachers.	Brazilian Journal of Special Education, 2010.	– Cross-sectional qualitative study; – Public school.	– Unnamed city of the great Sao Paulo. – Southeast region.	To know the process of inclusion of the student with Down Syndrome and Cerebral Palsy, from the comparison of the discourses of parents and teachers, and with that, to evaluate how the communication between them can affect the inclusion process.	– Opportunity for inclusion to reduce prejudice; – Expectation of parents when enrolling the child in regular education in the possibility of learning to read and write at least the name; – Teachers do not feel ready for inclusion; – Even without resources, they work for learning.
LILACS	ALVES, M. L. T.; DUARTE, E. The participation of students with Down Syndrome in School Physical Education classes: a case study.	Movement Journal, 2012.	– Case study. – Public school.	– Campinas, SP; – Southeast region.	Observe the reality of the inclusive process of children with Down Syndrome (DS) in school physical education classes.	– The student with DS had difficulties to participate socially with the class; – The student with DS did not present difficulties to understand and perform the activities proposed in class.
LILACS	KIBRIT, B. Possibilities and challenges in school inclusion.	Latin American Journal of Fundamental Psychopathology, 2013.	– Case report. – Private school.	– City and region not mentioned.	Framing a vision about the concept of inclusion in order to more consistently see it in the context of the school environment.	– The school was not prepared to receive a student with DS; – The class assistant was responsible for therapeutic and inclusive monitoring; – Teachers did not prepare adequate materials for the student.

Figure b: Evaluation of the articles according to the selected variables (conclusion).

BASE	Author (s) and article title	Periodical and year of publication	Type of study and nature of the educational institution	City and/or region of Brazil where the study was conducted	Objective	Main results
LILACS	ALVES, M. L. T.; DUARTE, E. Social inclusion and the student with Down syndrome: a case study in Physical Education classes.	Think Practice Journal, 2013.	<ul style="list-style-type: none"> <li>– Qualitative case study.</li> <li>– Public school.</li> </ul>	<ul style="list-style-type: none"> <li>– Campinas, SP.</li> <li>– Southeast region.</li> </ul>	To analyze the participation of students with intellectual disabilities, specifically with Down Syndrome (DS), during school physical education classes.	<ul style="list-style-type: none"> <li>– The student with DS found difficulties to interact with peers during physical education classes;</li> <li>– The student with DS has demonstrated important limitations in structuring social relationships.</li> </ul>

Source: Prepared by the authors (2019).

### Social inclusion and school inclusion of the student with Down Syndrome

The school has the role of promoting social relations among students, but when these relationships involve students with Down Syndrome, Teixeira and Kubo (2008) have shown that they are not effective. The authors describe that in a school with 4 students with Down syndrome, 3 did not receive any indication as "friend" by their classmates, this fact is worrisome to be able to lead to social isolation and discrimination.

Another fact verified was that students with Down Syndrome presented a school delay in relation to the other students, verified by the age difference of the students with the average age of the students of the class (Teixeira and Kubo, 2008).

The school can be considered an assistive technology for the inclusion of these students, another technology that can be used are physical education classes that promotes student interaction. Alves and Duarte (2013) verified this interaction, but students with Down syndrome presented limitations to participate socially with the class due to the difficulty of students with disabilities to reach the place of the physical education class.

Alves and Duarte (2013) applied the sociometric test proposed by Moreno (1994) at the beginning and end of the school term in order to obtain an indicator of acceptance of the student with Down syndrome. A question was asked for the third grade class about who they liked and did not like to play in physical education classes, and even the Down Syndrome student had increased his degree of empathy with the students in his class and had not been rejected by no colleague, social status relative to his colleagues was classified as ignored.

Socialization in the process of social inclusion is important, but it is not the only concern of mothers and teachers as Ferraz, Araújo and Carreiro (2010) conclude. Parents' expectation is that their children with Down Syndrome enrolled in schools will also learn to read and write.

It is understandable the concern of parents and teachers in the context of pedagogical learning, but there are barriers that surround this process, one of them is the teacher's unpreparedness and inadequate physical structure of the schools (Oliveira-Menegotto, Martini and Lipp, 2010; Block and Obrusnikova, 2007).

### **School, teachers and parents in the inclusive process**

The articles selected in this review, 100% (n = 6) cited the school's influence on the inclusion process.

The school can provide different types of interactions and learning among students, this is part of the inclusive process, but only the physical interaction does not guarantee this inclusion (Teixeira and Kubo, 2008; Oliveira-Menegotto, Martini and Lipp, 2010).

The inclusion process should favor the student to reach a degree of knowledge and intellectual development, in addition to maintaining a good social relation with their peers. This process should involve the school and parents, but Kibrit (2013) found that parents do not always care about this inclusion process.

Schools are strictly concerned with complying with the law and pass this responsibility on to the teachers, they assume the role of including the student, adapting activities and having greater concern to promote education, respecting the limitations of the student (Kibrit, 2013).

Planning an appropriate curriculum and making pedagogical adaptations to the needs of each student is an outcome presented by Oliveira- Menegotto, Martini and Lipp (2010) to favor an effective inclusion of students with Down syndrome.

The teachers do not feel prepared to attend the students with special needs, this fact is justified due to their inadequate training, noting that the discussion about Inclusion of students with disabilities began in the 1990s (Oliveira-Menegotto, Martini and Lipp, 2010).

Unprepared teachers maintain a negative attitude toward the student who needs care (Block and Obrusnikova, 2007). It is then necessary to approach this subject in teacher training and its exploration in the practical context to better elucidate the educational processes that involve them (Gilmore, Campbell and Cuskelly, 2003).

Teachers' lack of preparation for the activities carried out with students with Down's syndrome leads to a feeling of dissatisfaction for not reaching their goal Ferraz, Araújo and Carreiro (2010).

The unpreparedness of the teacher is evidenced by the absence of specific materials and activities for the student with Down Syndrome ((Oliveira-Menegotto, Martini and Lipp, 2010; Ferraz, Araújo and Carreiro, 2010 and Kibrit, 2013).

Alves and Duarte (2012) report that despite the difficulties, the relationship between teachers, students and parents is satisfactory. The parents maintain direct contact with the teachers through agendas, becoming aware of the events in the school, in addition there are meetings to approach the subject (Ferraz, Araújo and Carreiro, 2010).

The inclusive process of Down Syndrome students is directly influenced by the school, teachers and parents. The school should provide a suitable environment for students, teachers carrying out

pedagogical actions capable of promoting learning and parents in the participation and full monitoring of school activities.

## FINAL CONSIDERATIONS

This study had as limitation the small number of studies that approach the subject of the inclusion of the children with Down Syndrome in Brazilian schools, so this study portrayed only a small part of this population.

The results found were important demonstrating that the inclusion of students with Down syndrome occurs in public and private schools and only to the detriment of the laws.

Teachers face difficulties such as the unpreparedness of inadequate training to deal with students with Down syndrome and the inadequate infrastructure of schools in addition to the large number of students in the classroom.

Inclusion is a process that must be carried out by the school that must plan ways of teaching that are appropriate to the needs of each student, by the teachers who must have adequate training to attend the students with efficient educational practices for all, and also by the parents who should participate in the process of educating their children.

Este estudo sugere a realização de mais estudos que explorem a inclusão de alunos com Síndrome de Down no cenário da educação brasileira em diversas regiões para que se possa conhecer melhor o processo de inclusão dos alunos com Síndrome de Down.

This study suggests further studies exploring the inclusion of Down Syndrome students in the Brazilian education scenario in several regions in order to better understand the process of inclusion of Down syndrome students.

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# **Caatinga Biodiversity and Ecosystem Services: A Case Study with School Students Municipal**

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## **Abstract**

*Environmental education with a focus on biodiversity values can be an instrument for sensitization, reflection, construction of a critical vision and behavior change, being the knowledge of local Biodiversity, fundamental for the valorization and conservation of the native elements, including the Caatinga that has always been underestimated by its dry appearance and poor appearance. This work aimed to present a diagnosis on the environment, Caatinga biodiversity and ecosystem services, with students from a municipal school in Juazeiro / BA. In order to do so, we used qualitative and quantitative research, through bibliographic research, in which the conceptual and normative aspects were addressed through books, articles, journals and others, as well as through questionnaires for students. It is necessary that society acquires practices of environmental education as an educational process, providing knowledge and exercises of citizenship for a critical and conscious action.*

**Keywords:** Ecosystem; Biodiversity; Environmental education.

## **1. INTRODUCTION**

This research aimed to study the theme "Caatinga biodiversity and ecosystem services". A case study with students from the Antônio Francisco de Oliveira Municipal School in Juazeiro-BA, aiming to conserve the environment and the valorization of the Caatinga biome.

The caatinga is the only exclusively Brazilian biome, rich in its biodiversity has suffered from devaluation and constant deforestation. With a fauna completely adapted to the dry climate, the caatinga has gained attention due to its great biodiversity and endemism for being very heterogeneous (MMA,

2016).

Therefore it is essential that topics such as caatinga biodiversity and the environment are addressed in the classroom to raise awareness among students through environmental education, bringing elements about biodiversity conservation and how ecosystem services are important for the conservation of forests. Species.

The relevance of Environmental Education - EA is legally established through several Brazilian educational laws and guidelines, such as LDB (1996), National Environmental Education Policy (PNEA) (1999), National Education Plan - PNE (2001) and Curriculum Guidelines for Basic and Higher Education.

Within this scenario, Carvalho (2008), commented on the legality of the National Policy for Environmental Education - PNEA, when ratified and regulated, makes environmental education as compulsory at all levels of education and considers urgent and essential component of elementary education.

Nevertheless, its application in schools is still superficial and punctual, usually restricted to the disciplines of science, biology and geography, or to commemorative events such as "environmental day".

Its educational proposal is constituted as an identity and structuring element capable of developing a critical, participatory, transformative and emancipatory education, allowing the subject involved to be responsible and capable of promoting ethics and environmental citizenship (BRASIL, 1998).

The objective of this article is to present a diagnosis of caatinga biodiversity and ecosystem services, with students from the Antônio Francisco de Oliveira Municipal School (EMAFO) of Juazeiro Bahia and how to recognize the relationship between biodiversity and human wellbeing, reflecting on how Biodiversity is exemplified in everyday life, making students aware about the environment of their own community.

For this, the qualitative and quantitative research was used, through bibliographic research, in which the conceptual and normative aspects were approached through books, articles, magazines and others, as well as through questionnaires for the students.

Thus, the research aimed to arouse students' interest about the environmental conservation and make them realize that the conservation initiative can start with small attitudes and that the knowledge acquired in the classroom can be used at home.

## **2. METHODOLOGICAL PROCEDURES**

The quali-quantitative research, which fits as a case study, because it is related as a data collection instrument that according to Gil (2007, p.168):

The objective of the analysis is to organize and summarize the data in such a way as to provide answers to the proposed problem for investigation. Interpretation, on the other hand, aims to find the broadest meaning of the answers, which is done by linking them to other previously obtained knowledge.

### **2.1. Research location and subjects searched**



The research was developed at the Antonio Francisco de Oliveira Municipal School - EMAFO, located in the Goiabeira II community, Salitre Valley, 52 km from the city of Juazeiro Bahia, which serves about 240 students, distributed in elementary classes I and II, High School and Youth and Adult Education, working in the three shifts and 15 teachers all with postgraduate.

The survey was conducted with 35 students from the 8th grade of elementary school, in the age group of respondents is between 13 to 17 years old, 10 male and 25 female students.

They were also asked to come up with the idea of a game to be made with them in another workshop.

## 2.2. Data Collection

Initially a workshop was held with the theme: "Learning about the value of Caatinga's biodiversity and its ecosystem services in school education", linked to this course completion work was submitted for approval by the Research Ethics Committee of the University of Pernambuco, being approved by the license CAAE (96543918.5.0000.5207).

After the workshop on biodiversity and ecosystem services, students were asked to do some work on the Caatinga biome and to search which species they had most contact with where they live and then they should draw on the proposed subject.

After that, the students answered a semi-structured questionnaire, based on daily questions, relating the proposed themes and the level of understanding of the class, containing a total of 11 questions (objective and subjective), to obtain their knowledge about to these research topics.

## 3. RESULTS AND DISCUSSION

Figure 1. Draw of an 8th grade student representing the Caatinga with a greater diversity of species.



From the observation of the drawing, it was found the existence of cactaceae such as *Cereus jamacaru* (mandacaru), species that are very recurrent in the environment and of great importance for the caatinga.

The drawings showed each student's knowledge of local biodiversity, even if indirectly, it was expressed through images as an important means of displaying perception.

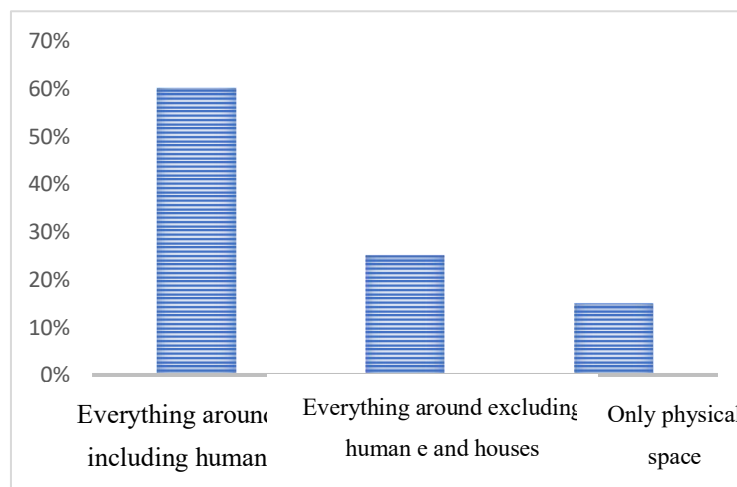
For Goldberg (2005), from drawing the child organizes information, processes lived and thought experiences, reveals his learning and can develop a unique style of representation of the world.

The species has morphological characteristics of adaptation to dry climate with water storage capacity, thus synonymous with drought resistance.

In addition, some of these cacti are frequently used to feed the herds, being offered in natura and in preserved form to the animals, such as xique-xique (*Pilosocereus gounellei*) and mandacaru (*Cereus jamacaru*) (ARAÚJO, 2010). In this sense, it is important that aspects related to biodiversity, conservation and current social and environmental problems are equally remembered by them.

When asked about the concept of the environment, 60% of students answered that they understand everything around them, including men, while 25% marked the alternative that excludes men and homes and 15% considered it to be just a space. physicist.

Figure 2. Students' answers about the concept of environment.



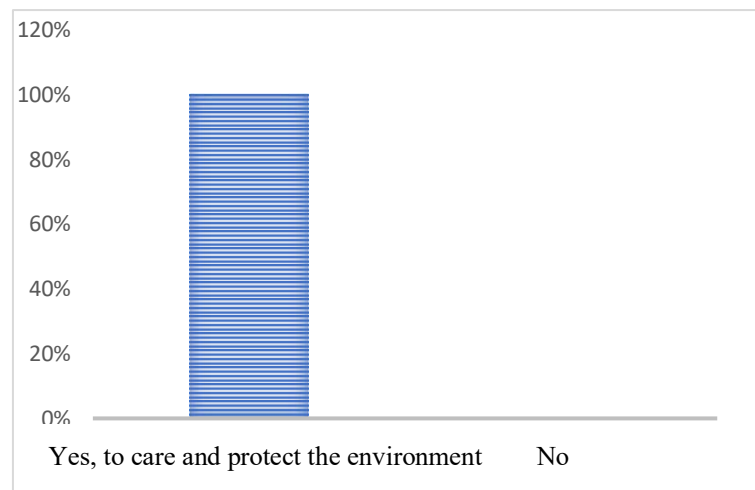
In this graph is observed that the students really know the meaning of environment and everything around it.

According to Sauv  (2005), when the environment is perceived by students as nature that we must respect and appreciate, the author proposes as interpretative paths the teaching strategies.

When the students were asked if they were part of the environment, everyone was unanimous in saying yes, and that they had the duty to care and protect the environment.

The environment is not just an object of study or a subject to be addressed among so many others; it is not something that obliges us for a development we want to be sustainable. It is the crucible in which our identity is forged, our relationships with others, our "being in the world" (SAUV , 2005, p. 317).

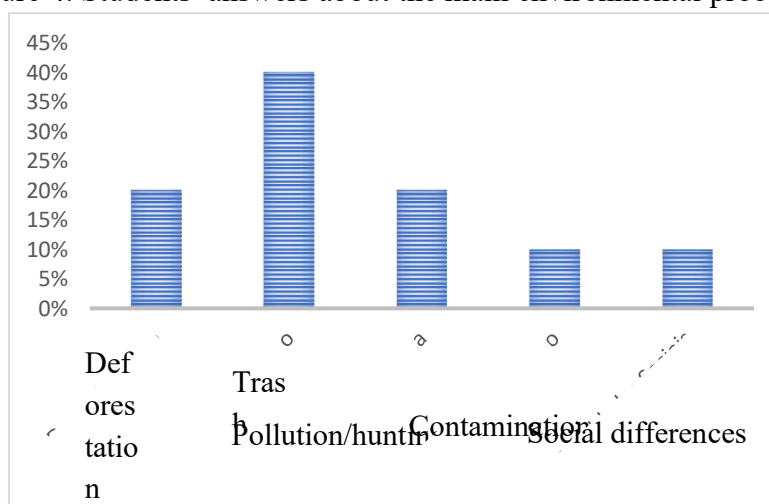
Figure 3. Students' answers when they were asked if they were part of the environment



When the students were asked about the main environmental problems identified where they live, they answered that the principal problems were: deforestation with 20%; 40% trash; air pollution and animal hunting appear in 20% of responses; soil contamination to 10%; and 10% selected social inequalities.

The accentuated deforestation might have been the main factor responsible for the advance of caatinga vegetation over some areas that could originally have been covered by wetter forests. The removal of these forests may therefore have accentuated the semi-acidity of the agreste (MOURA, 2006, p. 31).

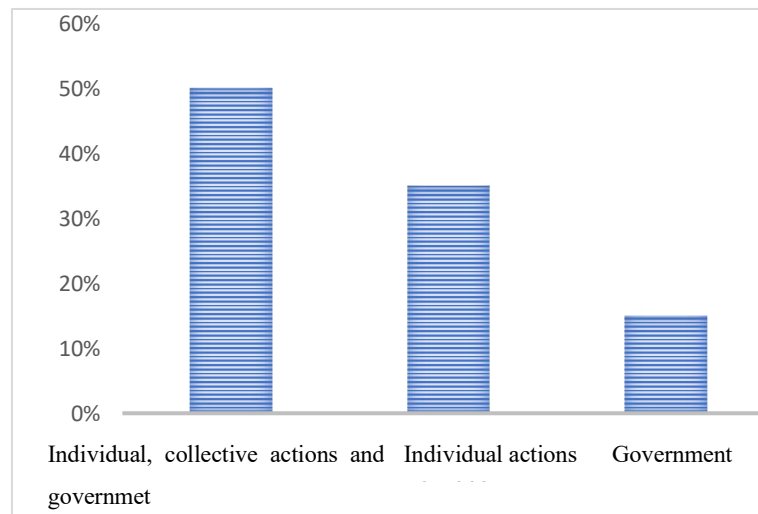
Figure 4. Students' answers about the main environmental problems.



After indicating the environmental problems, the students were asked if they had any responsibility for them and what solution could be used to solve these problems. All the students were unanimous to answer yes to their responsibilities, but 50% of them answered that the solution depends on individual and collective actions of society, as well as of government actions. Another 35% said that it depends only on the individual action of each citizen, and only 15% point out that it would only be by government

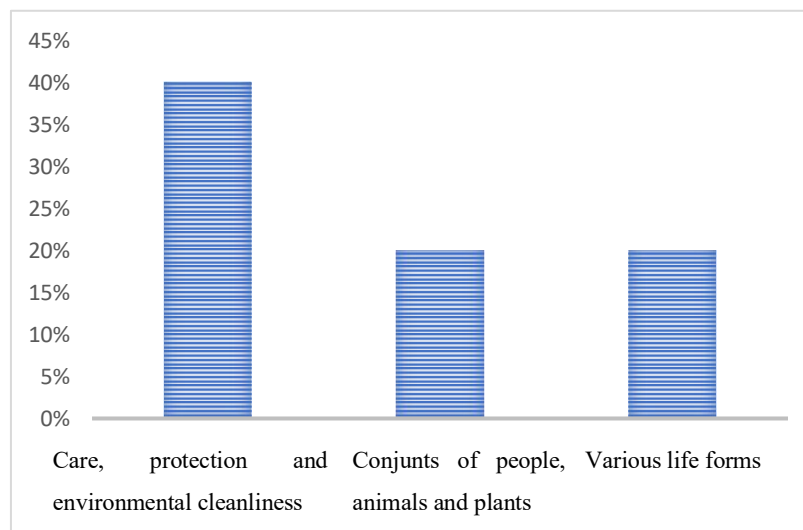
action, control and supervision.

Figure 5. Answers about the student's responsibilities for the environmental problems.



When the students were asked about what the word biodiversity means, 40% of the answers involved the terms care, protection and cleanliness of the environment, while another 40% cited a set of people, animals and plants and 20% was able to assimilate the word biodiversity to the various life forms.

Figure 6. Students' answers about what the word 'biodiversity' means.



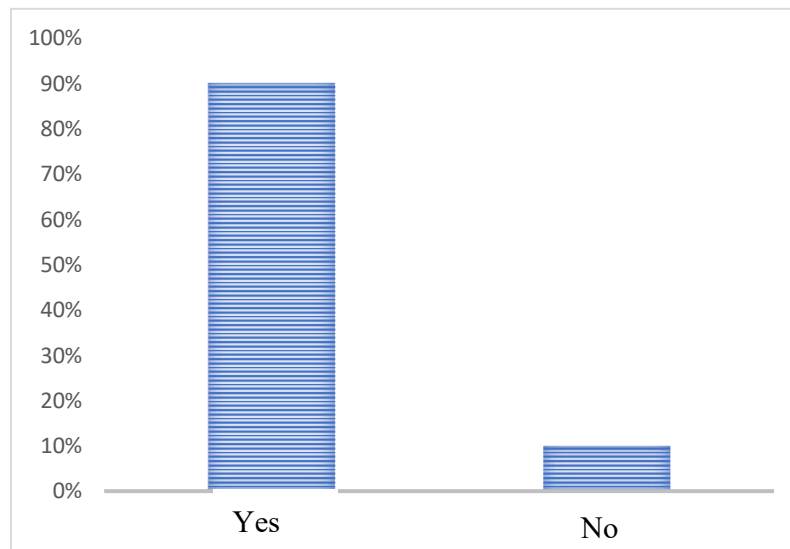
Besides that, the students were also asked if they valued the present biodiversity in their community where they live, and 90% they said that they did.

Therefore, it was observed that they related the term 'biodiversity' with the environment and not with the various life forms.

Students living in the Northeast region, where there is a predominance of the Caatinga ecosystem, are harmed by the little information addressed about local biodiversity. stimulating the observation of their surroundings, are essential strategies in educational practices (DO AMARANTE MATOS;

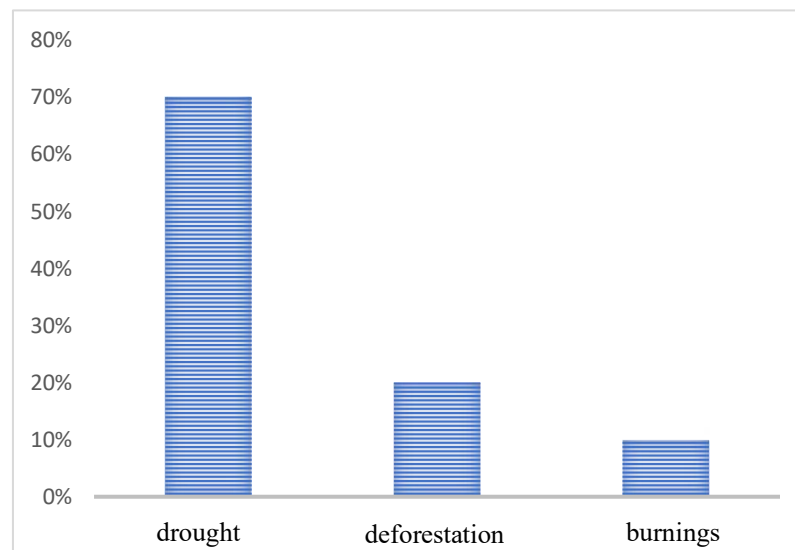
LANDIN, 2014).

Figure 7. Answers about if the students valued biodiversity.



The students were questioned about the words that best represented Caatinga, one of the most recurring terms was ‘drought’, with a percentage of 70%, followed by ‘deforestation’ with 20% of responses, and 10% for burnings. They also mentioned the suffering and death of animals caused by the lack of water.

Figure 8. Students’ answers when they were asked which word is best represented the caatinga.



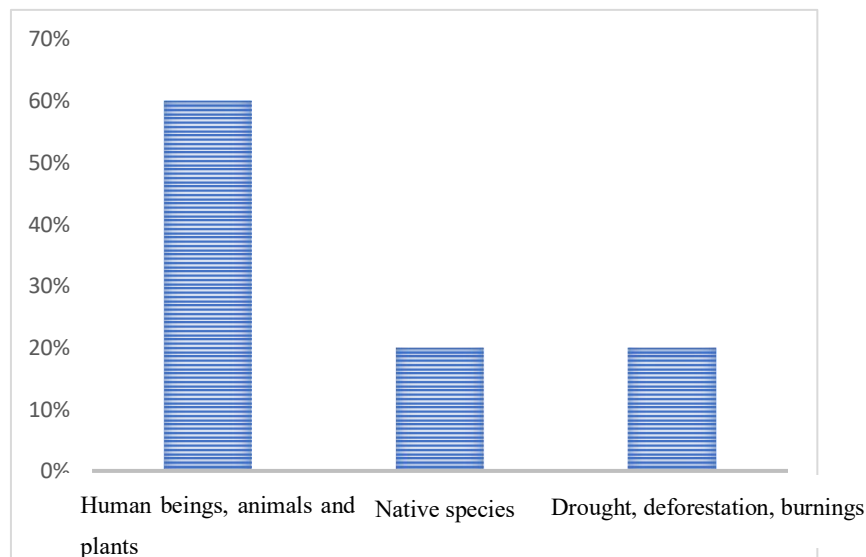
The graph shows a limitation of information that the students' have in to characterizing the caatinga, which seems to be related to the way that the subjects are approached in classrooms through books, that is the most used research tool in school.

Santos et al (2015), reaffirmed the textbooks’ deficiency when in the study it was perceived a less broad approach about the caatinga compared to other ecosystems that are better known, assigning

concepts to it in a simplistic way, citing only basic characteristics and relating them. o with drought and scarcity of natural resources.

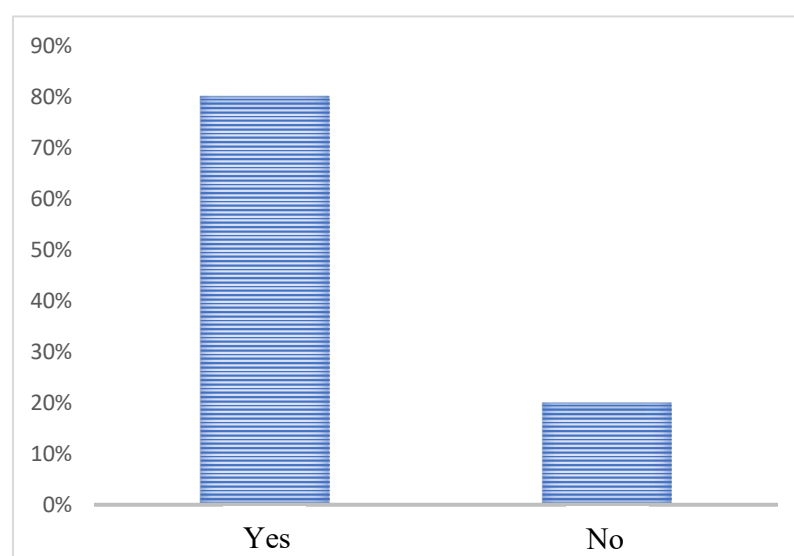
The question about the elements that better represented the caatinga, humans, plants and animals as a whole, reached more than 60% of the answers, another 20% cited some native species such as mandacaru, caatingueira and umbuzeiro and 20% of the terms were related. deforestation, drought and pollution.

Figure 9. Answers about which elements better represented the caatinga.



Regarding the importance of caatinga biodiversity, 80% agreed that it is important, and cited some examples as of its value: for subsistence; value of life; and value of nature itself. The others did not consider that caatinga has values due to drought.

Figure 10 Regarding the importance of biodiversity of the caatinga.

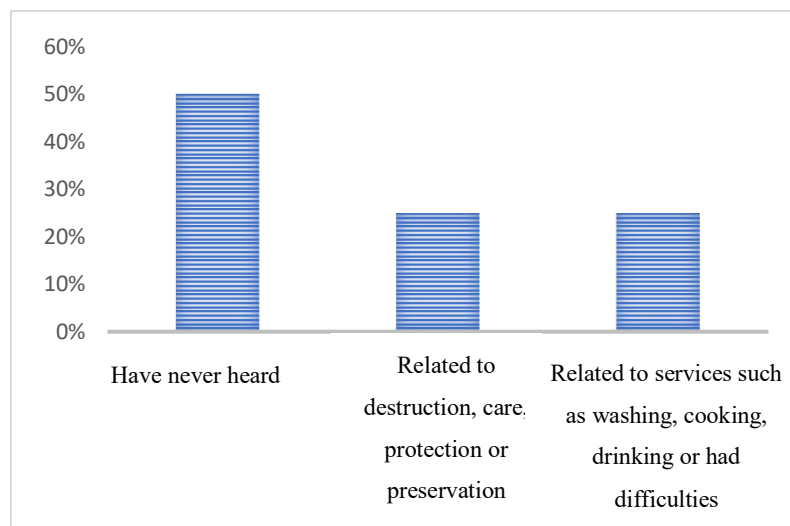


These results show how students are aware of the benefits that nature provides, and an interpretation of reality.

Bizzo (2001) states that students understand issues that are related to daily life, since this information obtained comes from experiences, popular knowledge, cultures and myths.

The last question was about the terms “environmental services” and “ecosystem services”. The question was if the students had ever hear about the terms; 50% said that had never heard, while only 25% risked responding with terms related to destruction, care, protection or preservation of nature and 25% related to services such as washing, cooking, drinking, which demonstrated a difficulty in recognizing the theme.

Figure 11. Answers about the terms ‘environmental services’ and ‘services ecosystem’



The graph notices that 50% of the students showed difficulty in recognizing the referred themes.

According to Andrade and Romeiro (2009), although not yet fully understood, the relationships between welfare and ecosystem services are complex and nonlinear.

#### 4. Conclusion

The results show that the biodiversity of the caatinga, the flora, and especially the cactus are the most frequent elements in the students' drawings. Although, they show in their answers they are unaware of the richness of the Caatinga biome.

What is most evident is their lack of knowledge about diversity and the ways to conserve the caatinga and make them understand that small habits such as the extraction of wood for the stove contribute to deforestation and endanger some species.

More than half of the students understands the environment broadly, including man, and can identify environmental problems where they live.

It has been realized that the concept of biodiversity is often confused with environmental protection rather than its concept, although most claim that it has different values. The term ecosystem services or environmental services is still poorly understood by students.

Although there was knowledge about the research topics, it was noted that many of the concepts are confused among students. These results may be due to the scarcity of information related to caatinga biodiversity in the school context and highlight the need for further deepening in order to better highlight

its values and the importance of its ecosystem services, as a way of encouraging conservationist actions and behavioral changes.

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# **Movement of Materials in The Port of Manaus Modern In Brazilian Amazon**

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## **Abstract**

*The movement of materials has become one of the centers of organizational attention to obtain competitive advantages, which is also perceived in organizations dealing with cargo transportation in the interior of the Brazilian Amazon. This study aims to describe the handling of materials made in the port of modern Manaus. Through a qualitative and quantitative study, the primary data were collected through observation and interviews, having as their subject the intentionally chosen vessel owners and commanders; Quantitative data were analyzed with T test and qualitative data with content analysis in triangular format. The results showed that there is an imbalance between the cargo and passenger transportation capacities in the surveyed vessels and that the material handling is done in an amateur way. The conclusion shows that, unless knowledge about the exploration of this business is deepened, the waterway modal will remain with the traditional characteristics that have persisted in the Amazon for decades.*

**Key-Words:** Material handling; Logistics in the Amazon; Amazonian vessels; River transport.

## **Introduction**

Rivers are the main means of transportation of the Amazon region. It is through them that the municipalities of the region are supplied and distribute their production. Nevertheless, there are few technical and scientific studies, such as Duarte, Kuwahara e Silva (2011) and Marques, Kuwahara and Andrade (2011), dedicated to the specificities of Amazonian waterway transport, especially in the state of Amazonas. It is assumed, from analogies with the reality of other regions, that the stock of knowledge about the movement of goods through this mode can generate benefits for the development and improvement of the Amazonian waterway transport.

Material movement, as a logical-operational scheme of moving materials from one point to another over short distances, such as within organizations and, in the case of this study, in the port area, contributes to transport efficiency. Thus, the more efficient material handling in the port, the more likely it is that overall transportation (from distributor to port and port to end customer) will gain in efficiency.

In this sense, this study aims to describe the way in which materials are moved in the port of Manaus Moderna. The findings describe the main characteristics of the “transportation” business, which is made up of vessels that carry goods from Manaus to the interior cities and from these cities to the Amazonian capital, how materials are moved from the port to the vessels and how The materials are handled inside the vessels for temporary storage to the destination port.

## **Material handling: theoretical foundations**

The issue of material movement permeates all organizational spaces of every type of organization and basically involves two central concerns: the need for action planning and the use of appropriate equipment for each type of material to be transported. The study by Santos and Guerreiro (2010) shows the example of a municipal health department that, when ensuring the supply of medicine, must plan and control the movement of materials. This purpose cannot be achieved without the use of appropriate means or planning for the distribution of medicines.

On the other hand, Azevedo and Uryu (2005) demonstrate that material handling is actually a reaction to the demands of a new business environment. The reason is that increasingly demanding customers and the increasing intensity of competitive intensification are driving companies to schedule changes in their warehousing and distribution structures. Thus, material movement becomes part of the business strategy of the organization, so that this effort can be converted, in some way, into a competitive advantage, either in terms of cost reduction or increasing customer satisfaction.

The level of concern about the accuracy of material handling has been the subject of organizational analysis because it influences the customer perception, negatively, if done inappropriately. When the movement is normal, it is not perceived by the client and even the organizational members. However, when this normality is broken, it is often easily perceived by members of the organization and also by customers, causing at least a reduction in satisfaction - and when satisfaction is compromised, this abnormality can be converted into dissatisfaction.

This is one of the reasons that explain why material movement should be identified and accompanied by documents that make it easier to understand why a certain movement is necessary and what is the

destination of the pieces (Drohomeretski & Souza, 2012). Thus, the percentage of error tends to be reduced, as the movement processes are documented, which facilitates the movement of materials movement within the organization and, at the same time, if the error occurs, facilitates the identification of its causes and the consequent correction. In order to avoid mistakes, as a result, sophisticated techniques and resources are being introduced into the reality of many different types of organizations to achieve agility and speed.

It is precisely in this sense that Silva (2010) says that the movement of materials became faster with the emergence of mobile robots in industries. Reasoning from the point of view of production lines, the author shows that automation arises there to alleviate the difficulties of little flexibility in handling trajectories or in the ability to adapt to the increase in cargo volume. To this end, vehicles have been developed with the ability to be programmable and progressively endowed with some autonomy, which brings faster and safer operation.

Unfortunately, for most organizations, as Pereira (2011) demonstrates, material handling is not properly planned. His study shows that there are numerous problems centered on the positioning and sizing of equipment carefully to rationalize the internal transport of materials. It is necessary to plan the movements in order to be more efficient and, thus, the productivity can be increased and, thus, eliminating the activities that do not add value, especially the unnecessary transportation of materials.

The study by Rodrigues et al. (2010) reports several problems related to the complexity of material handling and focuses on several inadequacies that can lead to movement errors and production process failures due to the large number of activities performed. To minimize such errors, companies have found in information technology a great ally in improving process quality and gaining information efficiency and speed.

Competitiveness has also been seen and addressed in the effectiveness of material handling. Studies such as Culcheshk et al. (2010) show that moving materials is vital to a company's survival and competitiveness. Competitiveness begins in the supply chain and ends in the distribution chain, but essentially in the design and implementation of the production system. And this is where the efficiency and effectiveness of the material handling system become essential tools in ensuring competitiveness because it ensures flexibility and agility to the production process. But in order to be efficient, it is necessary to have adequate equipment for each type of operation. And the integration of equipment with the stages of the production process is done through their contemplation in the design of the organization's production strategy.

It is in this sense that the study by Junqueira (2011) reports that material handling systems deserve special attention: because they are responsible for maintaining the material flow between machines, manufacturing cells, cost centers or between companies. Even when the movement does not add value to the product, special attention to it is necessary, because in every organization the need for efficient movement is essential so that all action can flow quickly and safely. When material handling does not add value, lack of integration with the production system detracts from value.

Costa (2010) considers that the movement of materials is intended to provide efficient transportation of finished products from the end of the production line to the consumer. In this case, movement planning would not be restricted to the internal dimension of the organization, but would now be part of the

organizational transportation system. In this way, material handling would integrate the production planning and control sector with the process stocking, packaging and delivery of the product to the end customer. Thus, the movement of materials would not only be restricted to the company's internal supply, but would be an integral part of materials management and the distribution chain.

Material handling is an interconnected activity system that is part of a large system of an installation or built-in functions (Paletta, 2010), such as care due to the fragility, size or weight of the object to be transported (packaging is designed for this purpose). so that there is no damage to objects when transported). This definition is really part of the reality not only of what happens within the organization, but also of the practical needs of moving materials throughout the logistics chain, from the most upstream supplier to the end customer. Thus, material handling would be an integral activity of the entire material logistics chain.

For this study, the internal movement of materials is the act of moving materials from one space to another within an organization, either to supply the production line or its middle activities, or in restricted areas, such as the Manaus Moderna port. This means that movement will only be studied from an internal point of view, even though its principles and equipment can effectively be used and integrated with movement within the supply and distribution chain. It will also be limited only to the simple displacement of materials, using the human body or mechanical or electronic equipment, geared both to feed the company's production lines and to supply non-operational production activities with materials.

## **Methodology**

The structured methodological arrangement to describe the handling of materials in the port of Manaus Moderna, general objective of the investigation, sought to answer two ancillary research questions: a) What are the main characteristics of the "Transport" business made by river vessels operating in the port? (b) How materials are moved from the port to vessels? The method designed was characterized by being descriptive, in the classification made by Nascimento-e-Silva (2012a), and qualiquantitative, with unit of analysis individual, level of interorganizational analysis (each vessel was considered an organization) and cross-sectional perspective.

The subjects of this study were intentionally chosen from commanders and / or boat owners who were not preparing for transportation on the day of data collection. This intentionality criterion was essential for the subjects to have sufficient time to provide all the information and data that would clarify the questions posed to them, which would not be possible on days of travel because the entire crew, including the commander and / or owner, have to deal with numerous problems typical of these organizations on travel days. These subjects were also chosen due to their high degree of knowledge about the transportation activities, the transported materials, the specificities of the vessels and the Amazonian river network. Four subjects were selected, all vessel commanders, since none of the owners were present. These commanders were chosen because they had the necessary time (two hours or more) for the interview and were fully willing to answer all questions regarding the research protocol items.

The data collected were all of primary type. We opted for the primary data due to the scarce documentation and studies on river transport in the Amazon and also the lack of concern of these vessels

to document their activities. For the collection, a research protocol was used to be used in accordance with the observation and interview techniques: for the observation, it was centered in the understanding of the type and the way the materials are moved from the port to the vessel and from the vessel to the internal location where these materials would be stored; For the interview, the focus was on collecting quantitative data describing the main aspects of the transportation business and qualitative data that allowed identifying the material handling techniques inside the vessel, as shown in table 1.

The use of protocols is very common in organizational investigations, such as the study by Cunha, Passador and Passador (2012), and other areas of science (Arruda et al, 2012; Costa Júnior, 2012). In logistics, recently this tool has been used more intensely to deal with extremely complex qualitative phenomena, such as the investigation by Manga (2012) and Pantaleão (2012), and in search of in-depth explanations about certain aspects of logistics reality, as can be seen in Vieira (2012), Ferreira Neto (2012) and Mota (2012). Experience has shown the effectiveness of this tool both for adequate data and information collection and for the validation process of results.

Table 1. Summary of the research protocol

<b>The business</b>	<b>Material handling in the port</b>	<b>Material handling on the vessel</b>
Shipping features	Drive description	Drive description
Route cities	Way of movement	Receipt of material
Travelled distance	Handling equipment	Material packing
Carrying capacity	Type of material transported	Stock area
Crew quantitative	Material characteristics	Handling equipment
Average revenue	Operators risks	Safety equipment
Schooling of the crew		Most common damage and malfunctions
Vessel dimension		

Observations were recorded and interview responses recorded in a field notebook; Afterwards, the quantitative data were organized in spreadsheets and the qualitative data in synthesized charts. These procedures were necessary so that they could undergo the analysis process capable of generating the answers sought for the research ancillary questions, as recommended by Nascimento-e-Silva (2012b).

The data collected were all of primary type. Quantitative data were analyzed with descriptive statistics: simple frequency to summarize data and correlation tests to look for associations between variables. Summarizing the data by frequencies or percentages allows us to see the quantitative dimension of the categories under analysis and, by extension, the phenomenon under analysis; In this case, the phenomenon is the movement of materials in the port of Manaus Moderna. Again, the method used is “field research” rather than “case study” since the latter requires at least three sources of evidence (this study used only two: interviews and observations).

As descriptive tools, linear correlation tests were used to discover associations between variables. Correlation results were analyzed as follows: from 0.0 to 0.2, there is no correlation; from 0.21 to 0.5, poor correlation; from 0.51 to 0.7, mean correlation; from 0.71 to 0.9, strong correlation; and above 0.9, very strong correlation. This means that the higher the test result, the higher the correlation and, consequently, the stronger the association between the two correlated variables.

Data from interviews and qualitative observations were organized in synthesizing tables and analyzed through content analysis. The results were generated from the finding of similarities of answers to the questions in the protocol. For example, for the question concerning the types of equipment used by workers in material handling, whose data were collected by observation, first all the equipment used by each worker was listed individually; This listing was then worked out to allow identification of the most frequent equipment to finally generate the response. In some cases, as in the example of the main difficulty in moving materials from each vessel, the data collected by the interviews were crossed with the data collected via observation; In this example, it was noticed that the equipment used is obsolete, old, which was verified by the answers provided by the commanders through the interview.

## Results

In accordance with the specific objectives of this investigation, the results achieved describe the main characteristics of the “Transport” business made by river vessels operating in the port of Manaus Moderna, how materials are moved from the port to the vessels and how the material is handled. packed inside the vessels.

### Business Characteristics

As shown in the results shown in Table 2, the main operating characteristics of the vessel transport business are as follows: a) they have a point of departure, destination and route in the same locations, both from Manaus to the last city of the itinerary and on the return from this last city to Manaus, b) with little variation, the one-way mileage is the same as the return, c) however, the length of the trip up the river is almost twice the descent, d) the average number of cities on the course is approximately 4 ee) the average boat size is 21.25 meters measured from bow to stern.

These results indicate the predominance of traditional exploitation of this means of transport. By traditional is meant the continuity of the same system of market exploitation (trajectory, type of vessel, ported cities, among other characteristics) for several decades, with few changes, including technological updating, such as the use of radio for communications. What can be seen, therefore, is that in many decades few changes have been made to the waterway transport system in the region, changes focused, for example, on the type of engine and safety equipment of the vessel (as in the case of the radio, which is used for communication between vessels along the way). These changes, it seems, have not yet covered the logistics part of the business.

Table 2. Modal Operation Characteristics

Vessels	Cities	One way trip (Km)	One way trip (Days)	Route back trip (Km)	Route back trip (Dias)	Vessel size (in meter)
A	2	1,536	12	1,536	3	25
B	5	700	3	700	1	30
C	3	300	6	800	3	20
D	5	500	2	600	1	10

On the other hand, the financial and production characteristics, as shown in table 3, of the waterway modal business practiced by the surveyed vessels operating in the port of Manaus Moderna are as follows: a) the average transport capacity of the vessels is 412 , 7, b) passenger capacity is 328 people, c) average revenue from cargo and passenger transportation from Manaus to the interior cities is R\$ 6,250.00 and from the interior to Manaus is R\$ 7,500.00 and the crew's schooling is the same as that of the vessel's commander.

As can be seen, there are significant differences between the carrying capacities between vessel C and D; there are differences between vessel A and others in terms of passenger carrying capacity, especially in relation to vessel B; there are differences between them in outbound travel billing; but there is similarity in your back billings. The differences noted in revenues are quite marked between vessel B, much larger in size and transport capacity, and vessel C, of medium size among the surveyed. These data and conclusions therefore require the search for more accurate and consistent explanations, which is why association tests will be used.

Table 3. Modal Business Characteristics

Vessel	Capacity of load (Ton)	Capacity of passengers	Revenues* (One way)	Revenues* (Return)	Schooling (Crew)	Schooling (Commander)
A	130	70	5,500.00	8,000.00	High school	High school
B	490	900	9,500.00	8,000.00	Hight school	Hight school
C	110	163	4,000.00	6,000.00	Elementary school	Elementary school
D	921	180	6,000.00	8,000.00	Elementary school	Elementary school

\*Revenues in real (R\$): 1 dollar is equivalent to 4.1 reais).

Correlation tests showed the following: a) there is no correlation between the cargo carrying capacity of these vessels and the passenger carrying capacity, ie a vessel carrying a lot of cargo does not necessarily carry many passengers since the correlation between These variables were 0.2; (b) the correlation between loading capacity and outward turnover is 0.1 and back turn is 0.5, which indicates that revenue is higher on return than on departure; c) the correlation between passenger transport capacity and outgoing turnover is 0.99 and return 0.3, which shows that revenue is higher with passengers on return; c) the correlation between outgoing turnover and vessel size is 0.7 and the turnover ratio is 0.1.

These results indicate the need to balance cargo and passenger transport capacity as follows: a) increase use of return cargo transport capacity and b) increase use of outbound cargo and passenger transport capacity. This balance can be made from the strategy of price-size marketing mix, which is the sensitive part of the business, according to the commanders interviewed, as follows: as boats necessarily have to make the round trip, transport prices freight and passenger charges can be reduced so that there are no costs (fuel, personnel, maintenance etc.) without revenue. This same strategy can be used in return, in relation to cargo transportation.

#### 4.2 Processo de movimentação de materiais no porto



According to the observations made, the river has a major influence on the regional economy, which is the most usual way to sell goods. There are many vessels leaving Manaus for the interior municipalities and vice versa, bringing and bringing fruits, appliances, stevedoring, and people. All observed movement is done using only the body as the means of transport. And this generates several problems, such as loss of goods, bags sticking, fruit damage, beer cans crumpled by falling on the way to the boat, the goods suffer many damages on the way to storage inside the vessel.

Four activities related to the handling of the port, namely receiving, transferring, selecting and sending were found. First, the truck arrives on a street that gives access to where materials are unloaded, after passing under a bridge that gives access to a large area for unloading the goods; The note is then taken to the person in charge of the boat for clearance; if everything is normal, the goods begin to be removed from the truck, which is done through the loaders (one is inside the truck passing the goods to another); The goods are placed at the head of the shipper, who thus crosses a sand trail until he reaches a ramp that gives access to a ferry where the boats are moored; then the porter climbs a small wooden ramp that gives access to the boat, walks to the hold, where another porter is waiting to pick up the goods; Then another ship loader picks up the merchandise, distributes it and stores it inside the boat.

All movement is done manually, which implies that the whole operation of transport and support of goods is done by the human body, which is the working instrument of the shippers. Due to these adverse ergonomic conditions, workers are exposed to some risk of illness, that is, they are exposed to injuries and hernias that are characterized as normal factors due to the type of work and how it is performed by the loader. In addition, throughout this journey, it has been observed that shippers often carry excessively heavy loads, with the aim of unloading the truck as soon as possible and loading all merchandise into the boat. Some use only a cloth tied to the multi-ply head to cushion the load carried. This type of procedure can cause serious spinal injuries over time. Regarding the products transported, it was noticed that from Manaus to the interior municipalities are transported appliances, thermal box, beers, soft drinks, chocolates, corn chips, milk in packs, toys, notebooks, furniture, clothes, jewelry. , satellite dishes, mortar, paints, cement and other building materials. All these goods are taken from Manaus to meet the needs of people living in the countryside. However, from the municipalities to Manaus are transported banana, watermelon, pumpkin, passion fruit, cocoa, orange, cucumber, pepper, bell pepper, maxixe, cheese, among others. It was found, therefore, that Manaus supplies the interior cities with industrialized products and the interior supplies it with food.

Goods are usually transported the way they are packed in the manufacturing process. In the observation made, no form of packaging was found in accordance with the unitization and palletizing techniques so that the goods could be transported more safely, so that they would not suffer damage during the journey made to the vessel. What the carriers use are ropes to tie several overlapping bags in a primitive unitization process and prevent them from falling during transport. Another finding is that the goods are distributed in the hold as follows: first the heaviest are placed so that the weight is well distributed in the hold and then the lightest depending on the order in which the goods will leave the boat: When the vessel goes to more than one municipality, the goods are placed in order of places that the vessel stops. Thus, the goods from the last location of the itinerary are stored first, and finally from the first.

In violation of material handling and storage techniques, various types of goods are stored together, with no consistent distribution. According to what was collected from the interviews to justify this procedure, what happens is that there is always a “last minute” merchandise to ship, so this is where there is room where it can fit, no matter how dangerous or fragile it is; and when the hold is full, the goods are stored on deck with the passengers.

Table 4. Difficulties in moving materials in your surveyed vessels

<b>Vessel A</b>	<b>Vessel B</b>	<b>Vessel C</b>	<b>Vessel D</b>
Little space in the cargo hold	Machine and electrical problems	Old equipment	Little space in the cargo hold
Low crew schooling	Low crew schooling	Low crew schooling	Low crew schooling
Best working conditions for crew members	Best working conditions for crew members	Lack of cold room	Machine and electrical problems
No place to store materials with high hazard	No place to store materials with high hazard	Few safety equipment	Lack of skilled labor
Poor sanitary conditions (for all passengers, there are only 2 bathrooms)	Poor sanitary conditions (for all passengers, there are only 2 bathrooms)	Best working conditions for crew members	Lack of cold room
Lack of adequate accommodation for crew members	Lack of adequate accommodation for crew members	No place to pack high hazardous materials	Few safety equipment (vests, small boats)
Lack of equipment in cargo transportation	Disorder in receipt of goods	Disorder in receipt of goods	Best working conditions for crew members

Table 4 shows the various difficulties encountered in vessels for the proper handling of materials. In all of them, amateurism and improvisation are present in practically the entire cargo and passenger transport business operated by these vessels. It seems that this reality has lasted for decades with almost no substantial changes to the business foundation and value chain of which this mode is part. Thus, the deepening of knowledge about this reality by Production Engineering is fundamental, regarding the creation of artifacts that facilitate the handling of materials, as well as Administration, regarding the design of efficiency acquisition formats and effectiveness in investments that add value to users of this traditional Amazonian system of distributing local wealth.

## Conclusion

This study showed that the handling of materials made in the port of Manaus Moderna is traditional, unbalanced and amateur. Traditionalism derives from maintaining the same form of business exploitation done several decades ago; the imbalance is of a financial nature as well as the proper use of cargo and passenger capacity; and amateurism is due to the lack of use of engineering and management techniques, tools and systems made in accordance with the technical and scientific requirements of enterprises. This means that, unless knowledge about this reality is deepened, these three characteristics tend to be perpetuated in the exploration of the Amazonian waterway transport mode.

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# Technology almost 4.0 application in developing a conveyor belt with low-cost, reused and accessible materials for bagging grains

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## Abstract

*With the technological development of a new class of wastes, the technological ones were created. Many times this waste is not processed correctly, having its hazardous disposal. Thus, recycling these materials is an alternative to end specific equipment. This work used this approach to develop a low-cost, affordable second-row conveyor belt. The conveyor belt was designed to bag, weigh, and monitor different volumes in a grain silo. Such equipment is of interest to smallholder applications as well as the integration between different areas of the Biosystems engineering course.*

**Keywords:** Agriculture 4.0, Remote Sensing, Transdisciplinaridade, Complex Systems.

## 1. Introduction

Automated or integrated intelligent computing agroindustry machinery is not widely used equipment for small farmers. The development of such equipment for process optimization, customized, innovative, and even low cost can meet both the needs of farmers and engineers with current technologies 3.0 and 4.0. Thus, integrating agricultural use equipment with IoT (Internet of Things), Big Data, Additive Manufacturing, Artificial Intelligence, and embedded sensory technologies.

Brazil is one of the largest exporters of grain in the World Market [1], and its challenge is to develop and incorporate these technologies in its industrial and agronomic fields. Although there is a government agenda for Brazil's preparation for challenges 4.0 [2], the steps of these changes are still small and arduous. An effective medium- to the long-term alternative is in higher education as a foundation for change and support for innovation.

The undergraduate Biosystems Engineering course has as one of its pillars the addition of 4.0 technologies to biological systems for sustainable development in land use, environment, agriculture, and industry. In this scenario, students and teachers of the Biosystems Engineering course at São Paulo State University (UNESP), designed and developed a low-cost prototype of a conveyor that automatically bags, weighs, and monitors grain.

## 2. Background

### 2.1 Conveyor belts system

A conveyor is a mechanism used to move large volume items or materials within a facility [3]. We can have two types of transporters, non-motorized and motorized. Regarding the latter, there is an integrated system such as chains, belts, rollers, motors, and other mechanisms that realizes the propulsion of the object. The non-motorized movement is made by human power or by gravity [4]. In this work, we highlight the conveyor belt system because they are widely used in agricultural processes.

The belt is one of the most critical components of the conveyor because it is moving and where the material settles. The choice of the belt occurs due to the characteristics of the material to be transported, roller type, travel time and, maximum tension [5].

Conveyor belts are of the following types, smooth, ribbed, sandwich, lifter, and sliding. It can be flat, U-shaped, and circular shape. With different operating inclination angles, application type, coating rubber, and conveying surface [6]. Curved conveyor belts provide more dynamism and efficiency to production lines as they feature more flexibility and centrality to integrate various components into the system.

## ***2.2 Transdisciplinarity in the construction of the didactic prototypes.***

Basarab Nicolescu was one of the first authors to work on concepts of multidisciplinary, interdisciplinary, and transdisciplinarity in the mid-twentieth century [7]. The author reports that the availability of information and knowledge beyond all that manipulated in previous centuries. Currently, we are in the era of complex systems, connected by technology 4.0. A system is a set of relatable elements. A system is complete when, from the interactions between its constituents - without interference from a controlling center - a new behavior emerges.

Bertalanffy, in 1973, developed the general systems theory (TGS), an interdisciplinary theory that aims to overcome the particular and exclusive problems of each area of knowledge. It focuses on the development of general principles and models suitable for use in various scientific fields [8]. The study of complex systems requires a multidimensional analysis of the subject content. In these, there is the need for interconnections of both knowledge and expertise that not only leads to transmission techniques and content but transcending disciplines.

Transdisciplinary is in the study of a problem with its multiple planes of analysis of reality and context. Additionally, it addresses the dynamics of relationships between different planes and the systems that make up the world. In this context, the interaction between disciplines can encourage the emergence of new techniques, methodologies, and knowledge in traditional practices that would take considerable time to be discovered or acquired. The involvement of students in the development of the conveyor belt goes beyond the acquired interdisciplinary content. However, it has tangency in all disciplines that integrate the Biosystems Engineering course.

## **3. Material and methods**

Initially, the conveyor belt construction process was made a previous study to define the materials, viability, and conditions to execute the process. We emphasize here that the vast majority of the materials used are affordable and inexpensive.

### 3.1 The project

Highlighting the use of low-cost materials, we use a set of chain-connected bicycle ratchets as gears. A 3D project was designed using Autodesk's Inventor Professional 2017 software, build 142, as shown in Figure 1a-b. The conveyor belt was defined as 60 cm in diameter, large enough to attach a grain silo. Eight bicycle ratchets positioned, as shown at points A-G in Figure 1c, were used.

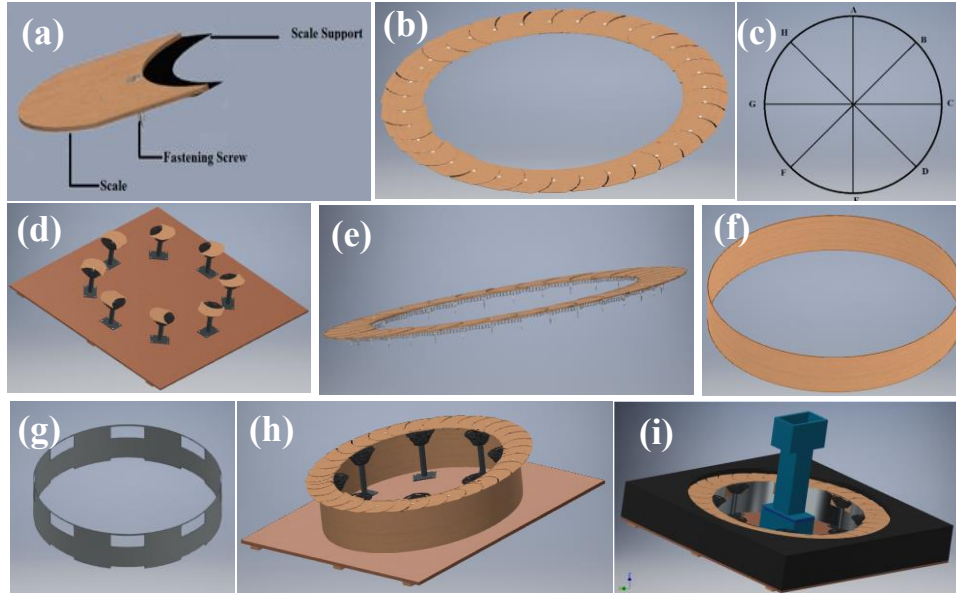


Figure 1 – Here, the 3D prototype is presented in (a) Scale model; (b) Circular Base of Scaled Conveyor Belt; (c) Turnstiles on a wooden base; (d) Ratchets and scale positioning; (e) Connected scales and fixed bicycle chain; (f) Wood plate; (g) Sheet metal; (h) and (i) Conveyor belt structure overview, respectively.

The conveyor belt gear system consists of a motor, ratchet, and bicycle chain. The chain was fixed on the scales and placed on the outside of the turnstiles. An electric motor, automotive windshield wiper, was connected to one of the ratchets and, when activated, drives the chain; consequently, the other ratchets start moving, as shown in Figure 1d-e. It was added to the project two plates, one of wood and another metal, to improve the stability of scales. Figure 1f-g shows these wooden boards with a diameter of 80 cm and a height of 15 cm, while the metal plates are of zinc with a diameter and height of 60 and 15 cm, respectively. The final prototype is shown in Figure 1h-i. The project used reuse of materials and at no cost, such as plywood (MDF), 12 mm, zinc plate, turnstiles, and bicycle chains, metal pieces, meat grinder, parts of printers, and a gallon of water.

### 3.2 Conveyor Belt Assembly

The assembly of the machinery was performed in the following steps:

- I. Cutting and assembly of the support structure for the treadmill: 1.20m extended quadrangular region;
- II. Fixation of the turnstiles according to the subdivisions calculated in Fig.1b;
- III. Positioning of the metal plate inside the turnstiles;
- IV. Fixation of four threaded bars for the stability of the conveyor belt;

- V. Allocation and stabilization of the ratchet currents;
- VI. Motor connection in one of the ratchets.

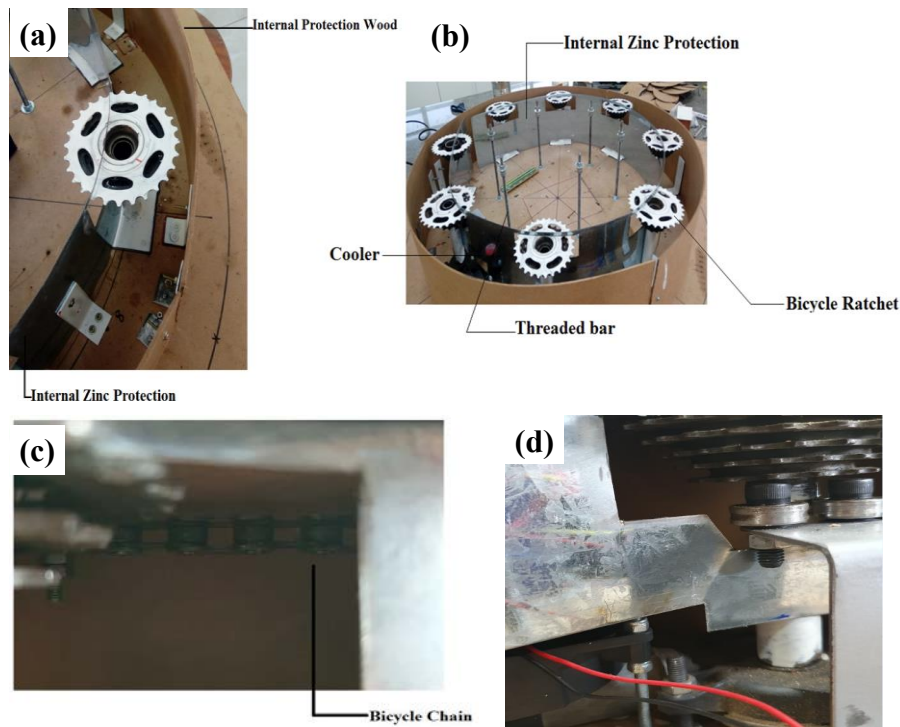


Figure 2 – Pictures depicting the steps of the assembly process in (a) and (b) parts I through IV while in (c) and (d) parts V and VI are shown.

Finally, a meat grinder was used as an endless thread, for bagging the grain, was fixed in the center of the conveyor belt. In this position was fixed the scale structure, a central top, the gallon of water - simulating a silo and automation and control devices.



Figure 3 – Final assembly of the conveyor belt with all items attached.

### 3.3 Process Automation

After theoretical and practical analysis, we use the following sensors and actuators:



(i) E3F-DS30P1 photoelectric sensor, fuzzy detection, PNP, normally open, supply voltage 10 to 30 Vdc, 300 mA output current, minimum actuation distance of 2 mm and the maximum sensing distance of 10 to 30 cm. Two photoelectric sensors were used, one for the object on the grain weighing rail and one below the silo for grain bagging, Figure 4a-b;

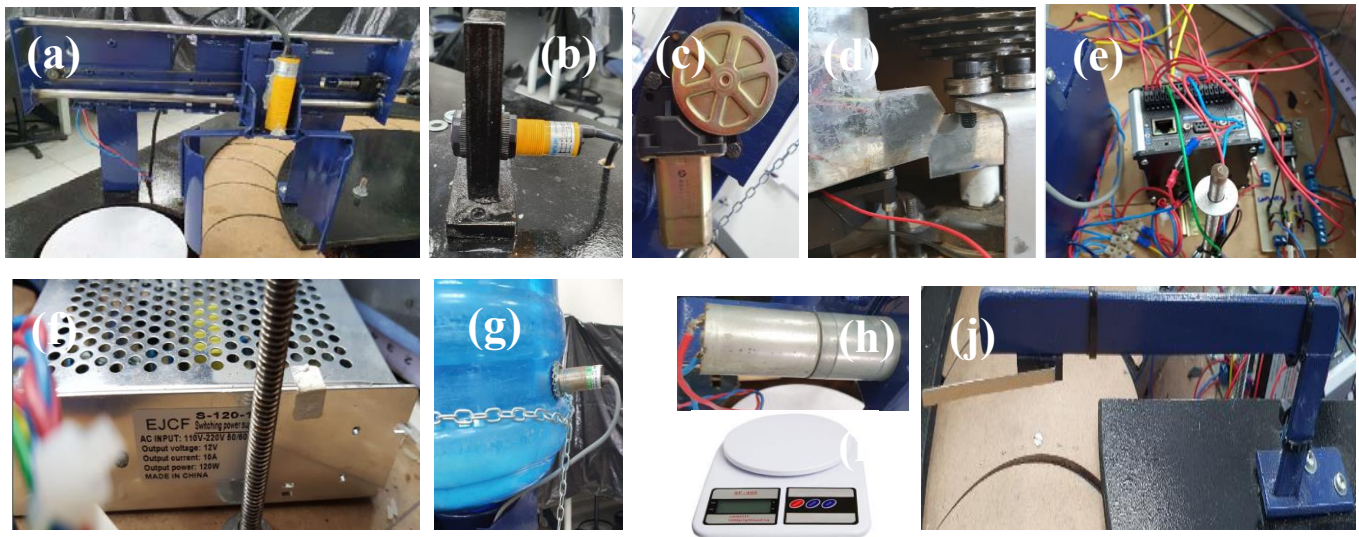


Figure 4 - a) Photoelectric on rail for weighing movement; b) Photoelectric in the bagging of grain; c) Electric motor for Silo; d) Engine allocated to one of the turnstiles; e) Rion of HI Tecnologia; f) 12V Beehive Source; g) Capacitive Sensor; h) Reducing motor; i) Precision digital balance and, j) Limit switch.

(ii) MABUCHI electric motor of 12V, eight teeth. Two motors were used: a) To move the infinite thread belonging to the meat grinder and b) In one of the ratchets to move the belt, as shown in figure 4c-d;

(iii) HI Technology Programmable Relay and Remote I / O, Rion model (HIO115), 10 to 30 Vdc supply voltage, with 8 digital inputs, 4 digital outputs, 3 analog inputs, with 1 encoder, 2 fast counters and 1 PWM, Ethernet or serial cable communication, Fig. 4e.

(iv) Switching Power Supply, EJCF - S120, 12 V, 10A and 120W for powering the entire system, Fig. 4f.

(v) Capacitive Proximity Sensor from the Sensorbras brand, PNP, with a sensory distance of 5 mm, with sensitivity adjustment, powered with a supply voltage of 10 to 30 Vdc. This sensor will control the amount of grain in the silo, Fig. 4g.

(vi) GM-25-BLA370-10-12D8 12V reducer motor for moving the rail that will lead the pot with the beans to the weighing place, Fig. 4g.

(vii) Clink brand SF 400 digital weighing scale, Fig. 4i;

(viii) Limit switch for process completion;

(ix) buttons to start and stop the machinery and emergency.

### 3.3.1 Ladder Programming

The programming was done in SPDSW, from HI Tecnologia, version 4.4.05, following the following steps:

I) It consists of turning the treadmill motor on / off through a main switch and activation of the silo photoelectric sensor.

II) Recognition of the container that will receive the grain by the photoelectric sensor positioned in front of the silo outlet. If the pot is recognized, then the response is stored with the value 1, otherwise 0. If 1, the crawler motor is stopped, the silo motor starts, and the grain dump begins for a time determined by the programmer. Upon completion of this time count, the treadmill returns to operation, and the container continues its course. In this step, we have the silo photoelectric sensor interruption and the scale photoelectric activation

III) Recognition of the container with the grain by the photoelectric sensor positioned on the scale. If the pot is recognized, the treadmill motor will stop, and the swingarm motor for the balance - left steering - will start for a while. At the end of this time, the container waits on the scale (for a period) to measure its weight. After weighing, the drive arm motor is started - now in the opposite direction - forwarding the container to the belt again. In this phase, there is the inactivity of the photoelectric sensor of the balance and activation of the limit switch.

IV) Conveyor belt motor is restarted. The container continues its path through the belt until the limit switch is activated, finishing the process.

There is also an emergency button that, when activated, deactivates all sensors and actuators of the equipment. The device will reboot only after activation of the master switch. The code is shown in Fig.5.

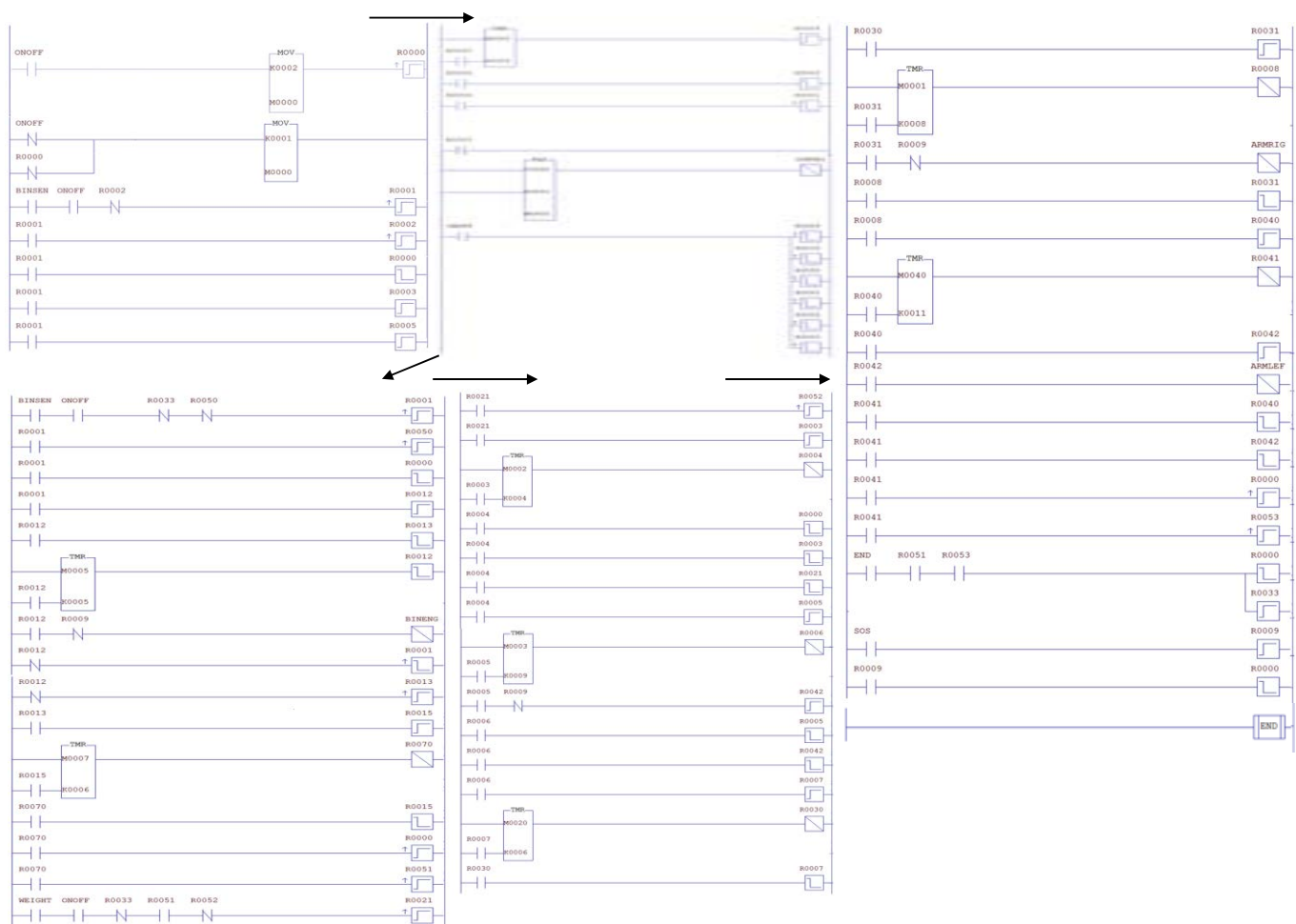


Figure 5 – Conveyor Programming.

### 3.4 The supervisory system

A supervisory system was developed using Elipse E3 software, version 4.8.352. This program was used to supervise the variables and devices attached to the conveyor belt, see Fig. 6.

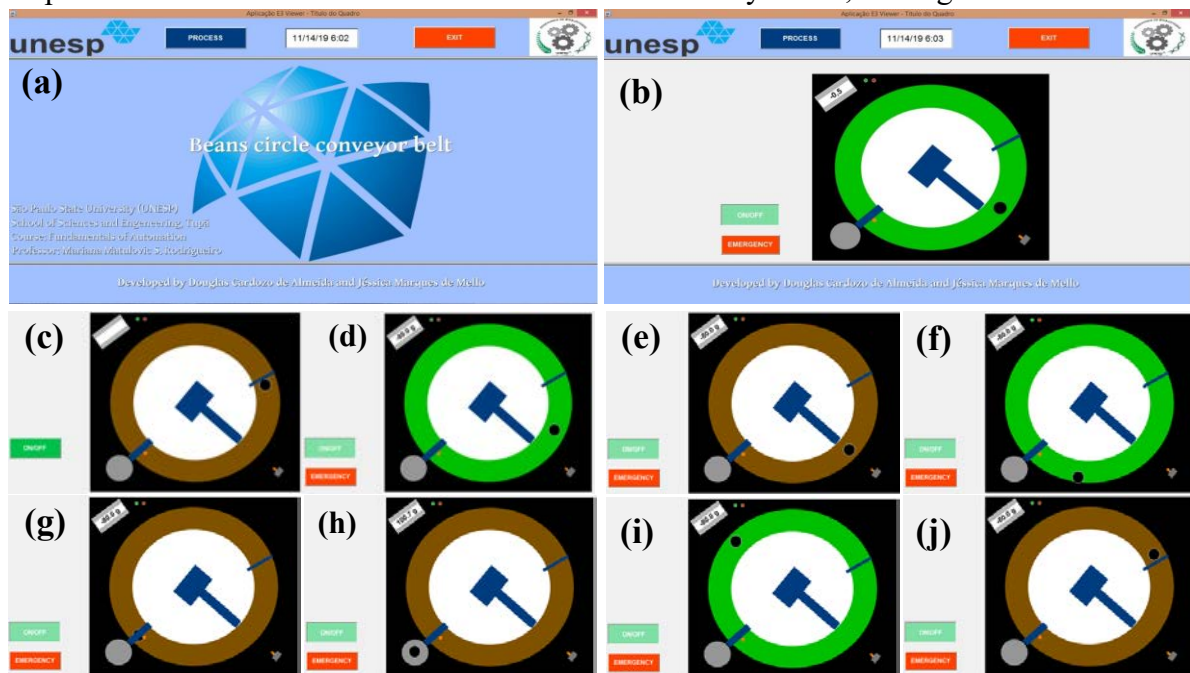


Figure 6 - The figure presents as different stages of the supervisory system (a) Supervisory initial screen; (b) Process Screen; (c) Process awaiting commencement; (d) Beginning of conveyor belt movement; (e) detection of the photoelectric sensor, treadmill and dump grain; (f) movement after bagging; (g) Scale photoelectric sensor detection and start of arm movement; h) weighing; (i) After weighing, one return to operation and (j) End point.

The Process screen shows the conveyor belt with the silo, the photoelectric sensor in the silo direction, the grain weighing conveyor and the machine display, Fig. 6a-b. In a sequence of images, all programming steps are supervised as shown in Figures 6c-j:

- (a) Supervisory initial screen;
- (b) Process Screen;
- (c) Process awaiting commencement;
- (d) Beginning of conveyor belt movement;
- (e) detection of the photoelectric sensor, treadmill and dump grain;
- (f) movement after bagging;
- (g) Scale photoelectric sensor detection and start of arm movement;
- h) weighing;
- (i) After weighing, one return to operation;
- (j) End point.

#### 4. Results and Future work.

Linking technology and sustainability is something that companies are investing in smart computing want. The construction of machinery with disposable materials, mainly digital and computational waste - such as those used in this prototype - highlights at least three essential points:

- 1) A large volume of technological waste generated;
- 2) Technological innovations are not capable of generating sustainable solutions;
- 3) The sustainable act is born of the conscience of each developer, buyer, and entrepreneur that moves the market;

In this context, by turning waste into educational and practical devices for smallholders, teachers and students fulfill the mission assigned to Biosystem Engineers to develop and incorporate intelligent computing into the sustainable use of land, animal and plant systems, agriculture, and agriculture. Industry. In order to make the prototype even more accessible, the programmable logic controller can be exchanged for an MSP430FR5949 microcontroller, and the entire machinery supervisory system available for mobile applications on the android platform.

#### 5. Acknowledgement

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# ***TeleMeios as a Virtual Environment and their possibilities in Hybrid Education***

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## **Abstract**

*The discussion contemplates the construction and development of collaborative digital tools to support distance teaching, with its origins still in the 2000s, within the scope of the Multimeios Research Laboratory, linked to the Faculty of Education (FACED) of UFC, located at city of Fortaleza / Ceará / Brazil. Thus, it aims to analyze the experiences of construction and (re) structuring of the TeleMeios Virtual Teaching Environment (VTE) and its adaptive possibilities in a hybrid context, with a view to subsidizing*

*formative actions in which learners and teachers can have access to virtual experiences in the learning environment which play the role of protagonists. As theoretical reference, there are the studies of Borges (2009), Jucá (2011), Moran (2015), Bacich; Tanzi Neto; Trevisani (2015) among others, which discuss about teaching and hybrid education, digital information and communication technologies, as well as other themes involving teaching and virtual and classroom learning. The research is bibliographical, of a qualitative nature, anchored in Lakatos and Marconi (2002), which makes use of publications such as textbooks, scientific articles, reviews, which deal with the subject. Among the findings, it can be highlighted that the TeleMeios environment has a formative potential to be explored and investigated, focusing on the structural and pedagogical design of virtual environments that surpass the concept of content repository and the idea of students as receptacles of knowledge. and teachers, as sole holders of knowledge.*

**Keywords:** Hybrid Teaching; *TeleMeios*; Virtual Environment; Digital Information and Communication Technologies;

## 1. Introduction

This scientific article is the result of research done at the Federal University of Ceará (UFC), focusing on digital technologies and teaching. The study involving this article corresponds to the construction and development of collaborative digital tools to support distance teaching, dating back to the 2000s. At this time, the Multimeios Research Laboratory, linked to the Faculty of Education (FACED) of UFC, located In the city of Fortaleza, he began his experiments aimed at structuring digital support tools that could be adapted and used in virtual and presential educational contexts.

Some experiments took place in person and others online through the *TeleMeios* Virtual Teaching Environment (VTE)<sup>1</sup> to support the investigations developed by Jucá (2011) and Andrade (2011). Since the 2000s, investigative actions involving teaching / research had already taken place in a hybrid format, considering this as teaching actions that mitigate face-to-face and online activities, but there was no study and understanding by the researchers of the concept meaning of hybrid teaching. The expression "hybrid teaching" was not clearly evident in the analysis of these studies, as it was not used in this formative space at that time. Nevertheless, the hybrid perspective was already implicitly present in these research contexts, especially in the development of didactic-pedagogical actions in *TeleMeios*.

Through its researchers, the Multimeios Research Laboratory develops hybrid teaching actions in undergraduate and postgraduate courses, which contributes to the advancement, knowledge and dissemination of the theme in this academic space. The subject "Educational Informatics", for example, has been offered in this format since 2015 in the Pedagogy course, dealing with issues related to the training of future teachers who will work with technological apparatus in computer labs of educational

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<sup>1</sup> Nomenclature established by the multimedia research laboratory that characterizes a Virtual Teaching Environment as a training space with formative and pedagogical intent, promoting reflection from the figure of a mediator trainer. Its characterization contrasts with the concept of Virtual Learning Environment, since its epistemic essence supposes the learning process without, technically, the need for a consolidated pedagogical proposal (SOARES, 2017).



institutions, in addition to the use of educational software in a pedagogical perspective, more recently connected to the questions related to the languages present in the cyberculture context. The subject "Virtual Teaching" is also offered in a hybrid way, since the first semester of 2018 to students of Master and Doctorate of the college, with the purpose of giving rise to discussions about teaching and learning in the virtual environment, as well as providing analytical experiences of courses and materials developed for remote environments.

From the end of the twentieth century, it is observed that hybrid teaching is highlighted in government educational policies and programs in the Brazilian context, among which the Open University of Brazil, the Open Technical School of Brazil, the "Profuncionário" Semipresential Courses<sup>2</sup>. The digital technologies used to support online teaching and learning in hybrid teaching contexts, such as the virtual learning environment *Moodle* that is spread around the world, is underused in relation to the resources it offers and the potential it presents in the world, support in the process of digital teaching and learning, as attested by Yunoki (2009) and Lisboa et al (2009). The question then arose: could *TeleMeios* be used as a virtual environment in the context of hybrid teaching? To answer this question, we seek to analyze the experiences of construction and restructuring of *TeleMeios* VTE and its adaptive possibilities in a hybrid context to enable formative actions in which students and teachers can have access to virtual experiences in which they play the role of protagonists.

The text is initially structured with a brief introduction. Following is the description of the methodology used to conduct the research with theoretical basis on hybrid teaching. In the following session, the correlations between the virtual teaching experiences developed by the Multimeios Research Laboratory through the *TeleMeios* environment are sought, understanding them as pedagogical proposals that have already been working in hybrid formats, even before knowledge and use of this nomenclature and classification, thus showing the trajectory of the Multimeios Research Laboratory with regard to scientific and experimental investigations in the field of hybrid teaching. At the end, we present considerations and considerations still needed when dealing with the theme "hybrid teaching" in the Brazilian / Cearense context, linking them to the use of *TeleMeios* and its possibilities in digital educational spaces.

## 2. Making the research

The research methodology was the qualitative bibliographic research. The bibliographic search for Lakatos and Marconi (2002), consists of reporting everything that has to be written about the chosen theme. Moreira and Caleffe (2006, p. 74) say that bibliographic research is "developed from the material already elaborated, built mainly from books and scientific articles". In the construction of the study we use textbooks, scientific articles, reviews, and others. The choice for bibliographic research was because

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<sup>2</sup> The Open University of Brazil, Open Technical School of Brazil and "Profuncionário" programs were large-scale, semi-presential governmental actions that emerged in the middle of the first decade of the 21st century in Brazil, with the aim of offer, respectively, teacher training courses through undergraduate, technical and technical courses aimed at non-teaching staff of public schools, making use of Digital Information and Communication Technologies. For further details of each of them, you can access the Ministry of Education page at: <http://portal.mec.gov.br/>.

of the need to know “the paths” already followed by teachers / researchers of the Multimeios Research Laboratory of the Faculty of Education of UFC, highlighting its theoretical and empirical effort.

We have appropriated the concept of hybrid education (BACICH; TANZI NETO; TREVISANI, 2015) and its use in Brazil. From this knowledge, we analyzed the experiences of the Multimeios Research Laboratory at the Faculty of Education of UFC, in which *TeleMeios* was used as Virtual Teaching Environment (VTE), to understand the possibilities of using this environment in hybrid teaching contexts. The study consisted of a survey of the scientific production developed by the Multimeios Research Laboratory on the use of the *TeleMeios* virtual environment as a possibility that links their experiences to the hybrid perspectives of teaching. It was important to carry out bibliographical research on the theme that deals with hybrid teaching in Brazil to deepen the theme.

The study seeks to contribute to the systematization of knowledge related to the experiences of the *TeleMeios* and its link to the hybrid teaching that is already under development at the Multimeios Research Laboratory, focusing on teaching, learning and research practices with hybridism, enabled by *TeleMeios* environment architecture, reinforcing its importance to the didactic-pedagogical mediation processes in virtual environments.

## 2. Theoretical framework

In this section we present an overview of what we discussed about hybrid teaching, taking the “magnifying glass” of Bacich's contributions; Tanzi Neto; Trevisani (2015); Moran (2015); Horn; Staker (2015), and others. The objective is to discuss about “the hard core” of the concept of hybrid teaching, from the one already studied, to subsidize the ongoing investigations in the Multimeios Research Laboratory.

### 2.1 Hybrid Teaching: initial ideas

For Moran (2015), hybrid education has existed for a long time, illustrated by the example of the teacher who passes an activity or reading for the student to do at home, then work in class. The author argues that hybrid teaching develops in a diverse society, is not limited to what is planned, materializes through various types of methodologies employed and contemplates a different audience in the sense of its formation and origin, thus characterizing its complexity.

Hybrid teaching is configured as the possibility of bringing together the best of classroom education and online education. It is therefore believed that the integration of the two teaching modalities can offer better learning outcomes. But what can be considered hybrid teaching? For Bacich; Tanzi Neto; Trevisani (2015, p.52),

hybrid teaching is a formal education program in which the student learns, at least in part, through online teaching, with some element of student control over the time, place, mode and / or pace of study, and by least in part in a supervised physical location outside his home (our translation).

With the hybrid teaching creates the possibility of a more personalized teaching for the student, being a



methodology with the focus on the student. According to Moran (2015), there are some models of hybrid teaching, designed with such purpose, namely: "flex", "a la carte", "enriched virtual" and "rotation".

The "flex" model is characterized by educational actions with emphasis on online teaching, in which students make a list of activities that should be considered in their study routine. The "a la carte" model enables personalized learning, in a place and time considered most convenient, in which the student organizes his routine according to the proposed objectives, and structured with the help of an educator. The "virtual enriched" model adopted by an educational institution in which its subjects will be online and in-person, allowing students to attend school only once a week. The "a la carte" and "virtual enriched" models are not common hybrid teaching experiences in Brazil.

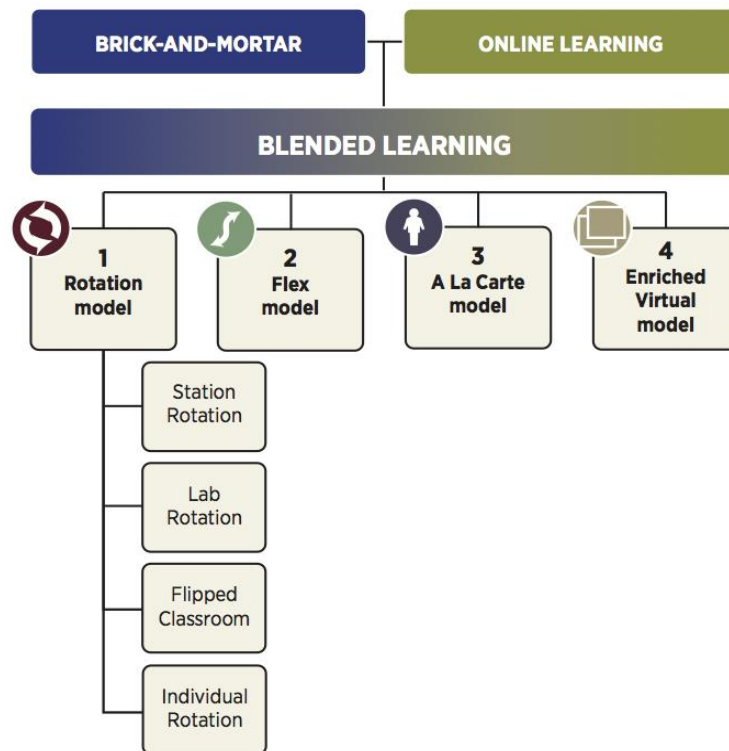
The rotation model is characterized by the execution of activities alternately by a group of students with a set time or guided by a teacher who may or may not be present. These activities may be read or written, but there must be at least one online activity in the curriculum. This model proposes four proposals: rotation per season; rotational laboratory; inverted classroom and individual rotation. (BACICH; TANZI NETO; TREVISANI, 2015).

In the proposed rotation by stations groups are organized, in which each performs a task, according to the orientations proposed by the teacher, and one of the groups will be developing their actions online, valuing the moments of collaborative and individual production. Students will switch groups according to the proposed time for each activity, with a rotation taking place until all students have participated in all groups. The activities are independent but work in an integrated manner as everyone will have access to the same content.

The proposed inverted classroom, more widespread in Brazil, is characterized by the theoretical part of the content being studied outside of school, through online teaching, and the practical part being debated in school, in the classroom. In the proposed individual rotation, there is a path to be followed by the student, which must be part of their study routine in order to achieve the studies outlined by the teacher.

The rotation model, rotational laboratory, is the most similar to the hybrid proposal presented and investigated in this work. It is characterized by classroom and laboratory use. Students will be divided into groups, where one part will be with the teacher in the classroom and the other part will be in the teaching lab making use of computers, individually and independently, with activities proposed by a teacher.

Figure 1. Hybrid Teaching Proposals.



Source: available at <<https://www.christenseninstitute.org/blended-learning-definitions-and-models/>>.

In all these discussions one cannot miss a central element, which are online activities, understood as those “[...] that stimulate, at the same time, the autonomy and interaction between the participants of courses offered semi-presently or completely at a distance” (GUERREIRO, 2015, p. 34-35). The pedagogical design of these activities must be intentionally prepared to achieve the intended pedagogical objectives and, at the same time, enable learning routes that meet different learning styles within the scope of hybrid teaching.

Hybrid teaching is sometimes considered synonymous with blended learning. It is characterized by the pedagogically combined use of face-to-face and distance activities, aiming that the subject learns effectively in these two teaching modalities, and should be considered the models previously presented, as well as others not discussed here. In the next section, it will deal with how it has been leveraged in *TeleMeios* VTE.

## 2.2 *TeleMeios: the Virtual Teaching Environment*

The structuring of *TeleMeios* VTE was based on a scientific research carried out by the *TeleMeios* Group<sup>3</sup> in 2006 in the context of the Multimeios Research Laboratory, at the UFC Faculty of Education. Santos (2010) defines *TeleMeios* as a telematics environment that integrates text, sound, image, mail and specific software sharing resources, with the purpose of providing teaching.

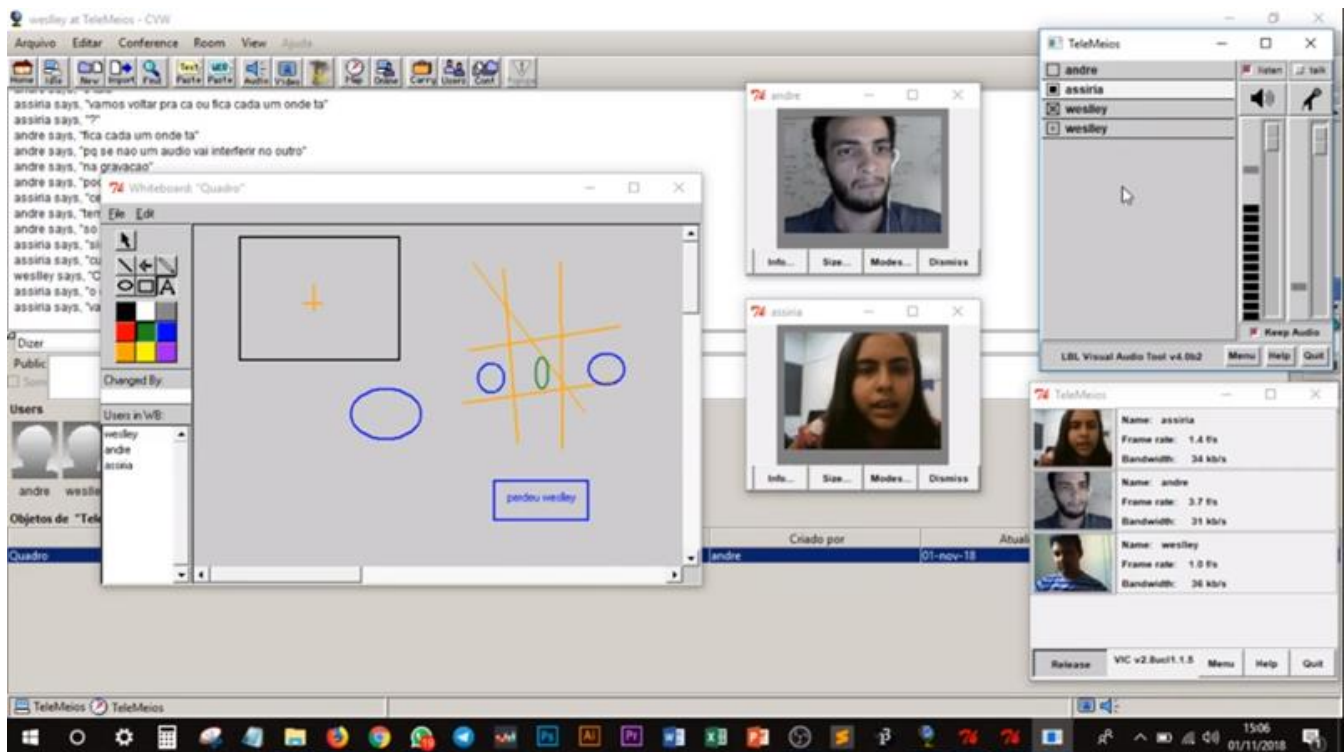
For Jucá (2011), the diversity of resources offered by *TeleMeios* can strengthen the didactic-pedagogical

<sup>3</sup> Group linked to the Multimeios Research Laboratory (FACED / UFC) formed by teachers, researchers and undergraduate and graduate students.

relationship between teacher and student so that both can interact in real-time synchronous moments and asynchronous moments with space and time difference, providing also greater student autonomy and also emphasizing the need for teacher mediation. Araújo et al (2019) increases that *TeleMeios* software can be used by the teacher to assist him with teaching purposes.

*TeleMeios* interface allows users to easily communicate, since it has a structure that is easy to read and understand, as shown in Figure 2.

Figure 2. *TeleMeios* Environment Interface in 2019.



Source: printscreen (2019). Available at < <https://www.youtube.com/watch?v=7NK5ffY30Zk>>.

Jucá (2011) and Andrade (2011) highlight the interaction between users made possible by the synchronicity present in the chat, audio conferencing and videoconferencing features, as well as the use of whiteboard and application sharing tools, which shows a differentiated pedagogical design of the environment.

It is important to consider that the *TeleMeios* environment brings with it a simplicity and “cleanliness” of design, besides being ergonomic, focusing on the learning to be developed, reason why it is necessary to investigate how it can be used in hybrid teaching actions. In the next section, we will deal with this, based on the results and discussions compiled from research already undertaken.

### 3. Results and discussion

We highlight the experiences of using the environment *TeleMeios*, described in the work of Jucá (2011) and Andrade (2011), in order to find possible approximations with theorists dealing with hybrid teaching and the pedagogical proposal of the environment under study.

Aspects related to the pedagogical mediation involved in the teaching of mathematics using Digital

Information and Communication Technologies (TDIC) were observed by Jucá (2011) when preparing and teaching a Course of Geometric Constructions at *TeleMeios* VTE. This author aimed, in his thesis, to observe the use of digital information and communication technologies in education, especially when dealing with pedagogical mediation in mathematical education in virtual environments, taking as transversal pedagogical support for its conduct the Fedathi Sequence<sup>4</sup>.

The course taught by Jucá (2011), divided into a pilot meeting and five classes lasting two hours each, took place in the virtual format in its entirety, in which there was total interaction between the subjects, teacher and students, through the resources made available by *TeleMeios* and run on networked computers. The subjects, who during the meetings were physically present in the computer labs LI 40, LI 41 and LI 42 (two students in LI 40, two other students in LI 41, the teacher in LI 42 and one mote student moving around the classrooms to support) at the College September 7 (FA7), communicated in real time via text chat, voice and image using audio conferencing and videoconferencing and, in an innovative way, through application sharing used during the meetings.

The experiences of Jucá (2011), in his study, materialized in synchronous e-learning<sup>5</sup> activities, as formative actions were designed, connecting students and trainer via the internet, aiming at the development of elementary geometric constructions through *GeoGebra* software, where everyone shared their experiences through problem solving. The study proved to be effective, showing that *TeleMeios*, being conceived in an e-learning proposal, provided horizontal and collaborative learning, however it was not evidenced as a hybrid use proposal, considered as teaching experiences that permeate online and face-to-face, neither 100% online nor 100% face-to-face.

Andrade (2011) sought to answer questions about how teacher mediation took place by using *TeleMeios* VTE and the Sequence Fedathi teaching methodology in teaching the determination of the equation of a straight line, and how this environment could favor the approach of subjects of the school Flat Analytical Geometry in his study.

In this sense, the researcher conducted experiments that involved the planning and execution of a teaching sequence, which was divided into six moments, lasting two and a half hours each, where the first and the last were conducted through face-to-face meetings, while the other four occurred virtually, using *TeleMeios* supported by *GeoGebra* software and a text editor.

The research environment was composed of two physical rooms, located in the building Research and Regional Studies Center (NUPER). In the presential moments, the subjects were in one of the classrooms, while in the virtual moments, the researcher, in the role of teacher, was placed in room 1 and the students, which totaled 4, in room 2. It was observed that the arrangement of the two classrooms made impossible any kind of eye contact between the researcher and the students, which characterized, during the virtual sessions, a pedagogical mediation without the presence of the teacher in the same physical space of the students.

The first didactic session, in face-to-face format, aimed to lead students to develop skills regarding the

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<sup>4</sup> The Fedathi Sequence is a teaching proposal created by researchers from the Fedathi Group that seeks to modify the teacher's attitude towards their actions, which leads the student into a learning situation (MENEZES, 2018).

<sup>5</sup> "Etymologically, the term e-learning corresponds to distance learning mediated by digital technologies" (MOREIRA; MONTEIRO, 2018).

resources (text communication, voice, video and application sharing) provided by *TeleMeios*, so that they could, in the next sessions, perform the proposed activities in the environment more autonomously. The second didactic session took place in virtual format through *TeleMeios*, when the researcher teacher shared the *GeoGebra* software with the students, so that everyone could know and use their geometric construction tools. The study of the determination of the equation of a straight line was performed during the didactic sessions three, four and five, virtually, through *GeoGebra* shared by *TeleMeios*.

In the last session, the students underwent a written assessment in the traditional format, all being physically present in the same environment using paper and pen, which aimed to verify the learning in relation to the content addressed. Andrade (2011) also clarifies that didactic sheets were elaborated with the purpose of presenting, during the didactic sessions, orientations, problem situations, exercises and guides to the students through the sharing of a text editor in *TeleMeios*, with the objective of highlight the learning pathway developed.

Andrade (2011) concludes that *TeleMeios* enables broad communication between users, teachers and students through the chat, audio conferencing, videoconferencing and application sharing features offered by the environment, which favor the performance of group activities. The researcher also emphasizes that the methodology of use of the environment is of fundamental importance in order to explore its potential, enabling a pedagogical mediation through the Fedathi Sequence, as appropriate, thus allowing a collaborative and horizontal approach to a given content.

It is observed that the research analyzed was articulating face-to-face moments in the conventional classroom and virtual moments (composed by synchronous and asynchronous activities) through *TeleMeios*, thus configuring a hybrid teaching perspective. From this experience, *TeleMeios* can then be verified as an environment that can be adapted and used in hybrid teaching contexts, either in person or at a distance, using virtuality.

#### 4. Final considerations

It can be concluded that *TeleMeios* as a hybrid virtual environment, which can favor peer and / or individual learning, in a teaching and learning proposal from a collective and collaborative perspective.

With the results evidenced in the studies by Andrade (2011), it is possible to notice that hybridity is much more characterized within the research, using mixed moments (presential and virtual) in its pedagogical actions. The studies conducted by Jucá (2011) have approximations with the perspective of e-learning insofar as they do not have presential intervention moments.

It is worth mentioning that this study is at an early stage, which requires teachers / researchers to plan and develop this environment in different formative contexts, which can use hybrid teaching with courses focused on corporate education, vocational education, higher education, high school, youth and adult education and others, to reapply concepts of pedagogical design under the parameters of hybrid teaching, aimed at the formation of different audiences with diversified formative purposes.

The research indicates that the *TeleMeios* environment has a formative potential to be explored and investigated, focusing on the structural and pedagogical designer of virtual environments that surpass the concept of content repository and the idea of students as receptacles of knowledge and teachers as holders

knowledge, enabling several virtual and face-to-face paths to be followed, with a view to learning that is effective and especially meaningful.

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# Differentiated Education Supervision Approaches in Schools through the Lens of Teachers

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## Abstract

*The purpose of this study was to examine the predominant approaches of education supervision in a randomly selected sample of schools in Beirut, Lebanon according to Glickman et al.'s (1998) differentiated model. For this purpose, 290 teachers ( $N_1= 290$ ) from 29 non-free private schools in Beirut ( $N_2= 29$ ) completed a survey. Data was analyzed using SPSS 21.0 for windows. Results indicated that: (1) teachers were not satisfied in schools with the education supervision behaviors in their schools; (2) the predominant approaches of education supervision were directive control, followed by directive informational, collaborative and least were non-directive behaviors; and (3) supervisory approaches were not differentiated in schools. Implications and limitations of the study and suggested.*

**Key Words:** *Developmental Supervision- Teacher Professional Growth- School Improvement- Differentiated Supervision*

## 1. Introduction

### 1.1 The Problem

Schools are continuously challenged to improve, change and reform (Darling-Hammond et al., 2009). However, teachers lie at the heart of any educational reform, school improvement or school effectiveness (Ghamrawi, Ghamrawi & Shal, 2017). The OECD (2019) suggest that teachers top the list of high performing schools. Thus, responding to teachers' professional needs for continuous growth is imperative for ensuring quality teachers who can secure 21<sup>st</sup> century education for their students (Hixson, Ravitz, & Whisman, 2012).

Despite the fact that both the international and local literature underscore the integral role of teacher professional development in securing quality education (OECD, 2019; Ingersoll & Collins, 2018; Ghamrawi, Ghamrawi & Shal, 2017; Al-Jammal & Ghamrawi, 2013); this same body of research has shown that the developmental opportunities for teachers are not structured to meet their individual needs. As such available programs fail to have a systemic impact on the knowledge base and skill sets of the entire school community (Bakkum, Ko, & Sammos, 2014).

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One of the critical factors that contribute to the failure of teachers' growth-promoting programs is the supervisory approach exhibited by educational supervisors with their teachers (Chien-Chin, 2018). In fact, teacher professional development is one domain of the domains of education supervision (Sergiovanni and Starratt 1993). So, when the supervisory approaches and techniques available to teachers in schools are low in quality, then teacher professional development and growth should not be expected to be any better.

Thus, while studies from across the globe have focused on teacher professional development and growth through many perspectives and approaches such as school reform (Lieberman & Wood, 2002), training methodologies (Campbell & Malkus, 2011), leadership theories (Ghamrawi, 2013a), school improvement endeavors (Gallagher, Woodworth, & Arshan, 2017); a small number of studies were attentive to the role of educational supervisors in schools in impacting and shaping teacher growth (Wanzare & da Costa, 2000).

Given all the discourse taking place in international, regional, and local research on supporting teacher growth, this study attempted to approach this notion from the perspective of educational supervision focusing on the degree education supervision is differentiated in schools according to teachers' needs.

## **1.2 Purpose of the Study**

This study attempted to investigate the pre-dominant approaches of educational supervision endorsed by private schools in Beirut, Lebanon. Besides, it attempted to examine the degree teachers were satisfied with such supervisory approaches in light of their strengths in supporting their professional growth.

## **1.3 Research Questions**

This study was guided by the following research questions:

- 1- To what degree are teachers satisfied with their education supervision experiences at their schools in terms of supporting their professional growth?
- 2- What is the approach of education supervision mostly endorsed by private schools in Beirut?
- 3- To what degree is education supervision differentiated in private schools in Beirut?

## **1.4 Significance of the Study**

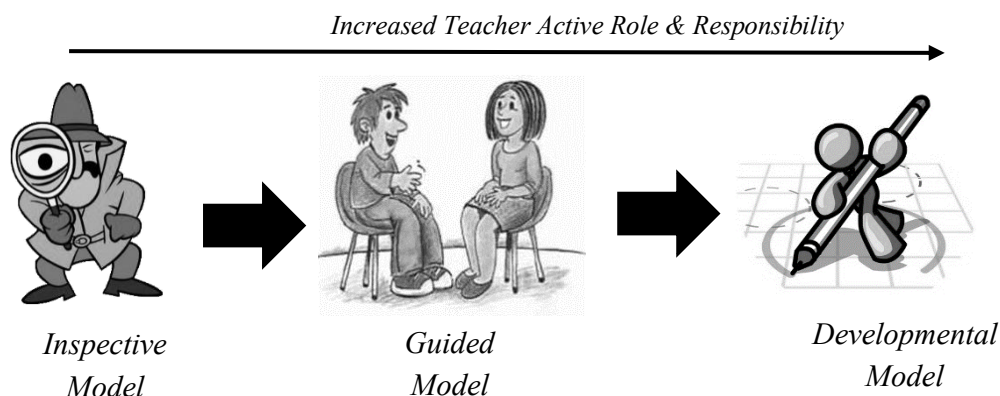
This study approaches teacher professional development and growth from an overlooked angle and perspective. In fact, while this notion has been addressed extensively through several angles, perspectives and lenses; it was not addressed explicitly through the vein of educational supervision practices and approaches in schools. Thus, the study is expected to constitute an important added value to the literature and to support practitioners especially those involved in the supervision of instruction.

## 2. Review of Relevant Literature

### 2.1 Supervision of Instruction

Traditionally, supervision of teachers has been viewed as the process through which middle or senior leaders evaluate the performance of teachers (Glickman, Gordan, & Ross-Gordan, 2014). Supervision has undergone dramatic ontological, epistemological and methodological evolution across the history of schooling. This can be attributed to the institutional, academic, cultural and professional dynamics that govern the highly convoluted nature of schools (Marzano, Frontier, & Livingston, 2011). Nolan and Hoover (2008) wrote “the purpose of supervision is to promote individual teacher growth beyond the teacher’s current level of performance” (p. 8).

In fact, supervision initially began as a process to control what teachers were offering to their students based on an external inspective approach (Marzano, et al., 2011). Yet, this inspective model of instruction supported schools only in ‘controlling’ schools rather than ‘developing’ them. In fact, within the entourage of such a model, teachers were able to know that they were not doing well in certain areas, without the least hint on how to improve. This has paved the way for the need and hence occurrence of new model to instructional supervision mainly the directive model (Marzano et al., 2014) also termed ‘Guided Supervision’. Through this model of supervision, teachers were guided as to not only ‘what’ to do in their classes, but also advise went beyond that to cover the ‘how’ of how they should be doing that. Unfortunately, this has led to the creation of dependable teachers who became more and more limited with what they would and could do (Marzano et al., 2011). That is to say, despite the fact that directive or guided supervision has offered teachers with roadmaps as to what to do in their classrooms, this model has yielded teachers who over relied on their subject leaders and hence narrowed down their horizons and creativity in schools. To respond to such challenges, developmental supervision started gaining popularity because it was rooted in development, improvement and enhancement of teachers’ skills and competencies without being judgmental or evaluative (Glickman et al., 2014). The developmental model of instructional supervision has leveraged the role played by teachers in planning for their professional growth. Thus, in this line, they are viewed as partners to middle and senior leaders in deciding on their career options for improvement purposes. Figure 1 displays the models to education supervision indicating the degree of activity of teachers’ role.



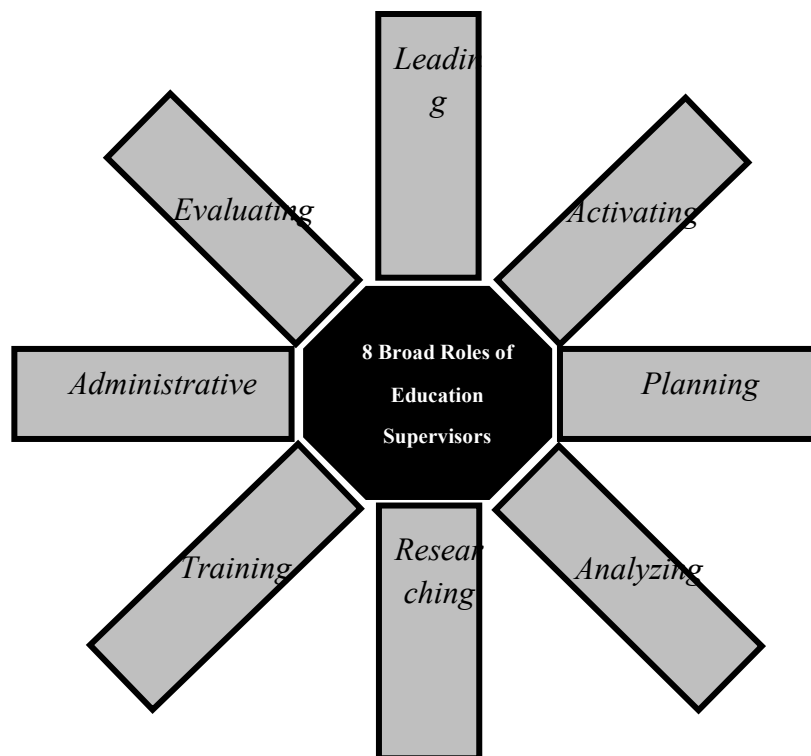
**Figure 1. Models of Education Supervision**

## 2.2 Roles Played by Supervisors

The term education supervisor is very stretchy in the literature. A supervisor can be a subject leader (Ghamrawi, 2013b); a head of a department (Marzano et al., 2011) or a school leader serving as an instructional leader (DuFour, DuFour, Eaker, & Many, 2006). In all cases the literature has highlighted the gross load carried by individuals seeking to carry out the role effectively and efficiently.

The literature is increasingly ascribing roles to education supervisors that are traditionally known to be part of school principals' tasks. For example, Ghamrawi (2013b) suggests that subject leaders play several roles in the school making them burnout easily. These roles she describes include subject leader as: change-maker, role-model, liaison, communicator, event-organizer and curriculum-developer (Ghamrawi, 2013b, p. 39).

In all cases, the literature of education supervisors' role and scheme of work may be synthesized into eight areas presented in figure 2.



**Figure 2. The Eight Broad Roles of Education Supervisors**

Figure 2 suggests that the education supervisor (From: Ghamrawi (2010, 2011, 2013a, 2013b))

- 1- *Leadership role*: which entails distributing leadership, creating cultures and sub-cultures conducive to learning and growth.
- 2- *Activating role*: which make the education supervisor responsible for the collaborating and catalyzing teachers to work towards enriching the curricula with all the activities that are

conducive to active learning and student-centered classrooms.

- 3- *Planning role*: which suggests that education supervisor take an active role planning for day-to-day activities as well as strategically in the same vein of school improvement plans.
- 4- *Analyzing role*: which entails that the education supervisor adopts an analytical data-based approach in all matters such as analyzing student scores on tests, curriculum review, needs assessments, and analyzing test items and making sure it is aligned with curricular objectives.
- 5- *Researching role*: which entails that the education supervisor develops an inquiry-based approach to problems in school so as to arrive into solutions that are grounded in evidence.
- 6- *Training role*: which entails that the education supervisor assumes a role in which he/she provides training to sub-ordinates based on rigorous needs assessment.
- 7- *Administrative role*: entails that the education supervisor maintains archives, support senior leaders in student and teacher distribution across classes, collect data, create reports and communicate about them. Through the administrative role, they act as liaisons between senior leadership and teachers.
- 8- *Evaluating role*: which entails that the education supervisor take part in observing teachers, providing continuous constructive formative feedback to them.

### 2.3 Differentiated Education Supervision

Because schools are challenged to change and deliver according to 21<sup>st</sup> century education demands (Ghamrawi et al., 2017); likewise, teachers are simultaneously challenged to grow and develop (Ingersoll & Collins, 2018). However, such growth is only possible when the needs of those teachers are met.

In the school system, a huge discourse on differentiating instruction has been undergoing leading to the acknowledgement of this approach to learning and teaching as being integral for all students to learn and learn well (Shal, Kibbi, Ghamrawi, & Ghamrawi, 2018). The same way instruction should be differentiated for students, education supervision need to be differentiated to teachers as well (Glickman, 2009). This is because teachers' needs, abilities, interests and time are varied and never converge to the exact identical pool.

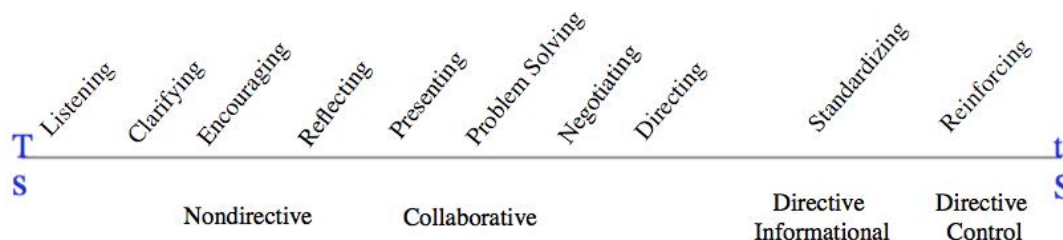
Glickman (2009) suggests that the concept of the isolated teacher springs out from the nature of the early one-room school houses which emphasizes: (a) isolation, (b) psychological dilemma and frustration, (c) routine, (d) inadequate teacher induction, (e) inequity, (f) inverted beginner responsibilities, (g) lack of career stages, (h) lack of curriculum and instructional decisions, and (i) conservatism.

The pre-dominant of the one-room school houses' culture was hierarchical and was rooted in compliance. To differentiate education supervision, there is a need to shift the cultural norms towards collaboration that is rooted professional growth (Ghamrawi, 2010). In the same vein, supervision should not be viewed as a single event or happening, but rather a continuous process that never sojourns (Glickman, 2009).

Glickman et al. (1998) suggested four approaches to differentiated supervision, where the roles of both the teacher and the supervisor vary:

- 1- *Directive supervision*: supervisor owned plan.
- 2- *Directive informational supervision*: supervisor suggested plan.
- 3- *Collaborative supervision*: supervisor-teacher mutual plan.
- 4- *Non-directive supervision*: teacher self-plan.

In other words, the model of differentiated supervision offered by Glickman et al. (1998) suggests various degrees of teacher and supervisor dominance in planning for teacher growth and development. Such a model springs out of a supervisory behavior continuum (Glickman et al., 1998) presented in figure 3. The corresponding behavior are illustrated in table 1. This continuum shows the movement from teacher-centered actions (big "T") to supervisor-centered actions (big "S"). It also further organizes supervisor behaviors into groups based on the amount of supervision each provides.



*T: Maximum teacher-centered actions & responsibility t: Minimum teacher-centered actions & responsibility*

*S: Maximum supervisor centered actions & responsibility s: Minimum supervisor centered actions & responsibility*

**Figure 3. Supervisory Behavior Continuum (Glickman et al., 1998)**

Directive supervision is best used when the teacher is new and needs directive guidance to adapt to school routines and requirements. This type of supervision is also useful with struggling teachers. In this case the role of the education supervisor is prescriptive using supervisory behaviors such as reinforcing, standardizing, and directing.

Directive informational supervision serves best teachers who are in their first three years of their teaching career. This approach supports teachers in becoming more familiar and confident in their teaching styles and strategies. In this case the role of the education supervisor is still prescriptive using supervisory the same behaviors of reinforcing, standardizing, and directing, but is more open to teacher suggestions.

**Table 1: Illustration of Supervisory Behaviors Presented by Glickman et al. (1998)**

Behavior		Illustration
1	<i>Listening</i>	supervisor sits and looks at the speaker and nods his or her head to show understanding

2	<i>Clarifying</i>	supervisor asks questions and statements to clarify the speaker's point of view
3	<i>Encouraging</i>	supervisor provides acknowledgement responses that help the speaker continue to explain his or her positions
4	<i>Reflecting</i>	supervisor summarizes and paraphrases the speaker's message for verification of accuracy
5	<i>Presenting</i>	supervisor gives his or her own ideas about the issue being discussed
6	<i>Problem Solving</i>	supervisor takes a the initiative in pressing all those involved to generate a list of possible solutions
7	<i>Negotiating</i>	supervisor moves the discussion from possible to probable solutions by discussing the consequences of each proposed action and narrowing down choices with questions
8	<i>Directing</i>	supervisor tells the participant(s) either what the choices are or what is to be done
9	<i>Standardizing</i>	supervisor sets the expected criteria and time for decision to be implemented, sets target objectives, and conveys expectations
10	<i>Reinforcing</i>	supervisor strengthens the directive and the criteria to be met by telling of possible consequences, either positive or negative

Collaborative supervision serves best teachers who already have some experience teaching and are very strong in their areas of expertise. The supervisor suggests ideas and alternatives, however, the decisions are made by the teacher and not the supervisor. In this case the role of the education supervisor is still consultative using the behaviors of problem solving, presenting and reflecting.

Nondirective supervision serves highly proficient teachers who initiate contact with the supervisor sometimes just to present to them an outstanding activity or approach they are exhibiting in their classes. The role of the education supervisor is still consultative, however, using mostly the behaviors of encouraging, clarifying and listening.

### 3. Methodology

This study adopted the positivist approach to research and has utilized quantitative surveying to collect information about the degree education supervision was being differentiated in schools.

#### 3.1 The Sample

There are 85 non-free private schools in Beirut according to the Lebanese Centre for Educational Research and Development (CRDP). All 85 schools were addressed via email, telephone or acquaintances of the researcher who worked in those schools. In all the three cases, schools were provided with information about the purpose of the study, how data will be used and its anonymity. Out of the 85 schools only 29 schools were interested and willing to pass the research survey to 10 of their teachers via WhatsApp to participate in the study. As such 290 teachers (N=290) participated in this study.

### 3.2 Research Instrument

The instrument consisted of three parts: the first part collected demographic data about participant teachers. The second part included a single item which requested teachers to rate their education supervision experience in their schools in terms of the degree it supported their professional growth and development. The item was rated by teachers on a 4-points Likert scale.

The third part attempted to investigate whether the type of the supervisory approach exhibited by education supervisors (*Directive supervision; Directive informational supervision; Collaborative supervision; Non-directive supervision*). For this purpose, 10 statements corresponding to the 10 behaviors (reinforcing-standardizing-directing- negotiating- problem-solving- presenting- reflecting- encouraging- clarifying- listening) of the 4 types of supervision (directive control- directive informational- collaborative- nondirective); were presented.

The fourth part requested teachers to respond to a single item where they would judge if the supervisory approach they encountered was identical across the school or not.

### 3.3 Data Analysis

Data was analyzed using SPSS 21.0 for windows. Descriptive statistics were used to describe and summarize the properties of the mass of data collected from the respondents. Means scores, standard deviations and percentages were calculated per each item of the survey instruments. In addition, Pearson correlation coefficient was calculated in order to investigate any relationship between the approach of education supervision exhibited and the corresponding methods of supervision.

## 4. Results

### 4.1 Demographic Data

The sample was 40.8% males and 59.2% females. The majority (39.6%) of teachers' age range was between 26-35 and novice teachers were no more than 10.4%. The demographic characteristics of participants are presented in Table 2.

Table 2. Demographic Characteristics of Participants

	%
<i>Gender</i>	
Male	40.8
Female	59.2
<i>Age (Years)</i>	
Less than 25	16.9
26-35	39.6
36-45	28.9
46 and above	15.6

<i>Experience (Years)</i>	
Less than 4	10.4
5-9	20.9
10- 14	23.1
15- 19	22.9
20 and above	22.7

#### 4.2 Satisfaction of Teachers with their Education Supervision Experience

Teachers were requested to rate their education supervision experience in their schools in terms of the degree it supported their professional growth and development. Results are presented in table 3.

**Table 3: Teachers' Satisfaction with the Education Supervision Experience in terms of its support to their Professional Growth**

Education supervision in my school is growth promoting.							
Rating	Strongly Disagree	Disagree	Agree	Strongly Agree		M	SD
Count	68	97	101	24		2.28	0.789
%	23.4%	33.4%	34.8%	8.2%		57.0%	
	56.8%		43.0%				

Table 3 shows that the number of teachers who were not satisfied with the education supervision experience in their school in terms of being growth-promoting (56.8%) was less than those who believed it was a positive one (43.0%).

#### 4.3 Approaches of education supervision Endorsed in Schools

Teachers were indirectly asked about the type of the supervisory approach exhibited by education supervisors (*Directive supervision; Directive informational supervision; Collaborative supervision; Non-directive supervision*). For this purpose, 10 statements corresponding to the 10 behaviors (reinforcing- standardizing-directing- negotiating- problem-solving- presenting- reflecting- encouraging- clarifying- listening) of the 4 types of supervision (directive control- directive informational- collaborative- nondirective); were presented. Findings are presented in tables 4 (a-j).

**Table 4a: Listening Behavior in the Education Supervisor-Teacher Relationship**

<ul style="list-style-type: none"><li>▪ Waits until the teacher’s initial statement is made</li><li>▪ Understands what they teacher is saying.</li><li>▪ Avoids thinking about how you see the problem</li></ul> <p><i>Listening is made to help the teacher think loud and hence arrive at solutions by themselves</i></p>										
Rate your Supervisor 1=lowest	1	2	3	4	5	6	7	8	9	10
	32	34	20	127	67	10	0	0	0	0
	11.0%	11.7%	6.8%	43.7%	23.1%	3.4%	0%	0%	0%	0%
<b>Listening Behavior</b>	<b>96.3%</b>					<b>3.4%</b>				
	<b>M= 3.66 – Percentage= 36.6%- SD=0.785</b>									



Table 4a suggests that the listening behaviors of educational supervisors were relatively low (36.6%,  $M=3.66$ ,  $SD=0.785$ ). Only 3.4% of the researched sample believed that their education supervisors exhibited an active listening role. In other words, supervisors were not highly keen to give an intellectual freedom for teachers to arrive at personal solutions for their problems.

**Table 4b: Clarifying Behavior in the Education Supervisor-Teacher Relationship**

- Probes for the underlying problem/additional information.
- Guides the teacher to reframe the problem.
- Avoids asking questions that are solutions.

*Clarifying is done to help the teacher further identify, not solve the problem*

Rate your	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
Supervisor	10	20	64	136	55	5	0	0	0	0
1=lowest	3.4%	6.8%	22.0%	46.8%	18.9%	1.7%	0%	0%	0%	0%
<b>Clarifying Behavior</b>	<b>98.3%</b>					<b>1.7%</b>				
	<b><i>M= 3.76 – Percentage= 37.6%- SD=0.015</i></b>									

Table 4b displays the finding that the majority of teachers (98.3%) were not privileged with educational supervisory approaches that help them identify their problems on their own rather than being told what their problems were. In fact, only 1.7% of researched teachers believed their supervisors exhibited clarifying behaviors during their work together.

**Table 4c: Encouraging Behavior in the Education Supervisor-Teacher Relationship**

<ul style="list-style-type: none"><li>▪ Shows willingness to listen further as the teacher begins to identify problems.</li><li>▪ Exhibits a body language that is supportive for the teacher to dig more into the problems.</li><li>▪ Validates concerns and emotions with neither brushing fears nor exaggerating them.</li></ul> <p><i>Encouraging is done to help the teacher speak out in a non-threatening environment.</i></p>										
Rate your	1	2	3	4	5	6	7	8	9	10
Supervisor	5	10	20	17	208	10	20	0	0	0
1=lowest	1.7%	3.4%	6.8%	5.8%	71.7%	3.4%	6.8%	0%	0%	0%
<b>Encouraging Behavior</b>	<b>89.9%</b>					<b>10.2%</b>				
	<b>M= 4.80 – Percentage= 48.0%- SD=0.026</b>									

Table 4c shows that 89.9% of the researched teachers believed that their supervisors did not exhibit encouraging behaviors which would make them feel at ease to explore and share their problems explicitly with them. Only 10.2% believed they enjoyed such a privilege.

**Table 4d: Reflecting Behavior in the Education Supervisor-Teacher Relationship**

- Poses as many questions to help the teacher figure out a problem.
- Asks for more details to invite deeper thinking by teachers.
- Does not offer opinion.

*Reflecting is done to help the teacher review what has happened and how it can be improved..*

Rate your Supervisor	1	2	3	4	5	6	7	8	9	10
1=lowest	0	0	101	98	67	24	0	0	0	0
	0%	0%	.8%	33.7%	23.1%	8.2%	0%	0%	0%	0%
Reflecting Behavior	91.8%					8.2%				
	M=4.04 – Percentage= 40.4%- SD=0.051									

Table 4d shows that 91.8% of the participant teachers believed that their supervisors did encourage them to act out as reflective practitioners. Only 8.2% of this sample believed they were encouraged to review their practice and suggest amendments themselves to improve practice.

**Table 4e: Presenting Behavior in the Education Supervisor-Teacher Relationship**

- Requests the teacher to select actions that are do-able, feasible and concrete.
- Asks the teacher for a commitment to the decision agreed on.
- Suggests opinion and recommends ideas.

*Presenting is done to help the teacher commit to a plan.*

Rate your Supervisor	1	2	3	4	5	6	7	8	9	10
1=lowest	0	0	0	17	108	98	67	0	0	0
	0%	0%	0%	5.8%	37.4%	33.7%	23.1%	0%	0%	0%
<b>Presenting Behavior</b>	<b>43.2%</b>					<b>56.8%</b>				
	<b>M=5.75 – Percentage= 57.4 %- SD=0.038</b>									

Table 4e suggests that 56.8% of teachers were dealt with supervisors who manipulated them to commit to a plan they recommended. Yet a relatively appreciable percentage of 43.2% of the sample thought they were not subjected to such a behavior.

**Table 4f: Problem-solving Behavior in the Education Supervisor-Teacher Relationship**

<div>▪ Invites the teacher to think of all possibilities.</div> <div>▪ Asks the teacher to consider consequences of various actions.</div> <div>▪ Helps the teacher move from possible to probable solutions.</div> <div><i>Problem is done to help the teacher think of consequences of actions.</i></div>										
Rate your Supervisor 1=lowest	1	2	3	4	5	6	7	8	9	10
	0	12	16	88	161	13	0	0	0	0
	0%	4.1%	5.5%	30.3%	55.5%	4.4%	0%	0%	0%	0%
<b>Pb-solving Behavior</b>	95.6%					4.4%				
	M=4.50 – Percentage= 45.0%- SD=0.056									

Table 4f suggests that 95.6% of teachers who participated in this study were not encouraged to practice independent problem-solving. This is opposed to 4.4% of participant teachers who thought they were encourage to problem solve.

**Table 4g: Negotiating Behavior in the Education Supervisor-Teacher Relationship**

- Summonses the teacher to think of all possible solutions.
- Asks the teacher about expectations from a given solution.
- Helps the teacher arrive a mutually acceptable solution to a given problem.

*Negotiating is done to help the teacher arrive at an acceptable solution.*

Rate your Supervisor	1	2	3	4	5	6	7	8	9	10
1=lowest	0	3	69	57	96	27	33	5	0	0
	0%	1.0%	23.7%	19.6%	33.1%	9.3%	11.3%	1.7%	0%	0%
<b>Negotiating Behavior</b>	<b>77.7%</b>					<b>22.3%</b>				
	<b>M= 4.66 – Percentage=46.6 %- SD=0.026</b>									

Table 4g shows that 77.7% of teachers were not encouraged to get involved in a discourse/negotiation with their supervisors. This is opposed to 22.3% who said they were encouraged to do so.

**Table 4h: Directing Behavior in the Education Supervisor-Teacher Relationship**

<ul style="list-style-type: none"><li>▪ Tells expectations to teachers.</li><li>▪ Tells the teacher in a matter-of-fact what needs to be done.</li><li>▪ Forbids the teacher to avoid ideas he/she suggests.</li></ul> <p><i>Directing is done to help the teacher agree on the solution selected by the supervisor.</i></p>										
Rate your Supervisor	1	2	3	4	5	6	7	8	9	10
1=lowest	0	3	10	10	5	59	57	86	27	33
	0%	1.0%	3.4%	3.4%	1.7%	20.3%	19.6%	29.6%	9.3%	11.3%
<b>Directing Behavior</b>	<b>9.5%</b>					<b>90.5%</b>				
	<b>M= 7.29 – Percentage=72.9 %- SD=0.067</b>									

Table 4h shows that 90.5% of teachers were subjected to a directing behavior by their supervisors. As such, they would be dictated what to do rather than inquire about what should be done. Only 9.5% of the participant teachers thought they were not.

**Table 4i: Standardizing Behavior in the Education Supervisor-Teacher Relationship**

- Details the actions to be taken.
- Asks the teacher to develop the specifics of the activities.
- Creates success criteria for teachers' actions.

*Standardizing is done to ensure that the teacher complies with expectations.*

Rate your Supervisor	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
1=lowest	0	0	0	3	15	49	57	86	37	43
	0%	0%	0%	1.0%	5.1%	16.8%	19.6%	29.6%	12.7%	14.8%
<b>Standardizing Behavior</b>	<b>6.1%</b>					<b>93.9%</b>				
	<b>M=7.69 – Percentage= 76.9%- SD=0.091</b>									

Table 4i suggests that supervisors practiced a standardizing behavior on 93.9% of teachers involved in the study. This is opposed to only 6.1% of teachers who thought they werenot subjected to such a behavior.

**Table 4j: Reinforcing Behavior in the Education Supervisor-Teacher Relationship**

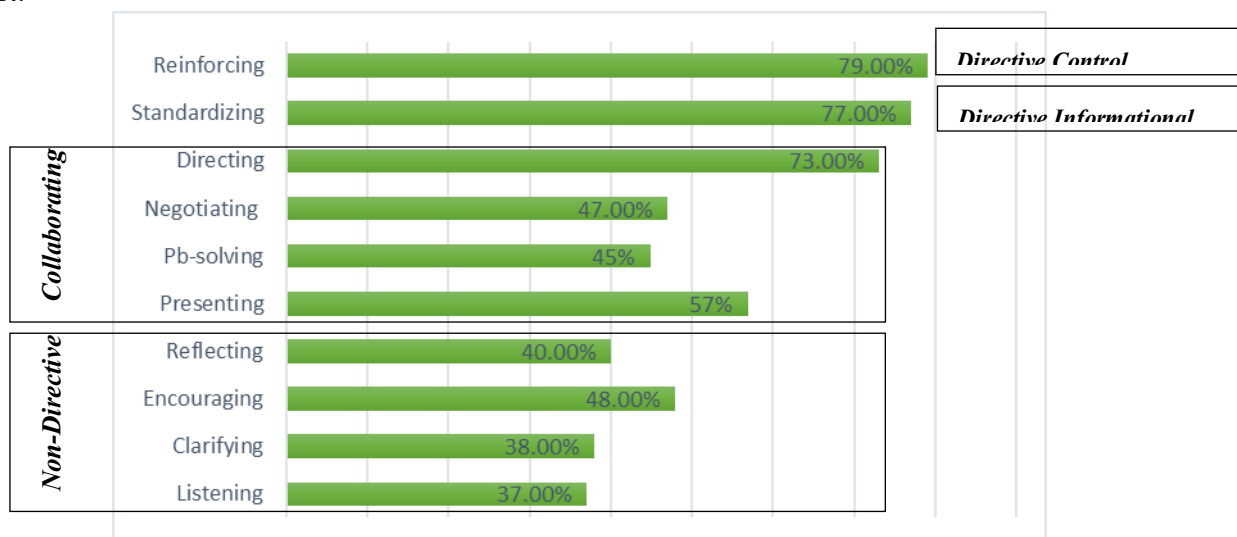
- Repeats and follows up on expectations.
- Reviews the entire plans and establishes times for checking on progress.
- Closes meetings by making sure the teacher clearly understands the plan.

*Reinforcing is done to ensure teacher’s understanding of the supervisor’s plan.*

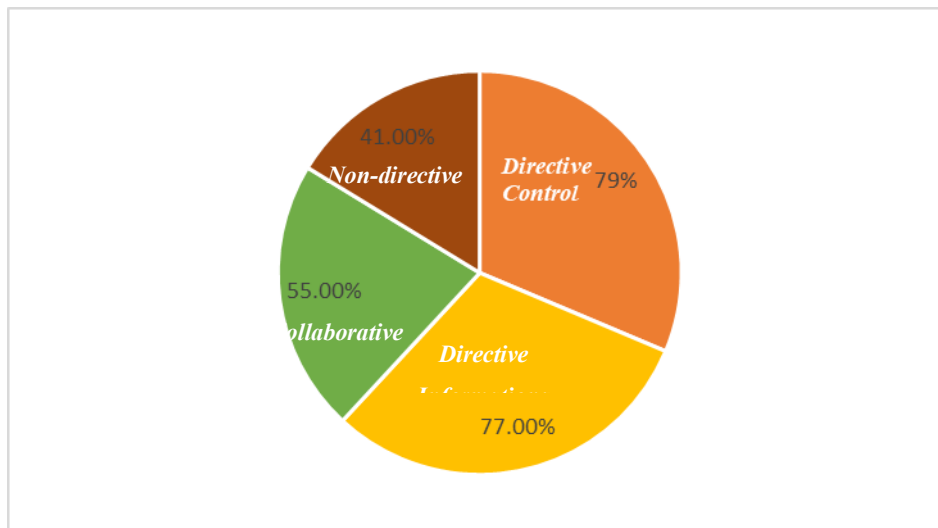
Rate your Supervisor	1	2	3	4	5	6	7	8	9	10
1=lowest	0	0	0	3	15	49	57	46	57	63
	0%	0%	0%	1.0%	5.1%	16.8%	19.6%	15.8%	19.6%	21.7%
<b>Reinforcing Behavior</b>	<b>6.1%</b>					<b>93.9%</b>				
	<b><i>M=7.9 – Percentage= 79.0%- SD=0.049</i></b>									

Table 4j suggests that 93.9% of teachers were subjected to reinforcing behaviors on behalf of their teachers; making them abide by their pre-planned roadmaps. Only 6.1% of teachers did not think they were so.

To summarize the findings from tables 4 (a-j), figure 4 displays all the 10 investigated behaviors with the corresponding percentages recorded per each. Figure 5 exemplifies the aggregated behaviors into the 4 approaches of education supervision according to Glickman et al., (1998). Both figures 4 and 5 show that directive control approach to education supervision tops the list of approaches, followed by the directive informational approach, the collaborative approach, and finally the non-directive approach which comes last.



**Figure 4. Summary of Behaviors exhibited by the Education Supervisor in the Supervisor-Teacher Relationship**



**Figure 5. Classification of Types of Education Supervision in Schools**

#### 4.4 Degree of Differentiation of Approaches to Education Supervision in Schools

The fourth part requested teachers to respond to a single item where they would judge if the supervisory approach they encountered was identical across the school or not. Findings are presented in table 5.

**Table 5: The degree Approaches to Education Supervision Are Differentiated in Schools**

Education Supervisors vary their approaches with teachers in school taking into account their years of experience, preferences, needs, abilities, etc...							
Rating	Strongly Disagree	Disagree	Agree	Strongly Agree		M	SD
Count	98	112	52	28		2.03	0.669
%	33.7%	38.6%	17.9%	9.6%		50.8%	
	72.3%		27.5%				

Table 5 shows that 72.5% of teachers reported that the approaches they previously evaluated (Tables 4-J) of education supervisors were static; meaning that were homogeneous across the school despite the experience of teachers, their preferences, abilities, needs, etc... This is a relatively high figure and suggests that no differentiation of educational supervision approaches is in place.

## 5. Conclusion

This study suggests that the predominant approaches of educational supervision are mainly directive control and directive informational. Collaborative and non-directive approaches to education supervision do not seem to be quite popular. This is quite alarming because it entails that the practices in schools fall into a low level of teacher activity as prescribed by Glickman (1998) continuum of behaviors and corresponding approaches to supervision. The scene is further worsened by the fact that the adopted approaches do not seem to be malleable and responsive to the contextual needs of teachers in schools. For education supervision to be effective, it needs to be differentiated and individualized to meet the needs of

teachers (Chien-chin, 2018). Given the authoritative approach of supervision and its rigidity; it is no wonder what teachers reported a lack of satisfaction pertaining to their experiences with education supervision in their schools.

## 6. Limitations & Recommendations

This study is limited by the sample size where by only 29 free-private schools in Beirut out of 85 took part in it. So the degree of generalizability might be questionable. Besides, the study considered the perspective of teachers only. It is recommended to investigate the perspectives of education supervisors themselves as well. In addition, the investigation would be highly enriched by a qualitative dimension such as qualitative interviewing or observation. These would allow for gaining deep empathetic understanding of the concept being explored.

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# Information Communication and Technology; The Millennium Tool for Entrepreneurial Empowerment of Women

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## Abstract

*This paper is focused on Information Communication Technology as the millennium tool for Entrepreneurial Empowerment of women. It also highlighted the diversity of information communication and technology, indicators of empowerment. Little success has been achieved in the empowerment of women in Nigeria despite efforts of government and public organisations. This paper identified information communication technology as the missing-link in the education enterprise that should be giving a priority in order to achieve the desired success in the entrepreneurial empowerment of women in Nigeria. The writer recommends among others that there should be public-private partnership to make possible innovative approach in the training of women entrepreneurs in ICT through the sponsoring of e-learning initiatives or peer-peer informal learning strategies for women entrepreneurs.*

**KEYWORDS:** Information communication and technology (ICT), entrepreneur, empowerment, women empowerment.

## Introduction

In this new age, it is an obvious fact that women empowerment is a key to national development. As a result many countries are focussing on women by investing heavily in their education, skill development, health and their leadership training. Nigeria can not be left behind especially as a developing country where women constitute majority of the overall population. One of the major steps to achieve this dream is through entrepreneurial education. This involves the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as equipment for the individual to live and contributes to the development of the society. Entrepreneurial empowerment of women is a veritable tool for national development and transformation. This position is supported by (Olagunju, (2004): Ikechi and Edward, (2009) when they asserted that entrepreneurship act as a tool for income generation, raising productivity through innovation, facilitating the transfer of technology, playing key role in commercialising new products, redistribution of wealth and income, ensuring foreign exchanges and promoting social welfare. From the foregoing, the entrepreneur is the chief coordinator and organiser of the production process.

## **Concept of Information Communication and Technology (ICT).**

The term, information communication and technology, is used in different ways by different people. To some, it denotes the development of devices and systems and their application in the collection, generation, communication, recording, re-arrangement and exploitation of information. By this definition, information communication and technology includes all applications and commodities ever invented by man by which information is transferred, recorded, edited, stored, manipulated or disseminated (Groneman 1995). Though some modern authors view information communication and technology as limited to the application of recently invented computer and telecommunication technologies to capture, storage and dissemination of vocal, pictorial, textual and numerical information, Harrod, (1987); Javis, 1990), it is clear that its realms transcend just these recent inventions. Igbinoba (2005) defined ICT as the use of skill in combining information and communication process and devices to obtain, analyse, store, recall and transmit accurate information from one place to another at a very high speed. Orimolade (1999) cited in Ayeni (2005) defined ICT as the use of computers and telecommunication gadgets in information processing. Adebajo and Adebayo (2008) perceived ICT to be technological facilities that are used to receive, transmit, create, store and retrieve information. On the other hand, information communication and technology (ICT) is defined as a diverse set of tools and resources used to communicate, create, disseminate, store and manage information.

According to Okpara (2004), information communication and technology is the science of creating, collating, storing, and processing, utilising and disseminating data. Today, there is increasing interest in how computers and internet can improve education at all levels, in both formal and non-formal settings. Older ICTs such as radio and Television have for over forty years been used for open and distance learning, although print remains the cheapest, most accessible and therefore the most instructional delivery mechanism in both developed and developing countries. Information communication and technology (ICT) can be seen as the means of combining electronic and telecommunication devices to retrieve, analyse, create, store, recall and transmit information.

## **Meaning of Empowerment**

There is no universally acceptable definition of empowerment. Empowerment is a construct shared by many disciplines and areas; community development, psychology, education, economics, and studies of social movements and organisations, among others. In recent empowerment literature, the meaning of the term empowerment is also assumed rather than explained or defined. According to Rapport (1984), it is easy to define empowerment by its absence but difficult to define in action as it takes on different forms in different people and contexts. Zimmerman (1984) has noted that asserting a single definition of empowerment may make attempts to achieve its formulaic or prescription like contradicting the very concept of empowerment. According to Bailey (1992), empowerment is a multi-dimensional social process that helps people gain control over their own lives. It is a process that foster power (that is, the capacity to implement) in people for use in their own lives, their communities, and their society, by acting on issues that they define as important. These three components of the above definitions are basic to any understanding of empowerment.

Empowerment is a multi-dimensional social process. It is multi-dimensional in that it occurs within sociological, psychological, economic, and other dimensions. Empowerment also occurs at various levels, such as individual, group and community. Since it occurs in relationship to others, it is a process that is similar to a path or journey, one that develops as we work through it. Empowerment is a process of increasing the assets and capabilities of individuals or groups to make purposive choices and to transform those choices into desired actions and outcomes. Empowered people have freedom of choice and action. This in turn enables them to better influence the course of their lives and the decisions which affect them Eduwen, (2014).

In actual fact, empowerment speaks to self-determined change. It connotes bringing together the supply and demand sides of development, changing the environment within which poor people live and helping them build and capitalize on their attributes, from education and health care to governance and economic policy and activities which seeks to empower poor people and are expected to increase development opportunities, enhance development outcomes and improve people's quality of life.

## **What is women empowerment?**

Women empowerment simply implies giving opportunities to women who were originally, excluded from participation in matters that impacts on their welfare. This entails enabling women to perceive them as having the capacity and the right to influence their decision area. Moser (1989) defined women empowerment as the capacity of women to increase their own self reliance and internal strength, the right to determine choices in life and to influence the direction of change through the ability to gain control over material and non-material resources. Bakari (2001) stated that in the light of Moser's definition of women empowerment, it is important to note that the process of women's empowerment embraces areas of self-reliance, internal strength and capacity that entail the social, economic as well as political aspects of women's lives. Women must feel that they are able rather than unable to effectively participate in the issues that impact on their lives. From the foregoing, it is very clear that women empowerment is a deliberate policy of making women aware of their situation through raising their consciousness to determine their destiny in life.

Again, women empowerment is best defined as the expansion of agency throughout women's lives so that they become self-reliant, and a bridge to social change and community connectedness. It is on record that government at all levels including Federal, State, Local, International government agencies and non-profit community based organisations created programmes centred on women empowerment. Hence, with women empowerment the future prosperity of nations is guaranteed because these are people that would be actively involved in the economy, handle many offices and functions in government and even invest in our youths who are leaders of tomorrow.

## **Indicators of empowerment**

The indicators of empowerment are multifaceted. According to Bookman and Morgan (1984), some indicators of empowerment are as follows:

1. Confidence and understanding: example of people taking on new

responsibility, chairing meetings, organising events and initiating new activities, keeping clear records and good accounts or the level of contact with local officials concerning issues which are of concern/interest to the local community.

2. Skills in analysis and communication: development and refinement of group aims and objectives, meeting the officials and talking to local schools, letter writing, and contribution to local group newsletters, preparation of group strategies and action plans.
3. Trust, caring and tolerance: evidence of the delegation of responsibility within the group; initiative by the group to involve/contact disadvantaged and vulnerable people in the community, initiatives that encourage open debate and represent minority interest, providing additional facilities for members of the community e.g. organising regular breast cancer screening or visit by specialist in health care, youth work, planning law or community development.
4. Communication and cooperation: attendance at meetings, local group newsletters, telephone trees established for alerting members to important events/developments, evidence of links developing between villages/communities, new joint ventures and,
5. Access to information: acquisition of materials on group development, running small business, legislation etc perhaps held in the local library or resource centre; development of a database of contacts; and use made of the internet.

However, some of the indicators of empowerment can be summarised below:

1. Gaining access to education right from primary to tertiary levels.
2. Ability to aspire to political positions of authority in both government and private sector.
3. Freedom of association and contribution to issues of national discourse.
4. Empowered and skilled women that contributed to national development.
5. Less dependability on government by women for employment.
6. Initiative to mobilise women and youths for development.
7. Contribution to nation building through participation in civic activities, formation of NGOs, and fighting for the oppressed in the society.
8. Access to justice and legal aid.
9. Accountability and transparent honesty in governance.
10. Direct access to information Eduwen (2014).

## **Relevance of women empowerment**

It is obvious that a number of benefits are derivable from women empowerment taking into cognizance the indicator of women empowerment. Below are some of these benefits:

1. Security: With women empowerment, the spirit of patriotism will increase in

them and become security conscious in the affairs of the nation. Today, the armed forces of many nations are made up of women because they have been empowered. Empowered women are useful for information gathering, intelligence reports and protection of citizens.

2. Growth of entrepreneurs: Women empowerment facilitates the growth of entrepreneurs in the country. Thus women entrepreneurs are individuals that mobilise resources to achieve desirable results. They constitute the core of the private sector that drives the economy of the nation towards national development. Buttressing the above, Igbokwe (2006) asserted that the strength of the American economy is largely due to the contributions of its private entrepreneurs. Essential lessons to be derived from this assertion in Nigeria are as follows:
  - a. The private sector, not government drives the economy.
  - b. The giants grew from rags to riches.
  - c. They had good managerial skills
  - d. They hired the best of staff and keep operational cost low.
  - e. They were meticulous, hardworking and risk-takers.
  - f. They all had passion and true talent for their work.
  - g. They do not allow constraint to dominate their opportunities.
3. Technological development: Women empowerment facilitates technological development. Important discoveries in community and other sectors of the economy is made possible because women are empowered. There is no gain saying that empowered women create something different with value by devoting the necessary time and effort, assuming the accompanying financial, psychic and social risk, and receiving the resulting rewards of monetary and personnel satisfaction.
4. Poverty eradication: Women empowerment assists in the reduction of poverty among nations. When women are empowered financially, they invest in different businesses that generate profit to sustain the family, assist other relations who are poor and invest for future development.
5. Good governance: Good governance is achievable with women empowerment. The empowered women would do everything possible not to betray the confidence reposed in them during training, and transfer the leadership skills to leadership positions in the society. Again, with women empowerment on leadership, corruption and embezzlement of public funds by top officials of government and managers of industries will be grossly reduced if not totally eradicated.
6. Crime reduction: Crime is a barrier to national development. A number of people including women are involved in crime because they are not empowered. Therefore, any nation that is desirous of crime prevention and control should

invest massively in women empowerment. The basic fact is that if women are taught the evils and consequences of crime, there is every tendency that they will shun the unwholesome act. In essence, the empowerment of women should be seen as a priority to check crime in the society.

7. Good standard of education: A major problem facing many nations today is the failure to invest in the education of the women. The empowered women can contribute to the growth of education sector by donating generously to educational facilities in primary, secondary and tertiary institutions that are begging for the attention of the government. In addition, the women who are empowered academically accelerates the spirit of patriotism, award scholarship to students and be appointees of government into political positions.

## **Empowerment Strategies for Women**

There are a number of women empowerment strategies that have been put in place by government, private individuals, international organisations and the civil society. According to United Nations Research Institute for Social Development (2010), there are seven strategies priorities necessary for women empowerment. These seven inter-dependent priorities are the minimum necessary to empower women and alter the historical legacy of female disadvantages that remains in most societies of the world;

1. Strengthen opportunities for post primary education for girls while simultaneously meeting commitments to universal primary education.
2. Guarantee sexual and reproductive health and rights.
3. Invest in infrastructure to reduce women and girls burden.
4. Guarantee women's and girls' property and inheritance rights.
5. Eliminate gender inequality in empowerment by decreasing women reliance on informal empowerment, closing gender gaps in earning and reducing occupational segregation.
6. Increase women's share of seats in national parliaments and local government bodies.
7. Combat violence against girls and women.

Jokes (1997) is of the view that women empowerment should focus on three key intervention areas; i.e. increasing girls access to education, increasing women access to economic resources, and increasing access to and the quality of reproductive health services. Furthermore, women empowerment can be achieved through the following ways:

- a. Create Public Avenue where women can voice their opinions and be heard.
- b. Win over local community leaders in order to promote gender equality.
- c. Use men as ambassadors to advocate for women rights.
- d. Inform women about means of public participations in respect of how to obtain a job, information about colleges and their programmes investment opportunities and legal aid.

- e. Focus on removing exploitation, suppression and the general mobilization bias in other to enable women express their interests in the decision making process.
- f. Invest heavily in the education of the girl-child from primary to tertiary institution.
- g. Counsel parents not to compel their girls into early marriage.

Over the years, government has introduced a number of women empowerment strategies. According to Abdulganiy (2012), selected economic policies geared towards entrepreneurial empowerment in Nigeria are shown in the table below:

### Selected Economic Policies Geared Towards Entrepreneurial Empowerment

S/N	Programmes	Objectives
1	Agricultural Development Programmes (ADP)	The main purpose of the ADP is to stimulate increased food production and enhance the income of the rural population.
2	National Directorate of Employment (NDE).	Responsible for vocational skills development and small scale enterprises programme designed to combat unemployment.
3	National Economic Reconstruction Funds (NERFUND).	Provides long-term loans at concessnaire interest rates to promote small and medium scale industries projects.
4	Family Economic Advancement Programmes (FEAP).	Established to provide micro-credit facilities for entrepreneurs.
5	Micro finance Bank and Community Bank Programme.	Designed to make banking services more accessible and extend credit to the poor.
6	Better Life Programme/Family Support Programme (BLP/FSP).	Aimed at providing micro-credit facilities for women entrepreneurs.
7	National Poverty Eradication Programme (NAPEP)	Aimed at providing vocational skill development and small scale enterprises programmes designed to combat unemployment.
8	National Empowerment and Economic Development Strategy (NEEDS).	To eradicate poverty and unemployment.
9	Youth Enterprise with Innovation (YOUWIN).	Business plan competition aimed at job creation by encouraging and supporting aspiring entrepreneurial youth in Nigeria to develop and execute business plans.
10	Subsidy Reinvestment and Empowerment Programme (SURE-P).	Aimed at empowering youths and women to check poverty and unemployment.

Source: Abimbola (2007)

Youwin is added to the table as an update by Abdulganiy (2012).

Sure-P is added to the table as an update by Eduwen (2014).

In the same vein Bakari (1998), asserted that a lot of policies and programmes have been adopted as a means through which women empowerment can be achieved. These include the “Better Life for Rural Women” and the “Family Support Programme” initiatives. Other efforts include the creation of Ministry for Women Affairs at the Federal and State levels.

## Importance of Information Communication and Technology for Women

### Empowerment

It is obvious that women need information communication and technology in the process of their daily activities and adjustment to life situations. However, it is very sad to note that inspite of various policies and programmes aimed at women empowerment in Nigeria, little success have been achieved. A

major factor responsible for this failure is the lack of awareness and the need to embrace the use of information communication and technology as a veritable tool for women empowerment.

Information communication technology is highly necessary in any empowerment programme, be it at the local, state and especially at the federal level. This is because it is very crucial to educate the would-be- entrepreneur on how to manage entrepreneurial resources at their disposal; to charge in them to develop an entrepreneurial mindset and to give them orientation to uncover the trick and dynamics of entrepreneurship. Information communication technology can facilitate the empowerment of women in the internet activities through individual and group counselling. The growing access of the web in the late 20<sup>th</sup> century have allowed women to empower themselves by using various tools in the internet. With the introduction of the World Wide Web, women have begun to use social networking sites like Facebook and Tweeter to start online activism (Sutton & Pollock, 2000).

Information communication technology can amplify women and girls opportunities in education and employment and can bring greater access to health services. Women and girls embrace of technology creates benefits to their lives, the lives of their family and their community. It can also help women to succeed in all areas of their lives including education, business, carrier, politics and health. It can improve mobility, save time and enable collaboration which is the key for the lives of millions of women across the world.

Information communication technology helps in the collection and analysis of sex disaggregation data that can contribute to a better understanding of the needs, opportunities and the challenges of women and girls in a knowledge society. It can also have the potentials to provide services for women and girls, especially for those living in the remote areas.

## Conclusion

Information communication technologies have come to stay. There is no doubt that women empowerment is crucial to national development especially in the developing countries where women constitute majority of the overall population. Adult educator should embark on information communication technology programmes of enlightenment and orientation of parents, teachers, students and government to develop positive attitude towards the education of women right from primary school to tertiary institutions. This will increase women's capacity to be active participants in politics and question the wrong notion that women are inferior to men in the society. A proper use of information communication and technology for women empowerment should focus on health, vocational skills, agriculture, education, home rearing practices, education and leadership training for self-reliance and self- actualisation.

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## How to compare energy efficiency inspection tests on TVs?

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### Abstract

*It is a case study conducted in company X of the electronic branch located in the Industrial Pole of Manaus (PIM), the capital of Amazonas–Brazil. The problem was the need to develop a benchmarking involving energy efficiency inspection tests on televisions. The objective is to compare the performance of the standard method and the new method of performing the energy efficiency inspection test. To this end, quality tools were applied with data collected from the use of the time study of each test step. After data collection and analysis, it was concluded that the new test: a) has 67% of its steps performed automatically and 43% manually, its average lead time is 4h14min34, a gain of 33.5% in total time required to perform the test; b) can be developed with the application of Brainstorming, Ishikawa Diagram, GUT Matrix, PDCA, Vertical Flowchart in conjunction with Chrono-analysis. It is worth highlighting the importance of the local top management support so that each of these tools is used with autonomy and creativity by the collaborators involved in the project.*

**Keywords:** Energy efficiency; Inspection tests; Quality Tools;

### 1. Introduction

The Manaus Industrial Pole (PIM) is located in the State of Amazonas (Brazil) and has three economic poles: commercial, industrial and agricultural, with the industrial pole being its base of support. PIM has about 600 high-tech companies creating more than half a million direct and indirect jobs, mainly in the electronics, two-wheel and chemical segments (SUFRAMA, 2016). PIM concentrates some of the largest and most important electronics manufacturers in Brazil. The electronics sector is the largest employer of laborer and receives the most investments among all segments.

According to data from the Manaus Free Trade Zone Supervisor (SUFRAMA), 46 companies are responsible for the electronics production that involves more than 27,000 employees (SUFRAMA, 2015), primarily mobile phones, audio, and video devices, as well as televisions, etc. Among the electronics companies, this study was conducted in an organization responsible for producing tablets, smartphones, media players, video cameras, computer monitors, televisions and appliances.

For private reasons, the organization in question will be named as Company X and the study took place in June 2016 in the quality assurance sector, responsible for performing reliability tests on televisions, before and after being introduced into the market.

However, it focused on one of the reliability tests, the energy efficiency verification test, considered

relevant both to guide customers and televisions to receive Inmetro's National Energy Conservation Label (ENCE), the Procel Seal that ranks products according to energy consumption and/or energy efficiency, measured in kWh/month.

### 1.1 Problem formulation

The Energy Efficiency Inspection Test on televisions, conducted manually at Company X, was not reaching the high volume of new television models to be inspected, leading to delays in completing the reliability tests. Given this scenario, senior management opted in July 2015 to automate the energy efficiency inspection test on televisions to make it more efficient in facing the volume of televisions to be inspected.

This required investments in new equipment, training of employees, proper space for testing and installation of equipment. Since the implementation of the new inspection test (January 2016), no studies had been conducted to measure the efficiency of the new test, comparing it with the previous one.

So, the main question of the research is “how to analyze the efficiency of a new inspection test method aimed to reach the increase in TV set production volume?”

To this end, a bibliographic study on the quality tools was performed, as well as quantitative considering the time variable as the object of research, both for the old and the new inspection test, since the collection of the execution time of each method operations.

### 1.2 Importance of Research

At the time the study was being designed, data from the 25th Annual Survey on the Use of Information Technology (FGV, 2014) were used to identify that in 2013, 97% of the Brazilian population (Table 1) had a television in its residence, above worldwide average (72%).

Table 1 - Consumer electro-electronics and appliances in Brazilian households (value in millions).

PRODUCT	2007		2008		2009		2011		2012		2013	
<b>Stove</b>	55,282	99,9%	56,541	98,2%	57,638	98,4%	60,447	98,8%	62,063	98,75%	64,323	98,76%
<b>Television</b>	53,218	96,2%	54,753	95,1%	56,043	95,7%	59,381	96,9%	61,092	97,20%	63,281	97,16%
<b>Refrigerators</b>	51,158	92,4%	52,989	92,1%	54,716	93,4%	58,690	95,8%	60,744	96,65%	63,315	97,21%
<b>Radio</b>	49,641	89,7%	51,173	88,9%	51,466	87,9%	51,135	83,4%	50,821	80,86%	49,311	75,71%
<b>Washing machine</b>	22,259	40,2%	23,899	41,5%	25,968	44,3%	31,250	51%	34,654	55,14%	37,421	57,46%
<b>Freezer</b>	9,188	16,6%	9,236	16%	8,919	15,2%	10,077	16,4%	10,460	16,66%	11,103	17,05%

Source: FGV (2014).

Analyzing the evolution of the numbers in Table 1 for the year 2019, in May 2019 (FGV, 2019 p. 7) the percentage of households with TV was 119%, while the world average was 91%. Given the above, there is a need for companies to increasingly present products with high-quality standards to meet the demands of customers and regulatory agencies, focusing on continuous improvement of processes and products.

Thus, to remain competitive, Company X realized the need to improve the efficiency inspection test on televisions, which is why this study is relevant because it seeks to complement the investments made by comparing the performance of two methods of performing the television inspection test to simplify

processes, reduce lead time and increase the capacity of inspection samples. The research is relevant to the academy, as it offers a case study involving the use of quality tools in conjunction with the scientific methodology, whose knowledge generated can serve for the reflection of interested researchers on the subject, as well as for teachers for discussion in the classroom. For customers, the research contributes to guarantee the quality standard, by inspecting the energy consumption values of televisions in a more thorough and agile way. For the environment, it has its importance, as it reduces energy consumption in Brazil, minimizing environmental impacts and promoting the rational use of energy.

### **1.3 Objectives**

The overall objective is to compare the performance of two methods (standard and experimental) for performing the energy efficiency inspection test on televisions.

The specific objectives are:

- (a) to diagnose the performance of the standard inspection test used to estimate energy efficiency on televisions in the quality assurance sector;
- b) to analyze the performance of the experimental (new) energy efficiency inspection test on televisions applied in the quality assurance sector;
- c) to identify the positive points acquired as a consequence of the automation of the experimental inspection test, as well as propose the suggestion of new research for the academy and managers of the organization.

## **2. Theoretical Referential**

### **2.1 Regulatory Agencies**

Brazil has several institutions that regularly deal with energy efficiency, such as:

- Ministry of Mines and Energy (MME);
- ELETROBRÁS, responsible for the execution of the National Program for Conservation of Electric Energy (PROCEL);
- PETROBRÁS, responsible for the execution of the National Program for the Rationalization of the Use of Oil and Natural Gas Derivatives (CONCEP);
- National Agency of Electric Energy (ANEEL), responsible for the performance of the Energy Efficiency Program of the Electricity Distribution Concessionaires (PEE);
- The distribution concessionaires;
- National Institute of Metrology, Standardization and Industrial Quality (INMETRO), responsible for the achievement of the Brazilian Labeling Program (PBE).

In addition to these institutions, there are also industrial companies that have internal energy conservation programs. Others deal with the theme transversely or even sporadically. However, for this research, the INMETRO regulatory agency will be emphasized, more specifically for being responsible for the PBE.

### **2.2 INMETRO and PBE**

INMETRO is a federal agency, linked to the Ministry of Development, Industry and Foreign Trade,

which acts as Executive Secretariat of the National Council of Metrology, Standardization and Industrial Quality (CONMETRO), inter-ministerial collegiate, which is the normative agency of the National Metrology System, Standardization and Industrial Quality (SINMETRO). In its institutional mission, INMETRO aims to strengthen national companies, increasing their productivity through the adoption of mechanisms aimed at improving the quality of products and services. Its mission is to provide Brazilian society with confidence in measurements and products through metrology and conformity assessment, promoting the harmonization of consumer relations, innovation, and the country's competitiveness.

The Brazilian Labeling Program (PBE) is a performance labeling program coordinated by INMETRO. The PBE emerged from an initiative by INMETRO with society to create performance-focused conformity assessment programs to contribute to the rationalization of energy use in Brazil by providing information about the energy efficiency of the equipment available in the market. Therefore, there are conformity assessment programs that use the National Energy Conservation Label to provide information on product performance concerning energy efficiency (VIANA et al., 2012).

According to Viana et al. (2012), the objectives of the PBE are:

- Provide useful information that influences consumers' purchasing decisions, which may take into account other attributes than the price at the time of product purchase;
- Stimulate industry competitiveness by inducing the process of continuous improvement promoted by conscious consumer choice.

Products are subjected to laboratory testing, where they receive labels that differentiate them by the efficiency rating from “A” (most efficient) to least efficient “G” depending on the product.

### **2.3 Energy efficiency label**

The energy efficiency label is the seal of conformity that evidences the fulfillment of the performance requirements established by the technical norms and regulations, being this one of the product entry points to the sales points. Its main purpose is to inform consumers when buying the characteristics of appliances using the efficiency rating to identify the most and least efficient.

Each appliance line has its label, changing according to the technical characteristics of each product. For televisions, the rating ranges from A (most efficient) to E (least efficient). Figure 1 is an example of a standard label for televisions. It contains the Manufacturer Name (Nome do fabricante), equipment type (tipo de equipamento), logo, Energy Efficiency Indication (indicação da eficiência energética), Model, Screen Size in cm (tamanho da tela em cm), Screen Size in inch (tamanho da tela em polegada), Energy Consumption Indication in kWh/month (consumo de energia em kWh/mês).

### **2.4 Energy efficiency (EE)**

Because of the 1970s's oil crises, several countries sought to find other ways to generate and conserve energy. However, the issue involving EE becomes relevant in the 1990s because of the greenhouse effect, widely debated at international events as Stockholm Conference 1972; Rio 92, Rio +10 (MENKES, 2004 p. 1).

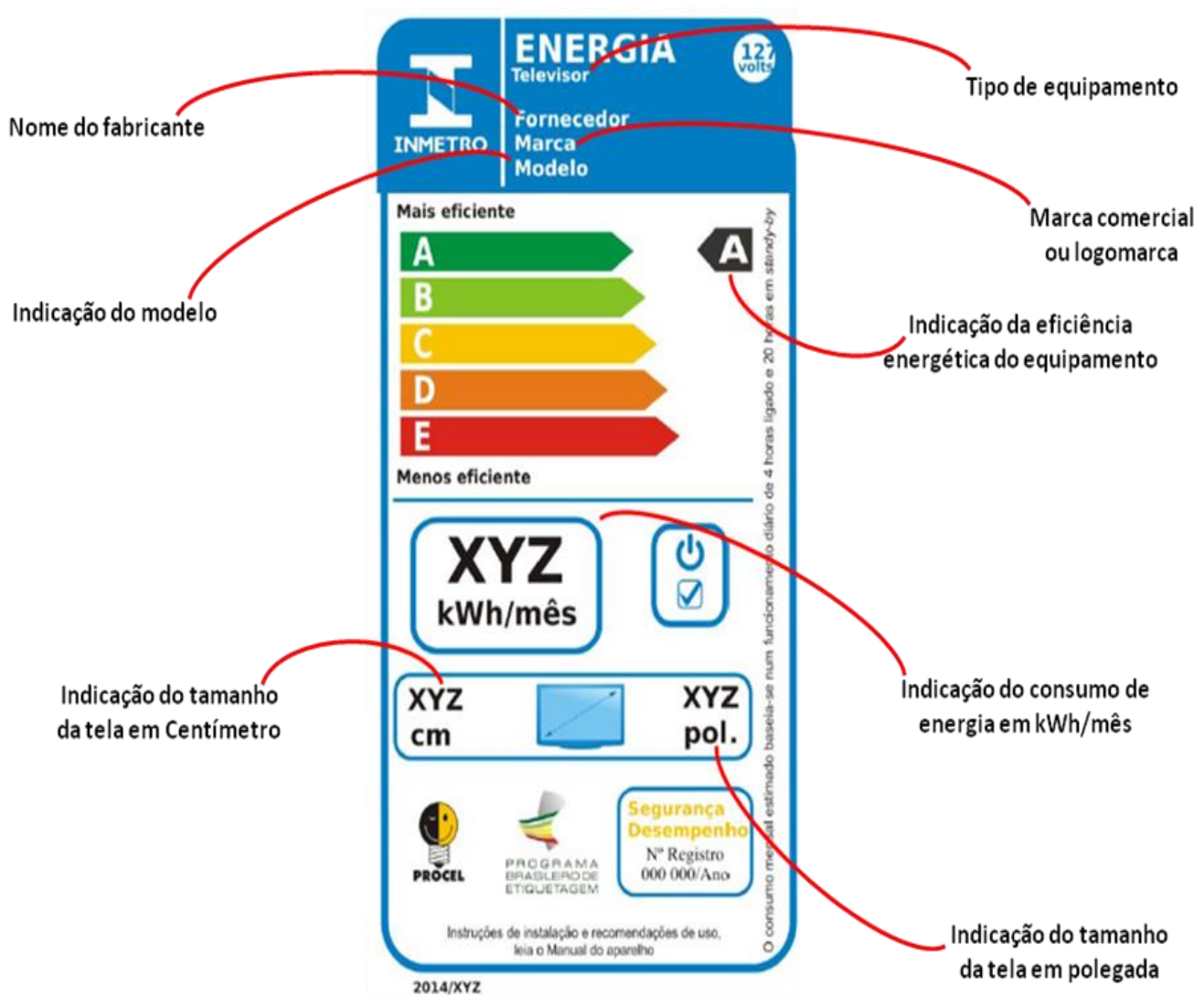


Figure 1 - Energy Efficiency Standard Label of televisions in Brazil

Source: Adapted from Portaria n.º 563 – INMETRO (2014).

According to the US National Policy Development Group, EE is the ability to use less energy to produce the same amount of lighting, heating, transportation and other energy-based services.

For the Brazilian Association of Energy Conservation Service Companies (ABESCO), EE is an activity that seeks to improve the use of energy sources, trying to do more with less. EE comes from the relationship between the amount of energy employed in an activity and that which is available for its performance.

Some authors believe that EE can be used as one of the best policies to be adopted by countries to reduce the greenhouse effect and contribute to the economy (CALILI; SOUZA, 2013 p.85).

Based on the previous definitions, the concept adopted about EE in this research is the optimization of the use of the electric power supplied to reduce the waste and still obtain a great performance of the appliance.

## 2.5 Quality

It may not be important to have a universal definition of the term quality, but it is important to understand it, regardless of the industry in which it operates, since quality is fundamental for companies, not only because of the offer of good products and services but also due to the continuous improvement of their production processes (ALGARTE, 2000).

Kotler (2000) says that, according to the American Society for Quality Control, quality is the totality of attributes and characteristics of a product or service that affect its ability to satisfy stated or implied needs.

In summary, there are several concepts of quality in the literature, some famous for the spread of various gurus:

For Deming, quality means satisfying customers now and in the future; for Juran, it means suitability for use or conformance to specifications, while Crosby defined quality as an adaptation to the requirements; Ishikawa believed that quality is an opportunity for continuous improvement, while Feigenbaum focused on total quality involving all sectors of the organization, Taguchi saw quality as a value for society (HASSAN et. al., 2000).

The term quality has been used in many situations and has evolved following administrative thinking over time, so each company must reflect and adopt its concept, the most appropriate tools and methodologies for your reality. Regarding the classification of the use of quality tools with some methodologies used in quality management, it is recommended to read the article “Basic Quality Tools in Continuous Improvement Process” written by Sokovic et al. (2009).

This article present the use of the 7 quality tools (Figures 2, 3 and Table 2) in the process of problem identification and analysis, as well as in three methodologies used for continuous improvement such as PDCA-Cycle, DMAIC and DMADV.

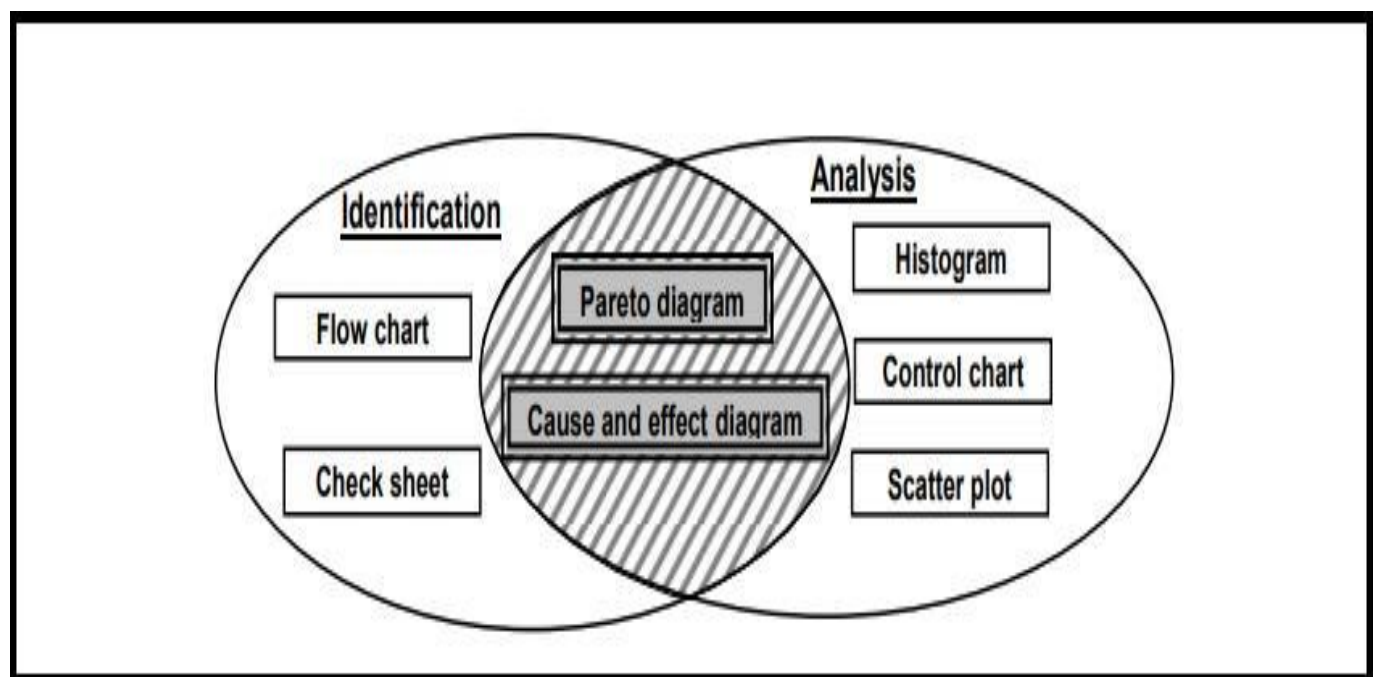


Figure 2 – Use of 7 quality tools in the process of identify and problems analysis.

Source: Sokovic et al. (2009 p. 2)



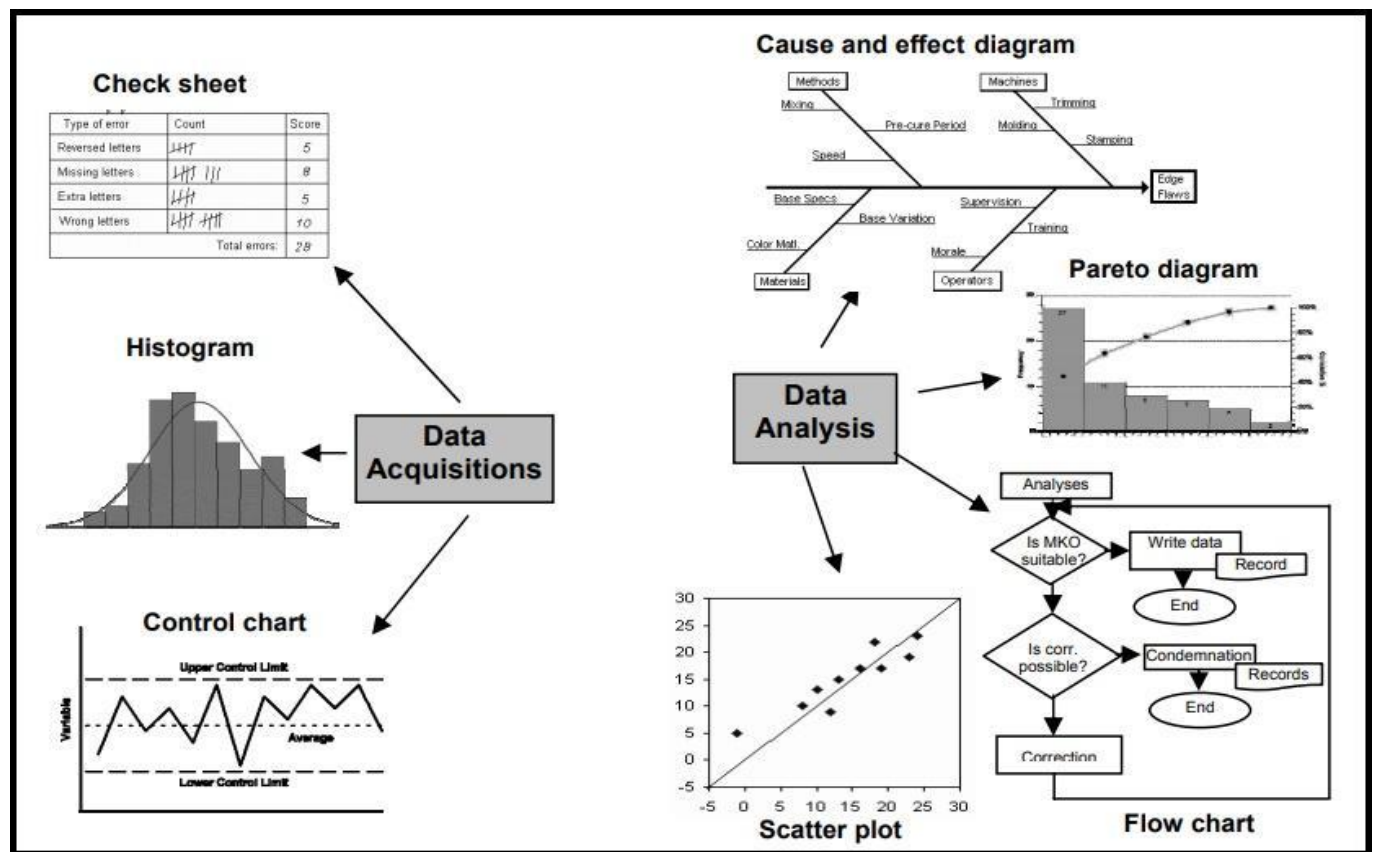


Figure 3 – The 7 traditional quality tools for data acquisition and analysis

Source: Sokovic et al. (2009 p. 3)

Methodology	Continuous improvement (PDCA-cycle)							Six Sigma (DMAIC)					Design for Six Sigma (DMADV)				
	Identify opportunity	Analyze the process	Develop solutions	Implement solutions	Evaluate results	Standardize solutions	Plan for the future	Define	Measure	Analyze	Improve	Control	Define	Measure	Analyze	Design	Verify
<b>7 QC tools</b>																	
Cause-and-Effect diagram		x								x				X			
Control chart			x		X				x		x	x				x	x
Check sheet	x												x				
Histogram	x								x				x				
Pareto diagram					X				x		x		x	X			x
Scatter diagram		x			X					x		x		X			
Flowchart																	
• Deployment flowchart	x	x	x			x							x				
• Linear or activity flowchart	x	x	x			x							x				
• Opportunity flowchart		x	x			x							x				

Table 2 – Application of quality tools in 3 continuous improvement methodologies

Fonte: Sokovic et al. (2009 p. 7)

The concept of continuous improvement was a cornerstone of the Eastern quality model, with the systematic use of the PDCA cycle (Plan, Do, Check, Action), created by Dr. Walter Shewhart in the 1920s and disseminated by Dr. Edward Deming during the reconstruction of Japan, which became known as the organizational learning cycle.

In summary, the PDCA represents the problem-solving cycle, used to perform stepwise improvements and repeat the cycle several times (SHIBA, 1997). According to Werkema (1995), the PDCA cycle is a management method that represents the path to be followed so that the established goals can be achieved. In the use of the method, it is necessary to employ several tools, it may constitute the necessary resources for the collection, processing and administration of the information necessary to conduct the PDCA steps.

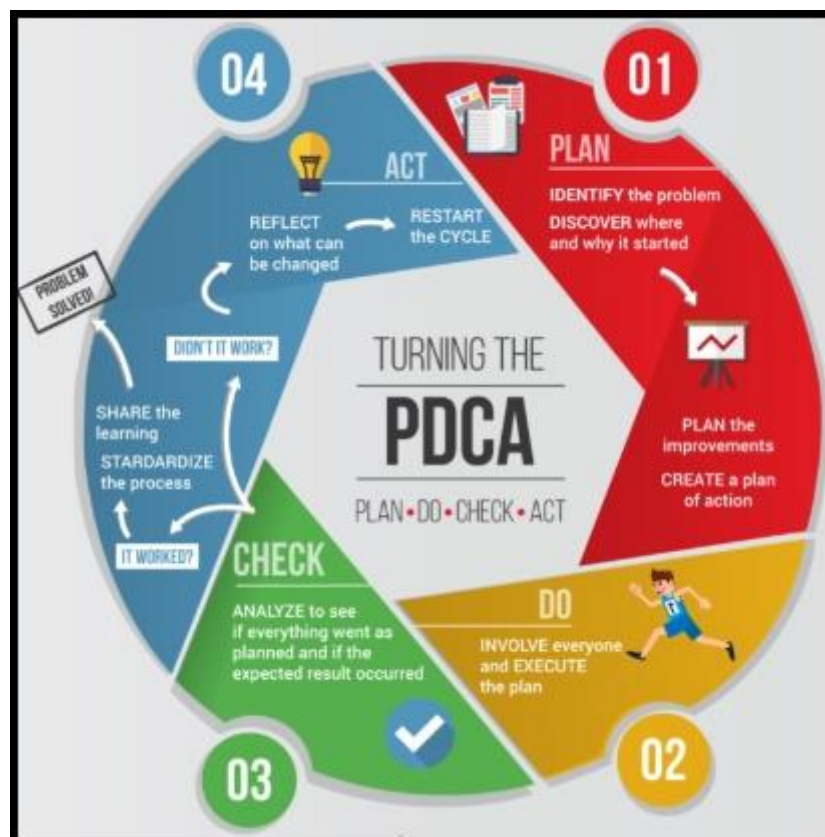


Figure 4 – Ciclo de Aprendizagem Organizacional PDCA

Source: Siteware < <https://www.siteware.com.br/en> >

The organizational learning happens when the cycle rotates over time with a series of actions involving clearly defining the problem, goal, plan building, plan implementation, training, delegation of responsibility, resource allocation, development of structures, definition of indicators, evaluation of results, standardization and dissemination of documents and good practices, correction plan, etc.

By completing one rotation over time, the company or team has accumulated enough experience for the next rotation, errors are reduced, and actions are performed more efficiently and effectively.

That is why PDCA is more than a tool, it is a powerful methodology in the process of continuous improvement of the organization (Figure 5), being used today with a high degree of evolution in several companies in Japan, considered the benchmark in quality.

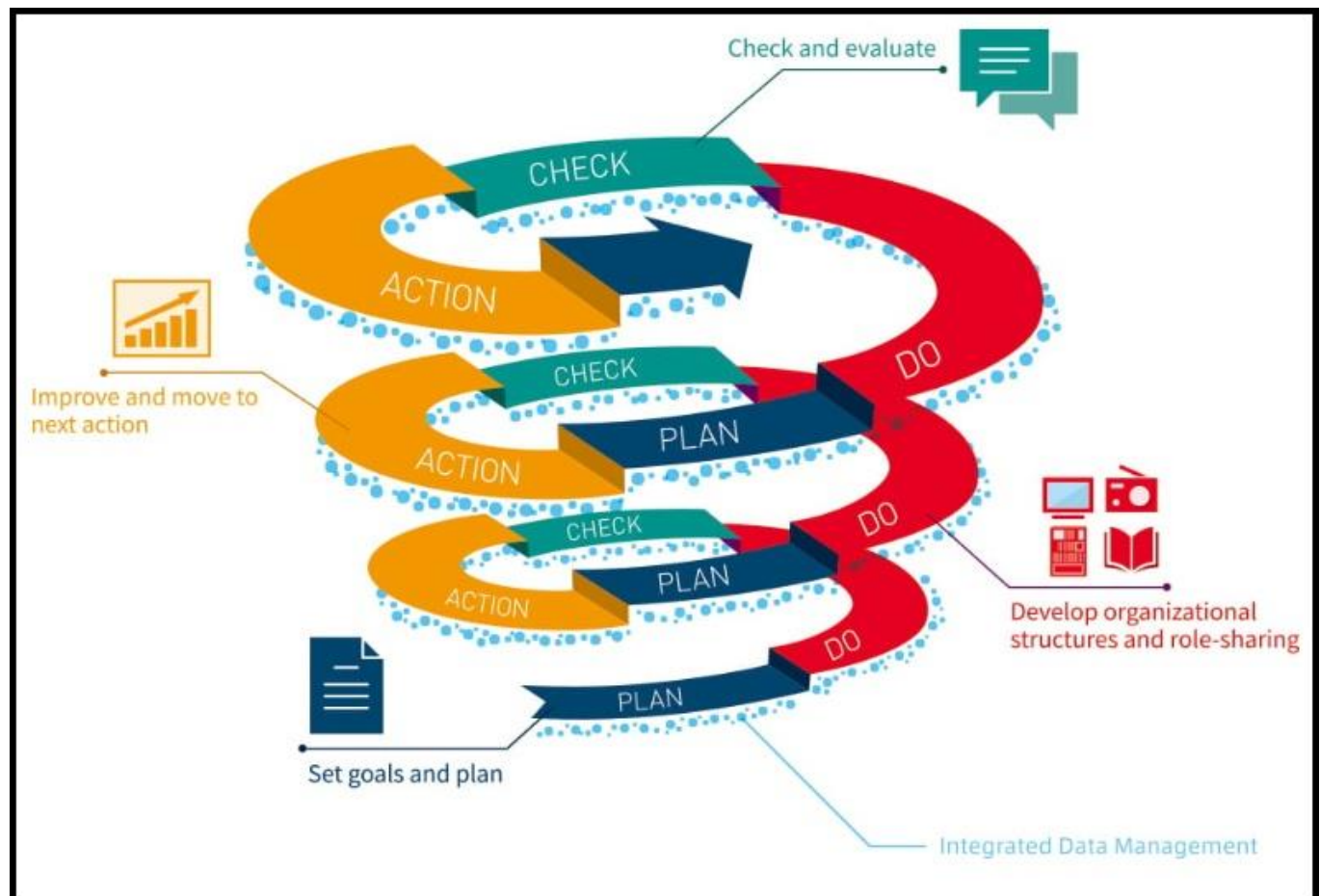


Figure 5 – Improvements promoted by the PDCA rotation

Source: Asahi advertising &lt;asakonet.co.jp&gt;

Regarding the quality tools, only the Flowchart, the GUT Matrix, and the Ishikawa Diagram will be reviewed, because of their application in this research.

### 2.5.1 Vertical Flowchart to compare process

A flowchart is a type of diagram that describes the processes. Although it is one of the most widely used tools in quality management, it is not clear who invented it, but the first records of documented standardization of flowcharts were introduced in 1921 by the Frank and Lilian Gilbreth (GILBRETH; GILBRETH, 1921) when presented to members of the American Society of Mechanical Engineers (ASME) a method called "Process Charts: First Steps in Finding the Best Way to Work."

The document with 24 pages is organized with the following topics: a) First step in finding the one best way to do work; b) Place of Process Chart in Management; c) Field of application; d) Simplicity of the process chart; e) Collecting the information; f) Utilising information; and g) Relation to standardization with symbols introduction and application (Figure 6 left side).

Besides, it is worth remembering that for the field of mathematics and electronic computing, two researchers made their contribution, Goldstine and Neumann (1947 and 1948) when they published a report at the Princeton University Institute for Advanced Studies, containing 194 pages on logical aspects and mathematicians of an electronic computing instrument (Figure 6 right side).

The preface of the report contains: 7.0 General principles of coding and flow-Diagramming; 8.0 Coding

of typical elementary problems; 9.0 Coding of problems dealing with digital character of the numbers processed by machine; 10.0 Coding of some analytical problems; 11.0 Coding of some combinatorial problem.

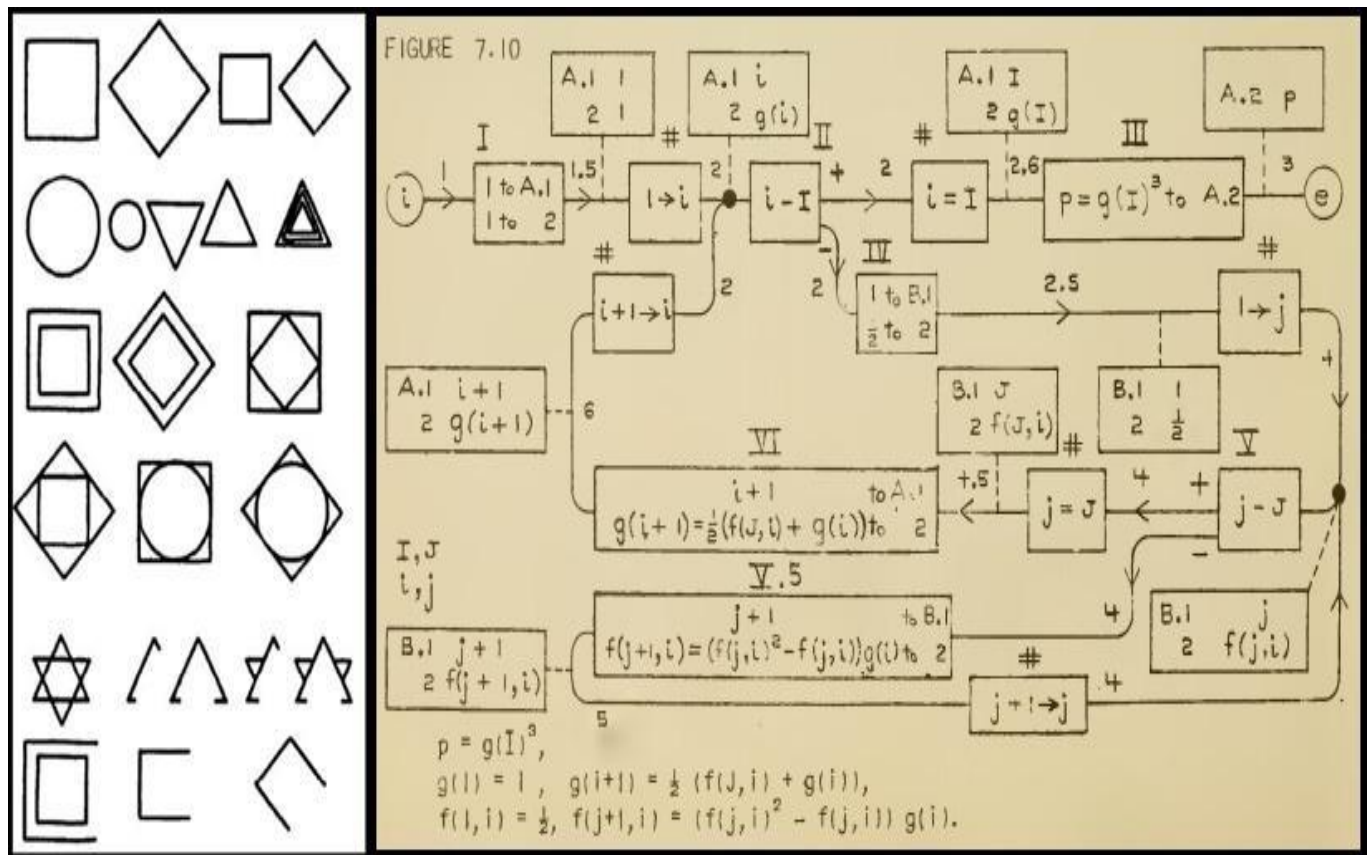


Figure 6 – Symbols examples used for Flowchart developed by Gilbreth, Goldstine and Neumann

Sources: Gilbreth and Gilbreth (1921 p.11); Goldstine and Neumann (1947 and 1948 p. 18)

Although the presentation was made in 1921, ASME only adopted the Gilbreths, Goldstine, and Newmann symbols in 1947.

However, it was from 1949 that the flowchart was used on a larger scale in companies (Figure 7) and universities when the American National Standards Institute (ANSI) set standards for flowcharts and their symbols in 1960 being revised over the years (eg ANSI X3.5, 1970), as well as the International Organization for Standardization (ISO 1028: 1973), adopted ANSI symbols in 1970, revised in 1985 (ISO 5807: 1985 replaced ANSI X3.5, 1970).

Currently, the flowchart is widely used by production managers to analyze production systems, seeking to identify opportunities to improve process efficiency (PEINADO; GRAEML, 2007).

In the market, there are several types of flowcharts, but for the purpose of this research, it is approached about the Vertical Flowchart, as it is very useful to present the basic information of the sector or department, to map processes, to connect the symbols, as well as to insert the execution time of each activity and the space traveled by the person responsible for the activity.


































	<b>Process</b>	An operation or action step.
	<b>Terminator</b>	A start or stop point in a process.
	<b>Decision</b>	A question or branch in the process.
	<b>Delay</b>	A waiting period.
	<b>Predefined Process</b>	A formally defined sub-process.
	<b>Alternate Process</b>	An alternate to the normal process step.
	<b>Data (I/O)</b>	Indicates data inputs and outputs to and from a process.
	<b>Document</b>	A document or report.
	<b>Multi-Document</b>	Same as Document, except, well, multiple documents.
	<b>Preparation</b>	A preparation or set-up process step.
	<b>Display</b>	A machine display.
	<b>Manual Input</b>	Manually input into a system.
	<b>Manual Operation</b>	A process step that isn't automated.
	<b>Card</b>	A old computer punch card.
	<b>Punched Tape</b>	An old computer punched tape input.
	<b>Connector</b>	A jump from one point to another.
	<b>Off-Page Connector</b>	Continuation onto another page.
	<b>Transfer</b>	Transfer of materials.
	<b>Or</b>	Logical OR
	<b>Summing Junction</b>	Logical AND
	<b>Collate</b>	Organizing data into a standard format or arrangement.
	<b>Sort</b>	Sorting of data into some pre-defined order.
	<b>Merge (Storage)</b>	Merge multiple processes into one. Also used to show raw material storage.
	<b>Extract (Measurement) (Finished Goods)</b>	Extract (split processes) or more commonly - a measurement or finished goods.
	<b>Stored Data</b>	A general data storage flowchart symbol.
	<b>Magnetic Disk (Database)</b>	A database.
	<b>Direct Access Storage</b>	Storage on a hard drive.
	<b>Internal Storage</b>	Data stored in memory.
	<b>Sequential Access Storage (Magnetic Tape)</b>	An old reel of tape.
	<b>Callout</b>	One of many callout symbols used to add comments to a flowchart
	<b>Flow Line</b>	Indicates the direction of flow for materials and/or information

Figure 7 – Symbols used to develop flowcharts

Source: BreezeTree < <https://www.breetree.com/downloads/flow-chart-symbols.pdf>>

Because of its simplicity in filling and the volume of useful information, it is the recommended a vertical flowchart type for comparing processes that are being modified.

An example of Vertical Flow Chart is presented in Figure 8, where you can check:

- a) the basic information of the sector where the process occurs;
- b) the number of each step;

- c) the Distance (m), the Time (s);
- d) four types of activities (operation, transport, inspection, wait and storage);
- e) the description of each step.

Current process:			Process Flowchart					Sheet nº:
Proposed process:								
Process: Manufacture of soap bars						Date:		
Sector:						Responsible:		
Step	Distance (m)	Time (s)	Operation	Transport	Inspection	Wait	Storage	Description
1			●	→	□	□	▽	Separation of raw material
2			○	→	□	□	▽	Transport from the RM to the weighing site
3			●	→	□	□	▽	MRI fractionation
4			○	→	□	□	▽	Transport from MR to the place of waiting for ma
5			○	→	□	●	▽	Waiting for production
6			○	→	□	□	▽	Transport to processing machine
7			●	→	□	□	▽	Base mass mixing with RM
8			●	→	□	□	▽	Rolling of the mass
9			●	→	□	□	▽	Extrusion
10			●	→	□	□	▽	Separation of soap bars
11			●	→	□	□	▽	Pressing
12			●	→	□	□	▽	Finishing
13			○	→	■	□	▽	Inspection
14			○	→	□	□	▽	Transport to the packing location
15			●	→	□	□	▽	Product packaging
16			●	→	□	□	▽	Pallet assembly
17			○	→	□	□	▽	Transport from the pallet to the warehouse
18			○	→	□	□	▽	Product batch storage

Figure 8 – Example of Vertical Flowchart

Source: Think Lean Sigma <<https://www.thinkleansixsigma.com/article/flowchart>>

### 2.5.2 GUT Matrix to prioritize problem

The GUT Matrix was developed and disseminated in the 1970s by Kepner and Tregoe (1976 and 1981) to rationally prioritize actions or problems, taking into account Gravity (G), Urgency (U), and Trend (T) of the studied phenomenon, being a tool used by authors (GRECCO et al., 2011; VASCONCELOS et al., 2013; OLIVEIRA et al., 2016; PESTANA et al., 2016; VERZOLA, MARCHIORI AND ARAGON, 2014; BRANDÃO AND MESQUITA, 2018) to achieve various objectives.

Gravity refers to the cost, what is the economic gravity for the sector or company analyzed if nothing is done, and the scale from 1 to 5 can be used as shown in Char 1.

Urgency refers to the timeframe for solving the problem, while Trend concerns the evolution of the problem, the potential for growth. After recording each value, the multiplication  $G \times U \times T$  is done resulting in the total score and then the priority level classification is found.

The case of Chart 1 points out that of six problems analyzed of a car, the first to be attacked is the Bald

Tire (100 points), the second is the brake leak (45 points), while the least priority problem is the mudguard wrinkled. Thus, it is noticeable that one of the main advantages of this Matrix is that it helps the manager to more objectively assess the company's problems, contributing to the prioritization of corrective and preventive actions.

ESCALE	GRAVITY (G)	URGENCY (U)	TENDENCY (T)	
1	No gravity	No urgency	Unchanged	
2	Low gravity	Low urgency	Worst over time	
3	Gravity	Urgency	Worst in the medium term	
4	High gravity	High urgency	Worst in the short term	
5	Extreme gravity	Immediate action	Worst quickly	
PROBLEM	G (Cost)	U (Timeframe)	T (Evolution)	SCORE G x U x T
Bald Tire	5	5	4	100 (First)
Mudguard wrinkled	2	2	2	8 (6th)
Broken brake light	3	5	2	30 (4th)
Break leak	3	3	5	45 (2nd)
Broken Light bubs	3	3	1	9 (5th)
Flooded Engine	3	3	4	36 (3d)

Chart 1: GUT Matrix example using car problems

Source: MELO (2014, p. 23)

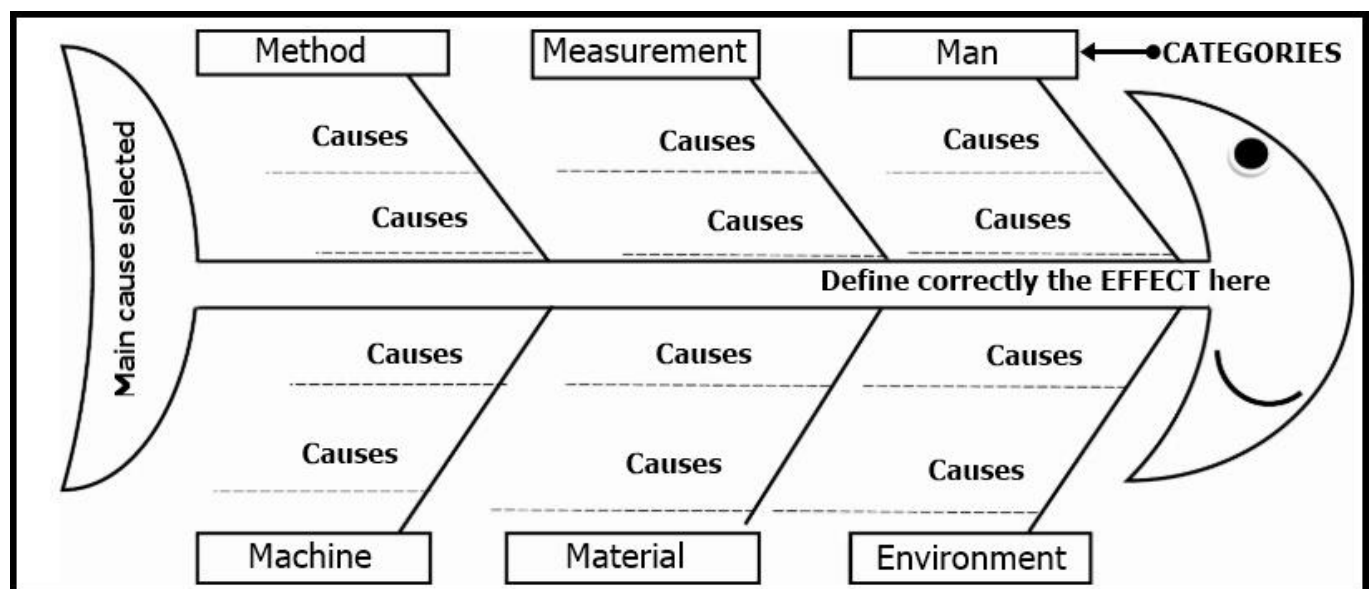


Figure 9 – Three main Ishikawa diagram elements (Effect, Categories and Causes)

Source: Author made improvements from Datavisiononline picture

### 2.5.3 Ishikawa Diagram

The Ishikawa Diagram or Cause and Effect Diagram are composed of three elements, the effect, the categories and the causes (Figure 9), created in 1943 at the University of Tokyo (Japan) by Dr. Kaoru Ishikawa. It is a widely used tool. It is known but unexplored in its potential, as it is most often used to

identify some causes of problems. In Japan, in addition to exploring as many causes as possible when trying to see the relationship with the “problem” effect, the tool is also widely used to identify causes to prevent a particular event (Figure 10), in order to not to necessary to take corrective action. In addition to this approach, it is also possible to identify the causes of an event (system, project, goal, process, or good management practice) that has been successful over time (Figure 11).

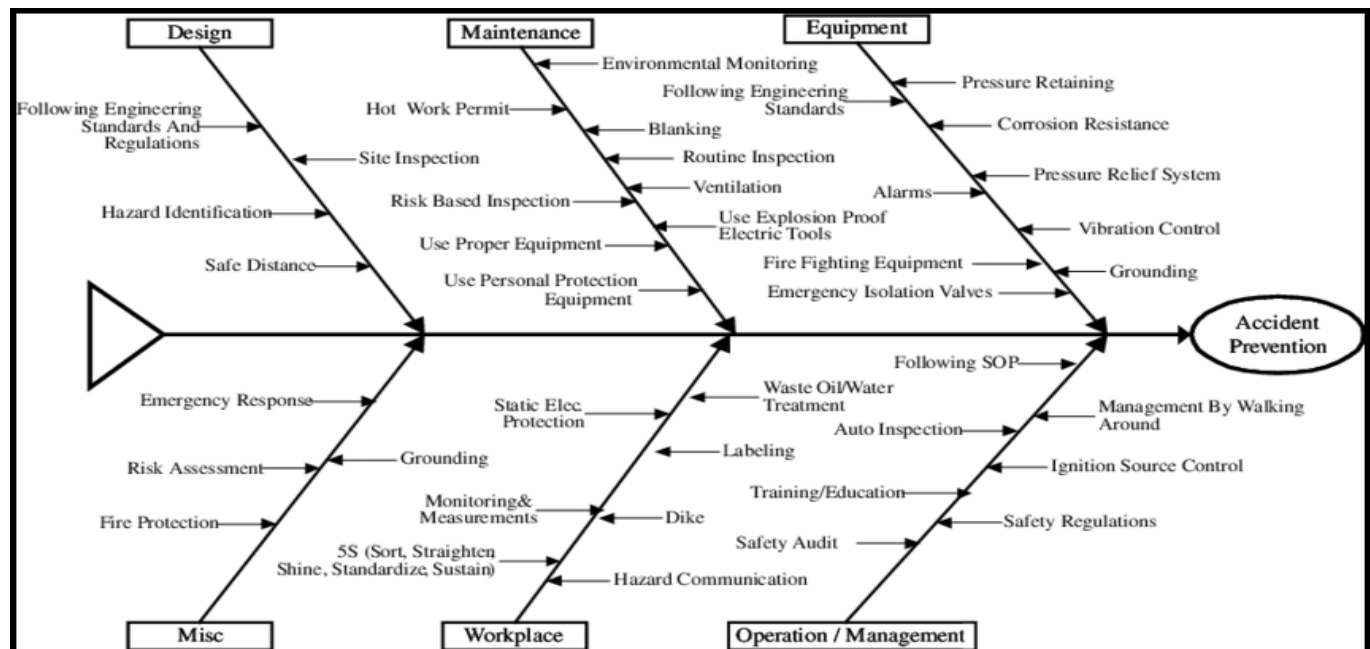


Figure 10 – Fishbone diagram to prevent accident

Source: Chang and Lin (2006 p. 55)

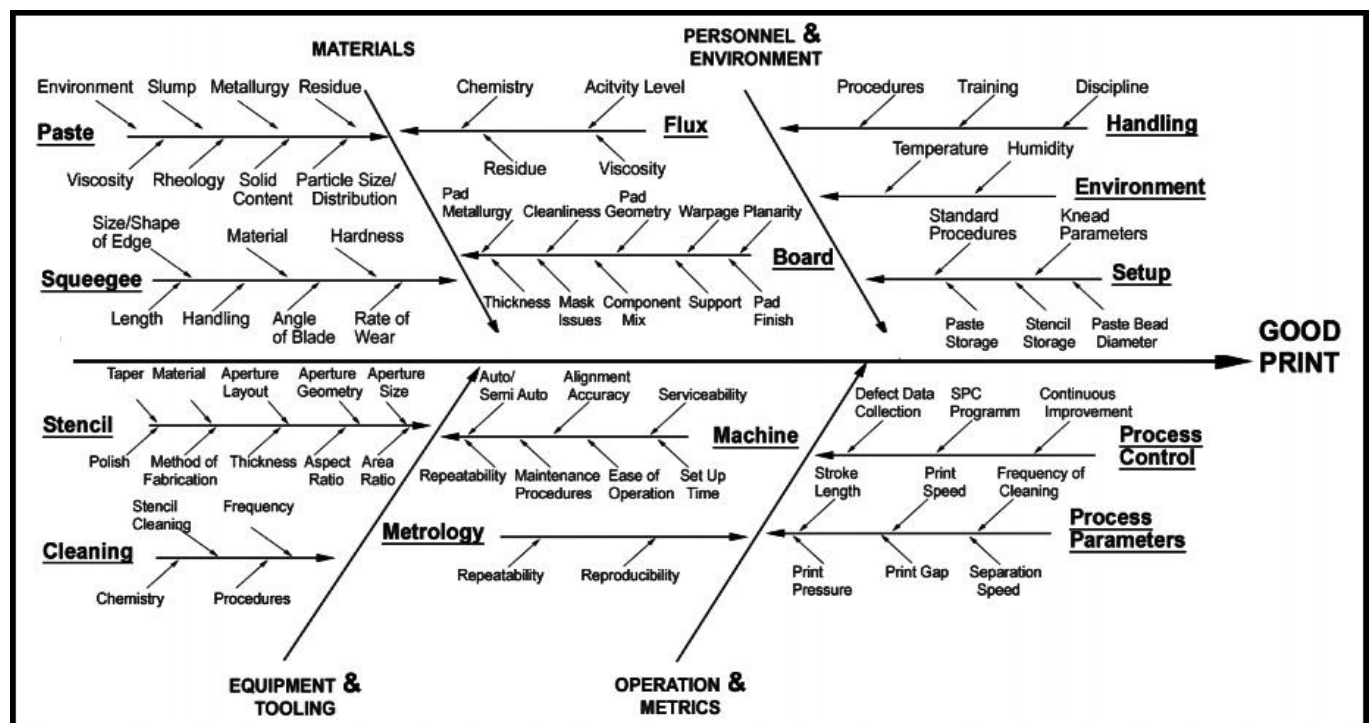


Figure 11 – Causes that contribute for good stencil printing process

Source: Fleck and Chouta (2003 p. 25)



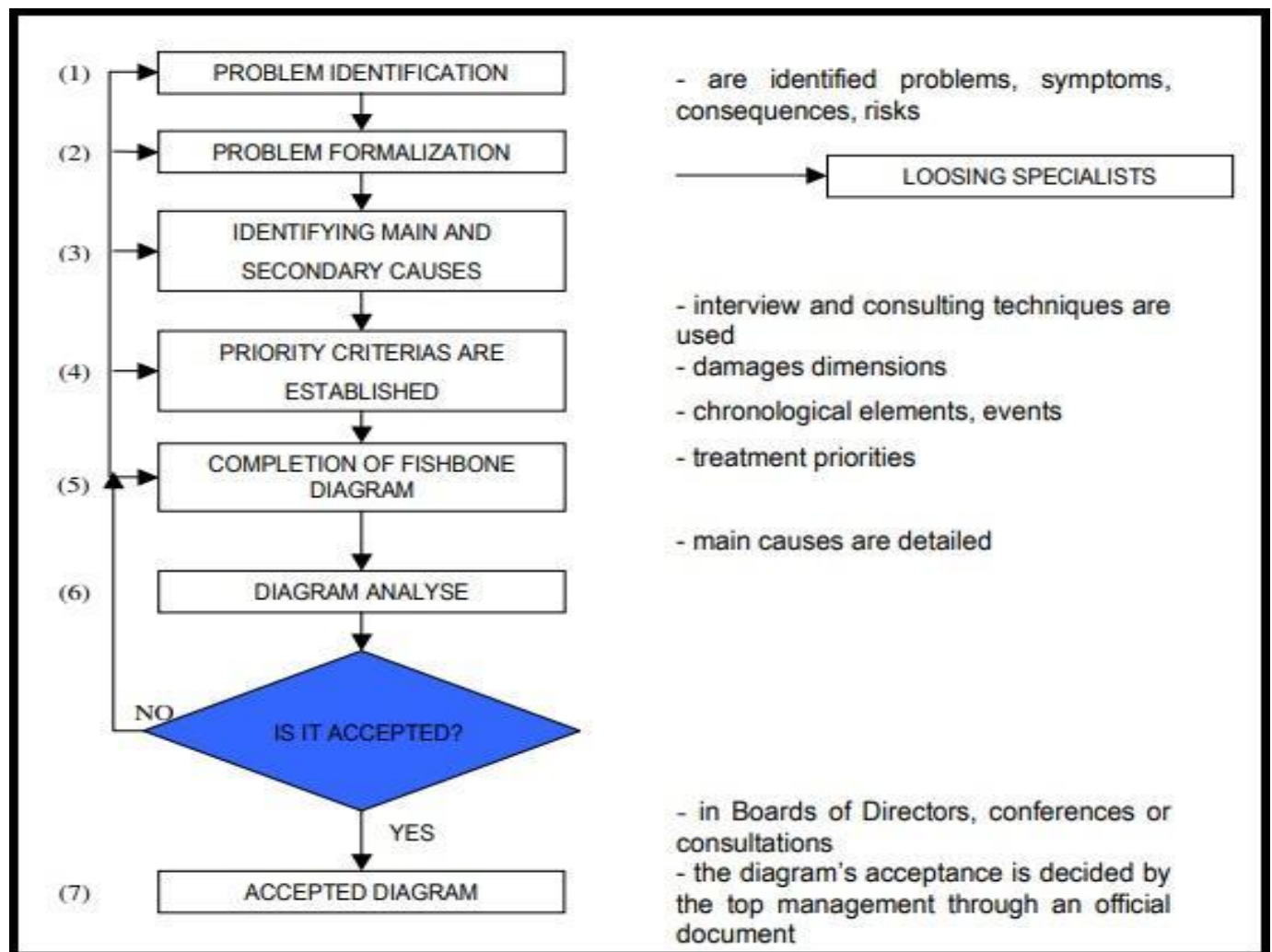


Figure 12 – Logic Scheme of Fishbone Diagram Implementation

Source: Ilie and Ciocoiu (2010 p. 2)

Basically this diagram is constructed as follows:

- Identify the effect to be analyzed by writing it to the right of the diagram. The accurate identification of the effect is very important so as not to spend time on the next steps;
- The survey of possible causes is usually done through brainstorming (WERKEMA, 2006), using the six Ms (materials, methods, machines, workmanship, measurement, and mother nature) to guide the discussion;
- Put the main causes in the branches (fishbone) to the right of the diagram;
- Repeat the process for the sub causes until the team realizes that the diagram is complete.

The Figure 12 presents a plan for implementing the Ishikawa Diagram that was developed by Ilie and Ciocoiu (2009 and 2010), with seven steps to study a problem and get manager approval: (1) Correct problem identification; (2) Formalization of the problem; (3) Identification of major and secondary causes; (4) Establishment of priority criteria; (5) Partial completion of Ishikawa Diagram; (6) Critical analysis of the diagram; (7) Decision and (8) Acceptance of managers.

Ilie and Ciocoiu (2010) conducted a study applying the diagram to determine the risk of a multi-cause

event (Loosing Specialists). It would be interesting if the methodology could be used with adaptations also to analyze causes to prevent events or to analyze the causes that contributed to the success of an event.

### 3. Methodology

The research is applied since the knowledge generated will be used by Company X. Regarding the objectives, the research is descriptive, since it will describe through the comparison between variables involved in the performance of two inspection tests. Data were collected and analyzed using a combined (qualitative and quantitative) approach through the case study, bibliographic research, chrono-analysis and the use of PDCA with quality tools (brainstorming, GUT, Ishikawa Diagram and Vertical Flowchart) to verify the performance of the efficiency test considered standard and the experimental test.

The research started in the first semester but was formalized and improved in the UFAM Production Engineering Course in the second semester of 2016, as described in Chart 2.

STEPS	JUNE	JULY	AUGUST	SEPTEMBER
Article Template Presentation	X			
Theme presentation		X		
Introduction: contextualization, problem, justification, objectives, and proposal of the topics for the literature review.		X		
Development: Presentation and discussion of the Bibliographic Review			X	
Data collection and analysis			X	
Discussion of Results				X
Final Considerations and advisor analysis				X
Essay and review of the article				X
Improvement and delivery the final version				X
Article defense				X

Chart 2 – Research Methodology Schedule

Source: Author (2016)

Regarding the data collection and analysis, performed in August 2016, the data were collected by the study of time, using the timer, of each test operation, both the standard method and also the new method. Then, the data were digitized and graphed for discussion of results and construction of the article that was defended for an examining board of the Production Engineering course of UFAM's Faculty of Technology.

### 4. Case study and Results

The case study took place in the Quality Assurance sector and focused on the reliability test performed to

verify the efficiency of the TVs produced by Company X.

In July 2015, senior management decided to automate the energy efficiency inspection test to improve performance after identifying that the standard test was unable to achieve the increased production volume of new television models to be inspected.

To assist in identifying the possible causes of the “Failure to Meet the Increased Volume of New TV Models” problem, brainstorming sessions were conducted to identify potential causes through the use of the Ishikawa Diagram (Figure 12).

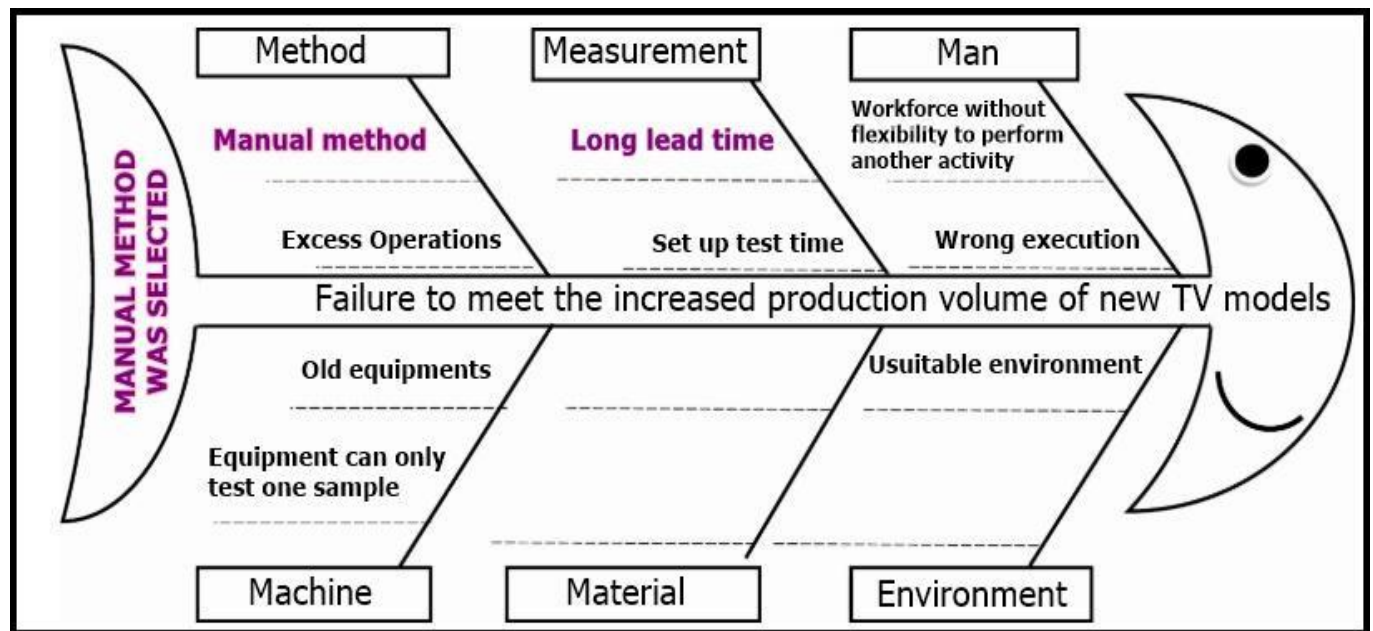


Figure 12 – Causes that contributes for the standard test to failure to meet increased production of TV

Source: Company X

EFFECT ANALYZED: Standard test failure to meet increased production volume of new TV models						
CATEGORIES	CAUSES	GRAVITY	URGENCY	TREND	SCORE	PRIORITY
METHOD	Manual method	5	5	5	125	First
MEASUREMENT	Test long lead time	5	5	5	125	First
MEASUREMENT	Set up test time	4	4	4	64	Second
METHOD	Excess of operation	4	4	4	64	Second
MACHINE	Equipment can only test one sample	3	4	4	48	Third
MAN	Wrong execution	4	3	3	36	Fourth
MACHINE	Old equipments	3	3	3	27	Fifth
MAN	Workforce without flexibility to perform another activity	2	2	2	8	Sixth
ENVIRONMENT	Unsuitable environment	2	2	2	8	Seventh

Chart 3 – Priorization of the nine causes through GUT Matrix analysis

Source: Author

Figure 12 points out 9 possible causes of the problem, after applying the GUT Matrix (Chart 3) the priority would be to attack two causes “Manual method” and “Test long lead time”, and it was chosen to attack “Manual method”.

Then an action plan was prepared for the implementation of the new (experimental) inspection test developed in partnership with the parent company. The plan was prepared based on the PDCA methodology, containing about ten actions performed as can be seen in Figure 13.

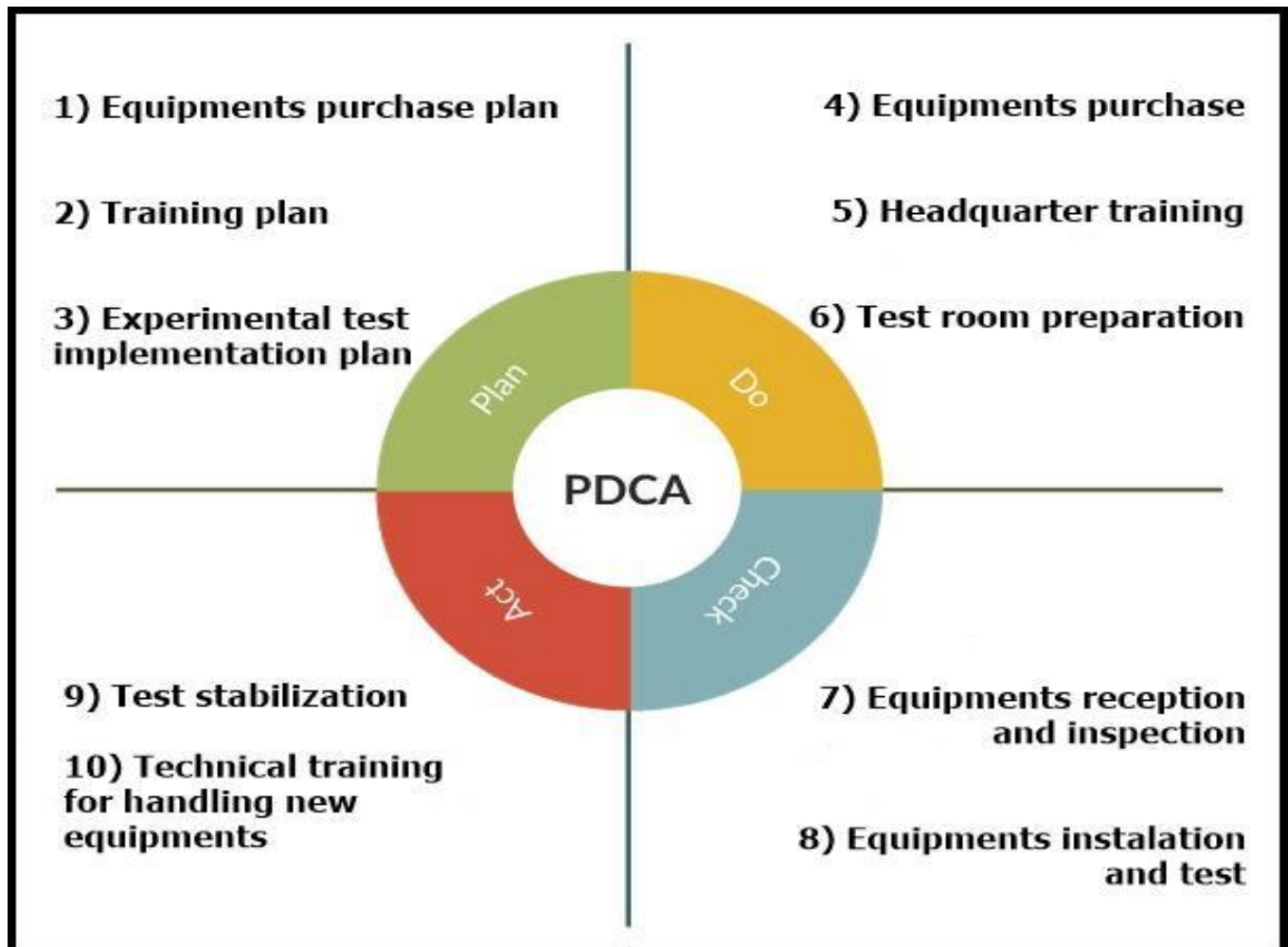


Figure 13 – The implementation of experimental test by using PDCA cycle

Source: Author

After concluding the PDCA rotation (Figure 13), the study of the experimental test performance was started, in order to verify the efficiency of the new test method, comparing it with the previous one.

The energy efficiency inspection test on televisions consists of inspecting the energy consumption values reported on the energy efficiency label on televisions from 13” (minimum inch) to 65” (maximum inch). When a new TV model is introduced, it will pass all reliability tests, one of them being the energy efficiency inspection test (within the specified inches), where only one sample per model will be required to perform of the test.

The energy efficiency test is performed as follows: 1) Sound stabilization; 2) Power measurement (KW / h) in static mode; 3) Power measurement (KW / h) in dynamic mode; 4) Power measurement (KW / h) in



standby mode; 5) Measurement of TV screen area (diagonal measurement); 6) Model rating (From “A” to “E”).

Results were discussed between August and September 2016, based on the analysis of two variables: v1) inspection time; v2) the number of operations performed during the test.

Then, comparisons were made between the performance of the standard method and the experimental method of execution, using vertical flow charts to visualize the operations, the arithmetic mean and the lead time (total time in hours to execute the whole process).

The discussion of the results was made with the following topics: 3.1) to diagnostic the performance of the standard inspection test; 3.2) to diagnostic the performance of experimental inspection test; 3.3) to analyse the positive points acquired with the new inspection test; 3.4) to compare the 2 tests.





























































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Main symbol		Operation			Total	6	03:17:33	50,78%	Company:	X	
		Transfer of material				0	0	0,00%	Type of process:	Standard	New
		Decision or Measure				5	3:11:30	49,22%	Process`name:	Energy efficiency inspection test	
		Documentation				0	0	0,00%	Department:	Quality Assurance	
		Storage				0	0	0,00%	Data:	September 17th 2016	
Steps	Symbols					X Time	Accum.	% Accu	Description		
1						00:31:22	00:31:22	8,1%	To prepare the sample, connecting the cables and set up the equipment		
2						01:00:40	01:32:02	23,7%	To put the sample into off mode and disconnected		
3						01:03:07	02:35:09	39,9%	To put the sample into on mode		
4						00:35:26	03:10:35	49,0%	To prepare sound and image adjustment		
5						00:52:02	04:02:37	62,4%	To measure power in static mode		
6						00:13:09	04:15:46	69,8%	To measure power in dynamic mode		
7						00:15:51	04:31:37	69,8%	To measure the screen area		
8						01:04:38	05:36:15	86,4%	To measure power in stand by mode		
9						00:45:50	06:22:05	98,2%	To measure the visible diagonal		
10						00:00:41	06:22:46	98,4%	To set up the sample for the factory mode		
11						00:06:17	06:29:03	100,0%	To pack the sample		

Chart 4 – Lead time of standard inspection of a TV energy efficiency test

Source: Author

#### 4.1 Diagnostic Performance of Standard Inspection Test

The standard inspection test is performed manually using only one television sample, following 11 execution steps as described in Chart 4.

To diagnose the standard inspection test, 20 timed test cycles were first performed to determine the X Time in an hour of each step performed. From the completion of the 20 cycles, it can be seen that the lead time was 6h29min03 with almost 51% of the time devoted to performing operations and 49% of the time to measure.

After analyzing, specifically the operations where the measurements take place, you can diagnose the standard inspection test from the following points:

- Set up time: Because it is performed manually, to proceed from one operation to another, it is necessary to configure the measuring equipment and to connect the equipment cables to the television;
- Measurement of visible screen diagonal: When a sample is equal to or above 60 inches, one more person must be available to support the measurement;
- Fault Detection: If any cables are badly connected or equipment is misconfigured, or any other error goes unnoticed during the test, it is necessary to start the operation again, and if the error goes unnoticed by the end of the test, This may have a direct impact on the final result, and sometimes it is necessary to repeat the entire inspection test.
- Inadequate environment: The ambient temperature is a factor that influences the test measurements and should be stabilized at  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ . As there is no control of the ambient temperature, it was noted that this is one of the factors that hinder the measurement operations, as it causes variation in the values, besides generating discomfort for those who perform the test. In addition to not having a suitable ambient temperature for the test, the environment also does not have good acoustics, and due to this factor, it was noted that the sound structure hinders the operation of sound adjustment of the TV, which must stabilize in the 80 dB (decibel) level.

All of the points cited with their specific signs are related to the main causes that affect standard test productivity.

#### **4.2 Diagnostic Performance of Experimental Test**

The experimental test, called Energy System Measurement, was developed in partnership with Headquarter's R&D team, which communicates between the new measurement equipment and the TV. While the standard inspection test was fully manual, the experimental test performs 15 steps, of which 67% are performed automatically and 43% manually, as can be seen from Chart 5.

Twenty timed cycles were again performed to determine the average times (X Time) of each step performed to verify the performance of the new inspection test.

In 20 timed test cycles, it can be verified that the lead time was 04h14min34, this represents 65.4% of the standard test lead time which means a 33.5% reduction in time to perform the new test.

The creation of the Energy System Measurement seeks to eliminate the problems detected in diagnosis (Figure 12 and Chart 3) by eliminating their symptoms, or otherwise, they would develop in the future.

The main updates were:

- The setup times that occurred from one operation to another in the standard inspection test are not required in the new inspection test, from the connection between the measuring equipment and the television, the *Energy System Measurement* sends commands to the equipment proceeding to the next operation without manual intervention;
- Measurements of the visible diagonal of the screen have been automated through to the *Energy System Measurement*, which has a database with every possible inch of TVs with their proper tolerances. The system identifies the screen diagonal measurement based on the data entered into the system in the initial setup, where the size is placed based on the specification of the television;

- Automation of inspection testing has not only improved runtime and method of execution but has also reduced the risks of performing operations incorrectly. The usual method performed before required the execution of many processes, and if wrongly performed, it was necessary to restart the test, resulting in late delivery of the result. Optimizing operations, the risk of incorrect execution has been reduced, so that if there is any wrong execution, either from faulty cable connection or initial setup error, the Energy System Measurement can identify and send alerts to correct the error and proceed the test.
- To avoid ambient temperature influences in the test, the temperature was controlled after the air conditioners installation, reducing the variation in the measured values;
- In addition to having temperature control, the environment also underwent acoustic treatment, being installed acoustic dampers and carpet generating better sound performance.

















































































VERTICAL FLOWCHART					Lead Time (in hour):		04:14:34				
Main symbol	 Operation				Total	10	02:14:24	52,80%	Company: X		
	 Transfer of material					0	0	0,00%	Type of process:	Standard	New
	 Decision or Measure					5	2:00:10	47,20%	Process` name:	Energy System Measurement	
	 Documentation					0	0	0,00%	Department:	Quality Assurance	
	 Storage					0	0	0,00%	Data:	September 17th 2016	
Steps	Symbols					X Time	Accum.	% Accu	Type of operation and description		
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2						00:00:15	00:04:15	1,7%	Manual: open the Energy System Measurement		
3						00:01:44	00:05:59	2,4%	Manual: to insert sample data		
4						00:00:01	00:06:00	2,4%	Manual: to start the test by clicking START		
5						00:01:52	00:07:52	3,1%	Automatic: to stabilize sound and adjust image		
6						01:00:00	01:07:52	42,4%	Automatic: to put the sample in Standby mode		
7						00:40:00	01:47:52	42,4%	Automatic: to measure the power in static mode		
8						00:10:00	01:57:52	46,3%	Automatic: to measure the power in dynamic mode		
9						00:10:00	02:07:52	50,2%	Automatic: to measure the power in internet mode		
10						00:00:05	02:07:57	50,3%	Automatic: to set up the sample for the factory mode		
11						01:00:00	03:07:57	73,8%	Automatic: to put the sample in Standby mode		
12						01:00:00	04:07:57	97,40%	Automatic: to measure the power in Standby mode		
13						00:00:10	04:08:07	97,47%	Automatic: to measure the area and the screen visible diagonal		
14						00:00:10	04:08:17	97,53%	Automatic: to generate the report		
15						00:06:17	04:14:34	100,00%	Manual: to pack the sample		

Chart 5 – Experimental test called Energy System Measurement

Source: Author

#### 4.3) Comparison between the two tests.

Despite having more steps, the experimental test is faster and has almost 53% of the steps performed in operation and 47% as measurement, values very close to the standard test.

According to Chat 6, there was a reduction from 6h29min03 to 4h14min34 in lead-time, which means

about 2h14min29 time savings.

The major reductions occurred in the sound stabilization and image adjustment step following the area and diagonal measurement step.

Figures 14 and 15 show the times of each test, it is possible to notice less variability and considerable gain with the experimental test, since the standard test only perform testing on 5 samples per week, now the experimental can test 15 samples per week at least.

VERTICAL FLOWCHART					Lead Time (in hour):		06:29:03		
Main symbol	Operation	Total	6	03:17:33	50,78%	Company:	X		
	Transfer of material		0	0	0,00%	Type of process:	Standard	New	
	Decision or Measure		5	3:11:30	49,22%	Process' name:	Energy efficiency inspection test		
	Documentation		0	0	0,00%	Department:	Quality Assurance		
	Storage		0	0	0,00%	Data:	September 17th 2016		
Steps	Symbols			X Time	Accum.	% Accu	Description		
1	□	⇒	◇	□	▽	00:31:22	00:31:22	8,1%	To prepare the sample, connecting the cables and set up the equipment
2	□	⇒	◇	□	▽	01:00:40	01:32:02	23,7%	To put the sample into off mode and disconnected
3	□	⇒	◇	□	▽	01:03:07	02:35:09	39,9%	To put the sample into on mode
4	□	⇒	◇	□	▽	00:35:26	03:10:35	49,0%	To prepare sound and image adjustment
5	□	⇒	◇	□	▽	00:52:02	04:02:37	62,4%	To measure power in static mode
6	□	⇒	◇	□	▽	00:13:09	04:15:46	69,8%	To measure power in dynamic mode
7	□	⇒	◇	□	▽	00:15:51	04:31:37	69,8%	To measure the screen area
8	□	⇒	◇	□	▽	01:04:38	05:36:15	86,4%	To measure power in stand by mode
9	□	⇒	◇	□	▽	00:45:50	06:22:05	98,2%	To measure the visible diagonal
10	□	⇒	◇	□	▽	00:00:41	06:22:46	98,4%	To set up the sample for the factory mode
11	□	⇒	◇	□	▽	00:06:17	06:29:03	100,0%	To pack the sample

VERTICAL FLOWCHART					Lead Time (in hour):		04:14:34		
Main symbol	Operation	Total	10	02:14:24	52,80%	Company:	X		
	Transfer of material		0	0	0,00%	Type of process:	Standard	New	
	Decision or Measure		5	2:00:10	47,20%	Process' name:	Energy System Measurement		
	Documentation		0	0	0,00%	Department:	Quality Assurance		
	Storage		0	0	0,00%	Data:	September 17th 2016		
Steps	Symbols			X Time	Accum.	% Accu	Type of operation and description		
1	□	⇒	◇	□	▽	00:04:00	00:04:00	1,8%	Manual: to prepare the sample and connecting the cables
2	□	⇒	◇	□	▽	00:00:15	00:04:15	1,7%	Manual: open the Energy System Measurement
3	□	⇒	◇	□	▽	00:01:44	00:05:59	2,4%	Manual: to insert sample data
4	□	⇒	◇	□	▽	00:00:01	00:06:00	2,4%	Manual: to start the test by clicking START
5	□	⇒	◇	□	▽	00:01:52	00:07:52	3,1%	Automatic: to stabilize sound and adjust image
6	□	⇒	◇	□	▽	01:00:00	01:07:52	42,4%	Automatic: to put the sample in Standby mode
7	□	⇒	◇	□	▽	00:40:00	01:47:52	42,4%	Automatic: to measure the power in static mode
8	□	⇒	◇	□	▽	00:10:00	01:57:52	46,3%	Automatic: to measure the power in dynamic mode
9	□	⇒	◇	□	▽	00:10:00	02:07:52	50,2%	Automatic: to measure the power in internet mode
10	□	⇒	◇	□	▽	00:00:05	02:07:57	50,3%	Automatic: to set up the sample for the factory mode
11	□	⇒	◇	□	▽	01:00:00	03:07:57	73,8%	Automatic: to put the sample in Standby mode
12	□	⇒	◇	□	▽	01:00:00	04:07:57	97,40%	Automatic: to measure the power in Standby mode
13	□	⇒	◇	□	▽	00:00:10	04:08:07	97,47%	Automatic: to measure the area and the screen visible diagonal
14	□	⇒	◇	□	▽	00:00:10	04:08:17	97,53%	Automatic: to generate the report
15	□	⇒	◇	□	▽	00:06:17	04:14:34	100,00%	Manual: to pack the sample

Chart 6 – The comparative performance of two tests

Source: Author



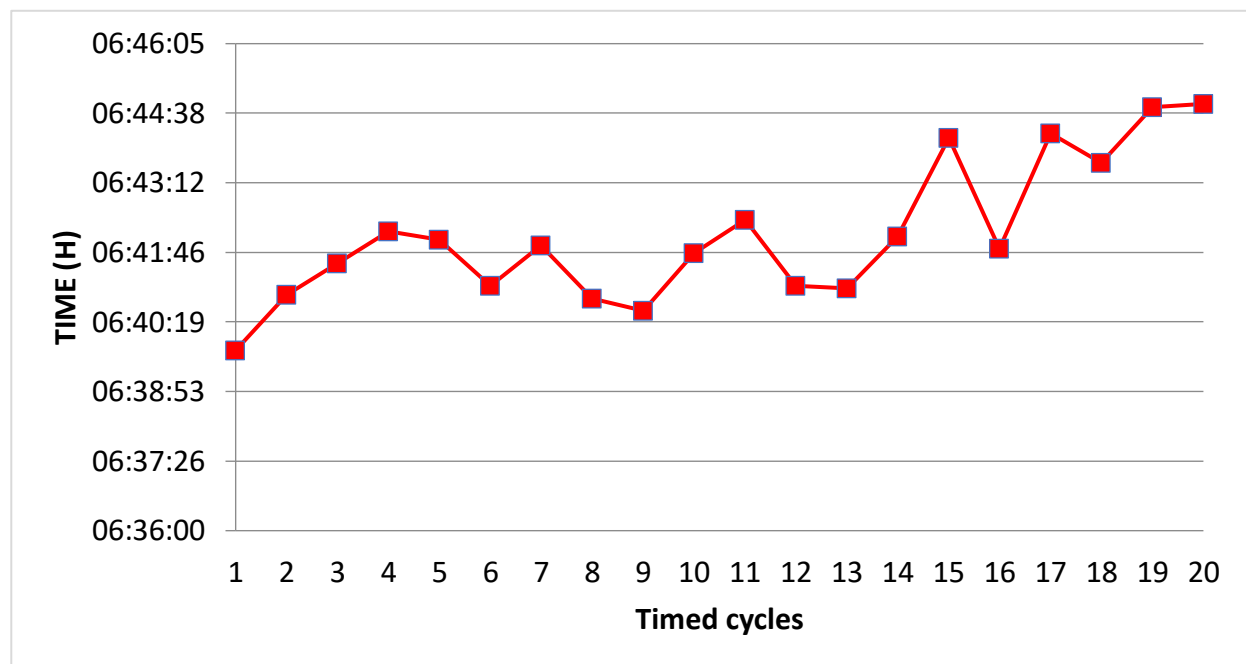


Figure 14 – Test standard lead times in 20 cycles of measurement

Source: Author (2016).

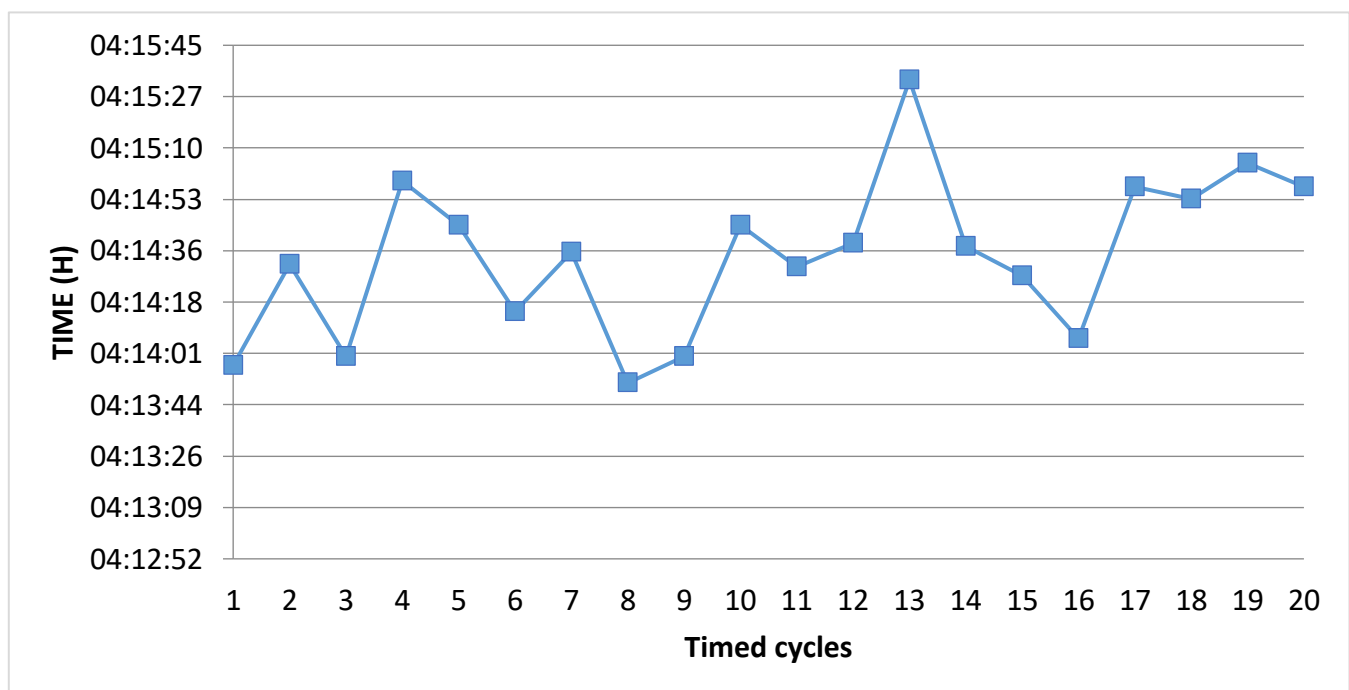


Figure 15 – Experimental test lead times in 20 cycles of measurement

Source: Author (2016).

With the introduction of the new automatic method for conducting the inspection test, there was no improvement only in the main points affecting the test, but the following positive points were also obtained:

#### a) Automatic report creation

One of the most important optimizations made by the Energy System Measurement is the report creation.

Previously, after completing the test, it was necessary to compile all the measurement values manually, and most of the time, the report was only generated the next day. With optimization, the test result report is generated seconds after the test is completed.

#### **b) Increased sample quantity for inspection**

The equipment used in the standard test could test only one sample per day and it was not possible to analyze or compare the measurement result of a particular television model if there were any abnormalities. After automation, the inspection test is performed with up to three samples at the same time and samples of the same TV model or different TV models. With test automation, testing can be performed on up to six samples during normal working hours.

#### **c) Workmanship Flexibility**

In the previous scenario, the standard inspection test, due to the long duration and also the number of operations, required only one person responsible for performing the inspection test and not having the flexibility to perform other industry activities.

With the implementation of the new inspection test, where major operations have been automated, there is no longer a need for a person responsible for performing the inspection test alone. The same workforce now has the flexibility to perform other industry activities beyond energy efficiency inspection testing.

## **5. Conclusions**

The article aimed to answer the question "how to analyze the efficiency of a new inspection test method aimed to reach the increase in TV set production volume?".

To this end, it was set a general objective (to compare the performance of the standard method and the new method of performing the energy efficiency inspection test) and three specific ones, the data collection and made with Company X's quality assurance sector data reached the following conclusions:

First) Standard inspection test performance diagnosis was performed 100% manually, its average lead-time was 6h29min03, performed in 11 steps with risks of set-up time problems, visible screen diagonal measurement, fault detection and because of the inadequate environment;

Second) The performance analysis of the experimental inspection test has 67% of its steps performed automatically and 43% manually, its average lead-time was 4h14min34, a gain of 33.5% in the total time required to perform the test. Among the positive points obtained are: a) the automatic generation of the test report; b) increase in the number of daily samples that can be tested as the new method; c) error reduction; d) improvement of labor flexibility to perform other activities in parallel;

Third) The analysis of the new inspection test used to attend the TV production volume can be done by applying Brainstorming, Ishikawa Diagram, GUT Matrix, PDCA (with feasibility study, equipment acquisition, training, etc.), Vertical Flowchart together with the chrono-analysis of the production steps. However, it is worth highlighting the importance of the support of senior management for each of these tools to be used creatively by the employees involved in the project.

To further research, a study of the problems inherent in the experimental test is suggested, since there was not enough time to identify them, to analyze their causes and to propose improvements to the managers of Company X.

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## How to evaluate Industrial Engineering undergraduate teachers?

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### Abstract

*In Brazil, teacher evaluation is required by the National Higher System Evaluation System (INEP, 2011). At UFAM, it is done through the student portal, which is considered ineffective, compromising the process of continuous improvement of teaching and learning. The article evaluates the students' level of satisfaction with the quality of the services provided by the teachers who taught discipline for the FT/UFAM Industrial Engineering course, to propose suggestions for improvements. To this end, the UFAM evaluation portal was studied, then a review of performance evaluation articles allowed the development of a questionnaire (Appendix 1) that was applied in 2011 to 112 (70%) students enrolled in the 2nd, 4th, 6th and 8th periods of this course. After analyzing the data, it was concluded that: a) the UFAM website to evaluate teachers was considered negative by more than 1/3 of the respondents, and the obligation to answer, the excessive amount of questions, the lack of feedback and improvement actions discourage students from responding; b) On the other hand, the application of the questionnaire revealed that the best-evaluated subjects were Special Topics of Industrial Engineering I and II, Management of Technological Innovation, Sanitation Applied to Production, Calculus II, Linear Algebra, Transport Phenomena, and Digital Electronics, most of which were taught by teachers of 2nd and 4th period. For improvement, it is recommended to identify the good teaching and learning practices of these teachers to apply seminars and disseminate them through FT/UFAM.*

**Keywords:** Teacher evaluation; Performance; Satisfaction;

### 1. Introduction

The Federal University of Amazonas (UFAM) is located in Amazonas and in 2011 offered 96 undergraduate courses divided into 21 academic units, including the Faculty of Technology (FT) located in the city of Manaus, consisting of five departments (Graphic Design and Expression; Construction; Electronics and Telecommunications; Electricity; Hydraulics and Sanitation; Geotechnics and Transportation) serving 1633 students enrolled in the second semester of 2011, which offered 10 undergraduate courses: Architecture and Urbanism = 79 students; Graphic Design and Expression = 286 students; Civil Engineering = 255 students; Computer Engineering = 186 students; Gas and Oil Engineering = 85 students; Electrical Engineering = 257 students; Materials Engineering = 93 students; Mechanics = 101 students; Industrial Engineering = 218 students; Chemical Engineering = 73 students. To evaluate and improve the quality of the courses, it is necessary to have an effective (efficient and

effective) system of teacher performance evaluation, having students as evaluators, since they are the clients served by the teaching community.

According to Ramos (1999), a teacher evaluation system made by the students is a decisive instrument in the perspective of betting on the teacher's personal and professional development and, simultaneously, on the student's responsibility, clearly aiming at a logic that sees the evaluation of the discipline and professional performance.

In this sense, for teacher evaluation, UFAM uses an online portal for the end of the period when the student evaluates all teachers of the subjects in which he was enrolled.

However, this evaluation has the following problems:

First) the evaluation system was not developed with the support of the students, not considering their perception of what is relevant in the teaching-learning process;

Second) as occurs only at the end of the period there is no possibility of immediate intervention when there is any non-compliance in the evaluated services;

Third) assessment results are not systematically used by students, managers and service providers in order to develop corrective and proactive actions over time. These problems lead to a) the repetition of errors by service providers; b) discontent student with the quality of services provided; c) the discrediting of students and teachers regarding the efficiency and effectiveness of the University's electronic evaluation system.

Given these problems, the general objective of this article is to evaluate the students' level of satisfaction with the quality of the services provided by the teachers of the Industrial Engineering course at the UFAM's Faculty of Technology to propose suggestions for improvements.

To this end, the specific objectives are:

- (1) to know UFAM's teacher evaluation system and experiences of other Brazilian universities;
- (2) develop and test an evaluation questionnaire that will periodically measure students' satisfaction with the services provided by FT/UFAM Industrial Engineering teachers;
- (3) propose suggestions for improvements to FT/UFAM Managers.

The main question of this research is "How to evaluate Industrial Engineering undergraduate teachers?"

The study is relevant because:

- 1) it may increase student motivation;
- 2) will provide information for teacher improvement, allowing the professional to know their strengths and points that require improvement;
- 3) will serve to improve the teaching evaluation system of the FT/UFAM;
- 4) provide information that will enable managers to develop a policy of training and appraising the teachers evaluated;
- 5) In the medium and long term, it will help the course to achieve academic excellence;
- 6) can be benchmarked and reapplied in other UFAM courses.

## **2. Theoretical reference**

### ***2.1 Reasons to measure and principles for measuring customer satisfaction***



Evaluate means value, determine the importance of something. For Barros (2010), at all times the human evaluates the elements of the reality that surrounds him. The evaluation process is a current requirement of society and is a way of monitoring programs to ensure effectiveness in organizations. From the perspective of quality of service, performance measurement provides, through the results obtained, the continuous improvement of processes. In general, something is measured to analyze strengths and weaknesses and propose improvements, not just to evaluate by evaluating.

There are seven good principles to follow when performing customer satisfaction measurement: a) what is the measuring reason; b) let customers report which ends results they want to be measured; c) search about the performance and competitors; d) follow-up on internal procedures that should produce the results that customers want; e) perform the measurements and verify the results; f) inform the staff about discoveries; g) verify what actions will be taken to standardize and disseminate good practices, as well as to correct what needs to be improved (adapted from WHITELEY, 1995 apud SILVA, 2011).

## **2.2 Key Performance Indicators**

According to Mello (2002), the use of indicators is one way to measure and evaluate the quality of products, processes, and customers. However, the use of an indicator system requires the structuring of indicators, the form of collection, processing and analysis, the labor and the use of results. According to Schröder (2005), the measurement of organizational results is an essential strategic issue, since only through an adequate estimation of organizational performance can attest how much the organization is “approaching” or “moving away” from its own goals.

According to Neely et al. (1995) apud Corrêa (2009), performance measurement can be understood as the technique used to quantify the efficiency and effectiveness of business activities. Efficiency will discuss waste-free resource utilization, the relationship between economic resource utilization, taking into account a certain level of satisfaction. In turn, effectiveness evaluates the achievement of the goal, the result of a process where the expectations of various customers are satisfied or not.

Rezende (2003) adds that a performance measurement system not only provides data necessary for management to control the various activities of organizations but also influences decisions and organizational behavior. A balanced measurement should be understood as a dialectical process that leads to the continual discovery of focuses and sources of improvement in the organization's existing intangible assets, rather than a simple comparison of predictions and achievements over a period.

There are several studies focused on organizational performance indicators, such as Van Bellen (2002), Fernandes (2005), Merchant (2006), Machado, Machado and Holanda (2007), Callado, Callado, and Almeida (2008), Menezes, Guimarães and Sellitto (2008), etc. A broad study of the characteristics of performance indicators used in research conducted in the fields of Administration, Accounting and Tourism from 2000 to 2008 revealed 24 terminologies (p. 381) used involving performance indicators as well as 21 concepts (page 382) extracted from the authors researched by Nascimento et al. (2011).

In this research, the indicators are considered flags that seek to express and demonstrate the reality in a way that is possible to observe and obtain more concrete data to improve the evaluation (COELHO, 2004), are considered supportive tools to evaluate processes (FREIRE; CHRISÓSTOME; CASTRO, 2007) and performance indicators are qualitative or quantitative elements used to detail the scope to which



objectives or goals have been achieved, observing the timeframe and resources used.

The development of performance indicators is not an end in itself, the creation and use are only justified as reference points, should be used as tools for questioning, critical and evaluative analysis of problem-solving management guidelines and practices.

In addition, there are aspects (Figure 1) that must be observed when creating a system of performance indicators, such as context analysis, organizational purposes (mission, vision, and values) and goals; the norms, communication and learning, assessment system, the correct amount of indicators per manager, training, strategic and operational alignment.

It is recommended that performance indicators are inseparable from the organization's vision, values and objectives. Thus, the choice of performance indicators follows normative principles, assuming a political, oriented decision to action based on goals nature, from the creation of a coherent information system that allows learning and assists in decision making (adapted from COUTO, 2005).

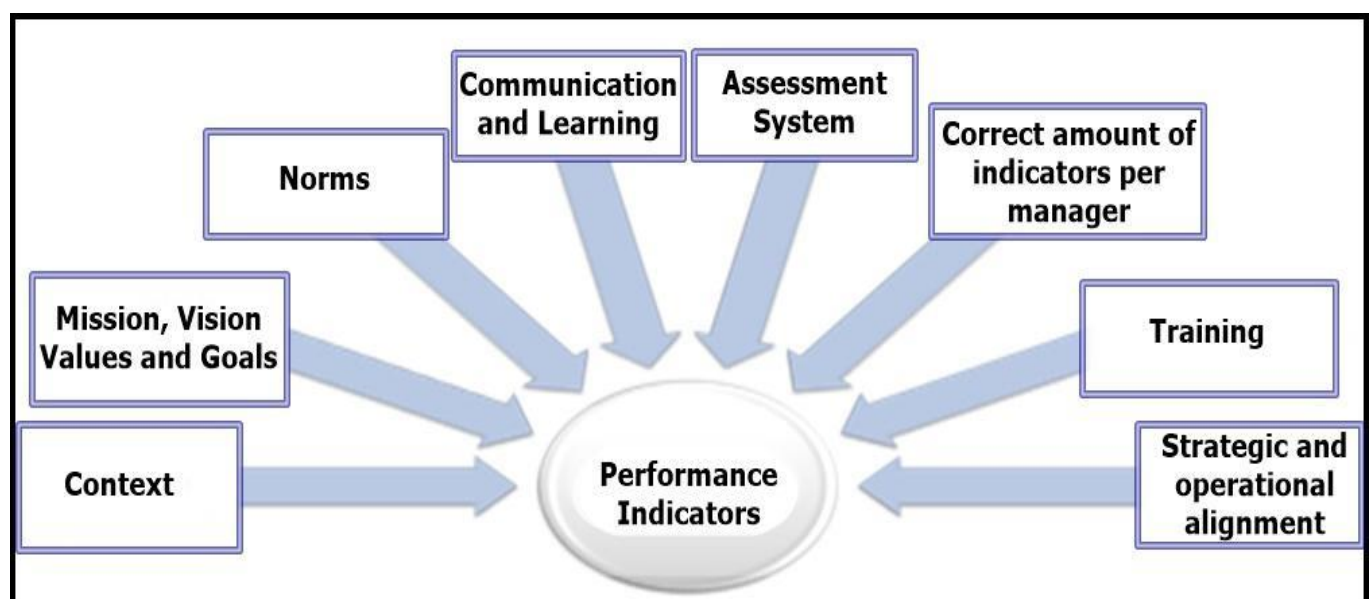


Figure 1 – Aspects to be considered during the development of a Performance Indicator System

Source: adapted from Couto (2005)

### 2.3 Quality in Higher Education Institutions

According to Mansur (2001), assessing quality in service means estimating how satisfied the customer is regarding the service through its various aspects such as efficiency, speed, and friendliness of the attendants, comfort, etc. The problem of valuing quality in services is to check the client's psychological aspects (what he thinks of the service) and this gives the problem a very subjective character. Educational institutions, as well as other service providers find it difficult to get consensus on how to measure quality, depending on the intangible nature of the services.

Given this, Ganesi and Corrêa (1994) point out that services are different from manufacturing, have characteristics such as product intangibility, customer presence, and participation and, generally, services are produced and consumed simultaneously. Thus, the services provided by higher education institutions are characterized by the essentially qualitative nature of the university. These institutions usually have a departmental structure, divided into different areas, with decentralized decision-making power based on

collegiate bodies, obeying the autonomy of the academic units and the academic freedom that the teacher enjoys as a professional and main production agent.

Marchesan (2006) points out that the practice of quality in university management is done through the harmonious articulation of the board with its teachers, employees, and students committed to the interests and objectives of the educational institution. This is the best way to seek and solidify recognition of the standard of teaching excellence and to prove the social responsibility of the educational task at all levels. According to Rupolo (2003), the pedagogical guidelines guide the establishment of its mission, its objectives, its goals and actions for teaching that should be idealized with a view to a quality formation that can be measured for a permanent qualification of its function.

Macedo (2001) also emphasizes that the measurement of the teaching and learning process is fundamental so that universities fulfill their role as promoters and socializers of knowledge, capable of compromising reality. To this end, the evaluation provides a global view in qualitative and quantitative terms, facilitating the resizing of policy and action plans.

Therefore, the evaluation process is not an isolated moment, but a public action for the school community to improve their administrative, technical and pedagogical practices in a critical and committed way (NAUJORKS, 2002).

For Strassburg and Moreira (2002), higher education institutions adopted an evaluate teacher performance system, and it is effective when it results in an improvement in teaching through self-critical teacher reflection.

#### ***2.4 Teachers' work in Higher Education Institutions ( HEI)***

There are challenges to higher education teachers in Brazil related to the information and knowledge society, perceived both through references to the practice of professions, as well as the legal guidelines announced by LDB 9394/96 and resulting curricular guidelines for undergraduate courses (CNE / MEC), which now require new skills for the restructuring of courses and pedagogical projects that enable the exercise of teaching as a reflexive, critical, transformative and emancipating act, resizing the academic life.

For Macedo (2001), teaching in higher education supposes the understanding of dimensions that characterize the structuring of an undergraduate course and the implementation of new training practices, with due clarity on the definition of each constituent element and the articulation between them.

The perception of this reality enables the inventive, entrepreneurial and productive potential of the teaching community in face of the daily possibilities of recreating the environment, instruments and work processes, stimulating the search for innovative solutions for the accomplishment of the required initiatives in face of the institutional questions that determine the scenario administrative-academic-pedagogical of undergraduate courses.

Thus, Zalbaza (2004) recommends some guiding principles: the study of the professional profile, the area of expertise, as well as the analysis of pedagogical strategies to be implemented so that teaching action is consistent with its objectives, based on a good curricular integration, with competent human resources and adequate materials, conducted by a careful evaluation system, elements that must be present in the Pedagogical Project that needs to be well explained in the paper and well understood, implemented and

managed by the teachers and students.

### **2.5 Teacher Evaluation**

The relevance of teacher evaluation concerning teaching functions is unquestionable but the great challenge is to build an evaluation system with shared procedures, articulated, contextualized to the local reality that helps improve service delivery while still considering, respecting and valuing teachers.

According to Strassburg and Moreira (2002), one should not restrict the evaluation of teaching quality only to the teacher's performance but should evaluate considering the overall dimension of the institution. In this context, educators should consider evaluation as feedback and one of the components of the institutional evaluation process is the survey of students' opinions about the didactic-pedagogical activities of their teachers. This is a complex task since it is up to the teacher to define which wills of the academics that are necessary (MACHADO, 1997 apud MEYER, 2006).

### **2.6 Evaluation of the teaching performance of teachers according to SINAES**

The pedagogical performance evaluation of the teachers of a higher education course is really important to reach academic excellence. In Brazil, Law No. 10,861 (April 14, 2004) establishes the National Higher Education Evaluation System (SINAES), which must be applied by all Brazilian higher education institutions (INEP, 2011).

This evaluation process takes into consideration aspects such as teaching, research, extension, social responsibility, institution management, and faculty, aiming to improve the quality of higher education, guiding the expansion of its offer, the permanent increase of its institutional, academic, and social effectiveness. This system has three main components: the evaluation of institutions, courses, and student performance.

The information obtained by SINAES is used by Higher Education Institutions (HEI) to verify their institutional, academic, and social effectiveness; It is also used by government agencies to guide public policies, as well as by the general public to guide their decisions about the reality of courses and institutions. Thus, HEIs need to evaluate faculty through a more scientific and participatory evaluation system.

### **2.7 Teacher assessment cases practiced in some HEIs in Brazil**

The eight cases presented were used to understand how some universities perform their teachers' performance evaluation, as well as contribute to the development of the data collection instrument.

The survey was conducted in 2010 by the students of the Industrial Engineering course of FT/UFAM, during the classes of the Quality Management course, taught by the author (SILVA, 2011), aiming to identify how HEIs with well-regarded courses evaluated their teachers, result of the study of the following Higher Education Institutions: Alves Faria College (Alfa), Physical Education College of Gravataí Ulbra, Anhanguera Educational, Federal University of Rio de Janeiro, Federal University of Minas Gerais, Pontifical Catholic University of Rio de Janeiro (PUC-RIO) and Federal Technological University of Paraná.

Usually, these are practices applied by HEIs with Industrial Engineering courses with good evaluation in

the National Student Performance Exam (ENADE) of 2008.

#### 2.7.1 Alves Faria College (Alfa)

According to Silva (2010), Alfa is located in Goiânia (State of Goiás-Brazil), even before any determination by the Ministry of Education (MEC), Alfa was already evaluating teachers. A methodology for applying data collection questionnaires and the N-Vivo 8 software for data processing is adopted. Silva (2010) also emphasizes that the information obtained is the result of decisions made after obtaining the data from the institutional evaluation of teachers. At Alfa, the academic community becomes the subject of the appraisal, committing itself to the transformations and changes in the quality level.

#### 2.7.2 Physical Education College of Gravataí Ulbra

According to Dornelles (2009), the teacher assessment is applied through a structured questionnaire, consisting of 10 questions, where the student assigns one of the following levels of satisfaction: 1 - Weak, 2 - Fair, 3 - Good, 4 - Very good and 5 - Excellent.

The collected data are analyzed using descriptive statistics, using tables and graphs. Statistical treatment is performed by the SPSS software for Windows version 10.0.

#### 2.7.3 Anhanguera Educational

In 2010, Anhanguera Educacional had 25 colleges, 2 university centers, and 1 university, located in the states of São Paulo, Rio Grande do Sul, Goiás and Mato Grosso do Sul. The organization had an institutional self-assessment program established since 1997, which contributed to the anticipation of the precepts contained in SINAES.

According to Casbonari (2007), among the 3 assessment instruments is the Teacher Performance Assessment (ADDA), where the student evaluates the teacher by giving grades from 1 to 5 (1 - Very weak, 2 - Weak, 3 - Regular, 4 - Good and 5 - Very good).

The results are statistically treated and published as teacher performance percentage indices, which are called Student Satisfaction Index (ISD) and High-Grade Percentage (PNA), a percentage in which students ranked teachers with high grades.

#### 2.7.4 Federal University of Rio de Janeiro (UFRJ)

According to Porto (2010), the Federal University of Rio de Janeiro (UFRJ) implemented on November 20, 2010, the Evaluation of Disciplines and Teachers by Students. Through a tool available in the Integrated Academic Management System (SIGA), students can evaluate, on a non-mandatory basis, all subjects taken in the semester.

Among other subjects, the questions include the degree of compliance with the menus, the effectiveness of the teaching method and the infrastructure.

The "Evaluation of Disciplines and Teachers by Students" was still available on an experimental basis at the Polytechnic/UFRJ and was inspired by a previous evaluation system employed at the Center for Technology and the Center for Mathematical and Natural Sciences of the University.

#### 2.7.5 Federal University of Minas Gerais (UFMG)

According to the UFMG website (2011), the student evaluation of the subjects studied during a semester is a procedure implemented at the University since 1996. It is done by completing, at the end of the semester, a questionnaire about each undergraduate subject in which the student was enrolled.

For each subject, an evaluation questionnaire is also completed for each teacher who taught it. The filling is done through the internet and occurs along with the registration process for the subsequent semester.

The student can decide whether or not to complete the assessment questionnaires by going to the assessment page on the internet to make their decision explicit. Also, this semester's graduating students are presented with a questionnaire to evaluate the course.

#### 2.7.6 Pontifical Catholic University of Rio de Janeiro (PUC-RIO)

The PUC-RIO evaluation system has been in use since 2002 and was redefined in 2005.

Undergraduate students evaluate teachers in that period at the end of each semester. Teachers and students can consult the results in the Teacher Assessment System using the online PUC login and password. The dissemination of these results has the following purposes:

First) to serve as a consultation tool for the student at enrollment, providing a conscious and transparent choice of subjects and classes;

Second) provide information for teacher improvement, allowing the professional to know their strengths and points that require growth;

Third) serve as a complementary tool for academic planning, generating historical data for the analysis of the progress of subjects and teaching performance;

Fourth) serve as a subsidy to the Institutional Evaluation process (PUC-RIO, 2011).

#### 2.7.7 Federal University of Rio Grande do Sul (UFRGS)

Since 2006, following the reformulation of the teacher's assessment by the student, the Institutional Assessment Secretariat (SAI) has provided to all UFRGS courses an online questionnaire to collect student feedback about the subject development as well as teacher performance.

In this questionnaire the student answers 10 questions, using a scale from 1 to 5, according to their agreement with the question, 1 to disagree and 5 to agree.

At the end of the questionnaire, the student may also explain the grade for each subject and teacher, and the student's name is kept confidential. Results reports are dynamically generated and made available to each unit if requested (MOTTA, 2009).

#### 2.7.8 Federal Technological University of Paraná.

The evaluation of the teacher by the student occurs in two moments: in the first and second semester of each year, through electronic form.

The evaluations remain in the database and are processed by the Information Technology Management Direction (DIRGTI). The results are released to the Academic Departments and Course Coordinators after the end of the semester so that students are not repressed when evaluating their current teachers.

It is worth remembering that the evaluations are performed through electronic forms, available on the

intranet and internet so that students can complement them according to their preference and availability.

### **3. Methodology**

The research has an applied nature since the knowledge generated can be applied by the managers of UFAM. Regarding the objectives, the research is descriptive, since it will use descriptive statistics to analyze the results without changing the values of the variables involved.

Data was collected and analyzed with a combined approach (qualitative and quantitative), through a case study, use of survey and bibliographic research, which was performed by reading articles that approached performance evaluation, including cases performed in Brazilian universities.

As few articles were identified it was considered the experiences described on websites of universities whose Industrial Engineering courses were well evaluated by the 2008 ENADE.

Given this, from reading of articles (STRASSBURG, U.; MOREIRA, DA, 2002; MACEDO, S. A, 2001; SILVA, 2011) and the analysis of the teacher evaluation instrument used by UFAM and the eight universities described in section 2.7, a questionnaire (Appendix 1) was developed to collect the data, containing 3 sections:

Section 1 has a question that evaluates from 0 to 10 the student's level of satisfaction with each teacher who taught the course over the period. The Scale used was Likert where 1 means very dissatisfied and 10 very satisfied. To this end, 11 items were placed to be evaluated, which were chosen from the literature review and also in consultation with students of the Industrial Engineering course who studied disciplines with the author in 2010. The selected items were: the quality of material presented in class; evaluation methodology; subject domain; available to answer question; dynamic classes; meets teaching plan; exposes the subjects clearly; demonstrates ability to motivate students; assiduousness; presents the partial scores and frequencies before the test; presents real cases of knowledge application.

Section 2 is an open-ended question about student opinion regarding the teacher's assessment by the UFAM portal. Section 3 is another open-ended question about what other indicators the student considers relevant to evaluate teacher services.

The target audience was 161 students enrolled in the 2nd, 4th, 6th and 8th semesters of the second semester of 2011, and the students of the 10th semesters were not consulted because they are not frequently in college because of Supervised Internship II or Final Project of Course.

The questionnaire was applied in the classroom, the pilot test was performed with 12 randomly selected students in the second half of October 2011 to verify the comprehensibility level of the questionnaire. As there was no need to make changes, the questionnaire applied to the other students from the end of October until the first half of November 2011.

Then, the data were collected, typed in a spreadsheet CALC for the development of Figures and Tables, aiming at the discussion of the results and the construction of an article that was defended in December 2011 for an examination board of the Industrial Engineering course at FT/UFAM.

### **4. Results**

In total (Chart 1), 112 students answered the questionnaire correctly, which represented almost 70% of

students enrolled in the 2nd, 4th, 6th and 8th periods or 51.4% of all students in the Industrial Engineering course enrolled in the second semester of 2011.

STUDENTS/PERIODS	2th	4th	6th	8th	Total
Enrolled Students	47	41	35	38	161
Interviewed Students	28 (59.6%)	28 (68,3%)	28 (80%)	28 (73,7%)	112 (69.6%)

Chart 1 – Number and percentage of respondents (October and November, 2011)

Source: Author

For the analysis, the general mean and standard deviation were observed. The sections present the analysis by period and for ethical reasons, the names of teachers will not be cited, using only the designation of subjects, as well as highlighting the level of satisfaction of the underperforming subjects.

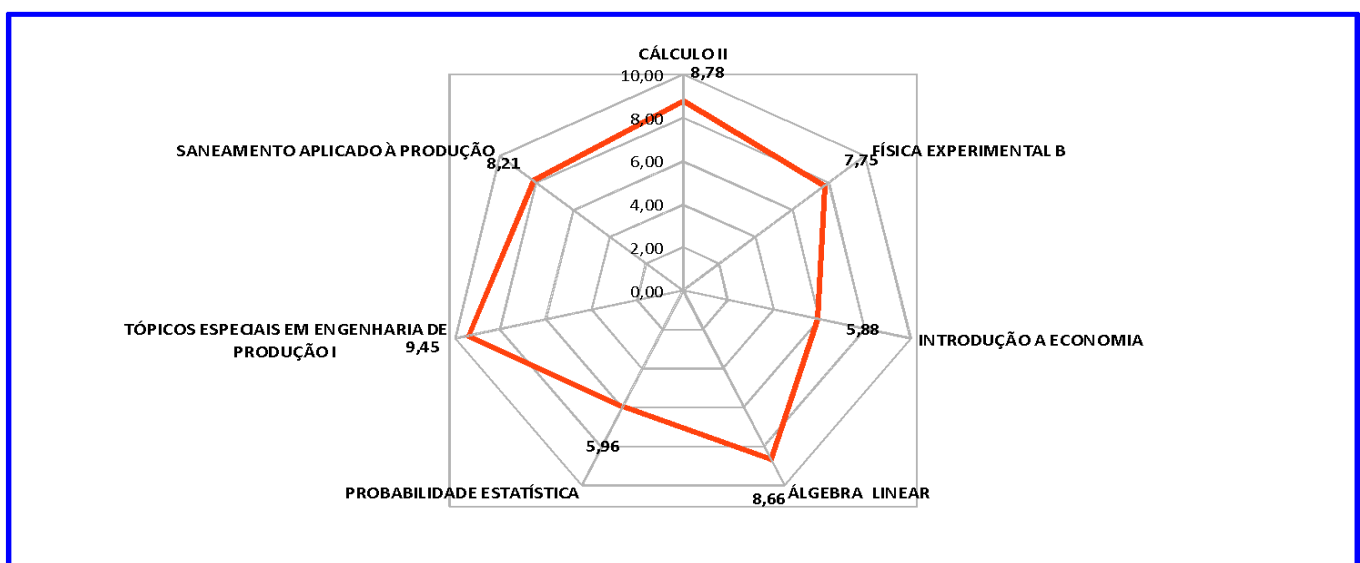


Figure 2 – Students' level of satisfaction with subjects taught in the second period of 2011

Source: Author

#### 4.1 Analysis of student satisfaction with the 2nd period subjects

Seven subjects were offered in this period (Figure 2): Calculus II (Cálculo II), Experimental Physics B (Física Experimental B), Introduction to Economics (Introdução a Economia), Linear Algebra (Álgebra Linear), Probability & Statistics (Probabilidade e Estatística), Special Topics of Industrial Engineering I (Tópicos Especiais em Engenharia de Produção I) and Sanitation Applied to Industrial Engineering (Saneamento aplicado a Engenharia de Produção). In the second semester there were 47 students enrolled, of which 28 (59.6%) answered the questionnaire correctly. Analyzing the results of Figure 2, it is observed that in general the teachers of the Special Industrial Engineering Topics I ( $X = 9.45$ ;  $S = 1.38$ ), Calculus II ( $X = 8.78$ ;  $S = 1.33$ ), Linear Algebra II ( $X = 8.66$ ;  $S = 1.64$ ), Sanitation Applied to Production ( $X = 8.21$ ;  $S = 1.13$ ) and Experimental Physics B ( $X = 7.75$ ;  $S = 1.96$ ) were the best evaluated by the students, while the teachers of Introduction to Economics ( $X = 5.88$ ;  $S = 2.41$ ) and Probability & Statistics ( $X = 5.96$ ;  $S = 2.61$ ) were considered regular.





Figure 3 – Performance of teacher that taught Economy Introduction

Source: Author

Regarding the Introduction to Economics discipline (See Figure 3), the main points that were considered below regular and need to be improved are: demonstrates ability to motivate students ( $X = 3.64$ ;  $S = 2.36$ ); teaches dynamic classes ( $X = 3.89$ ;  $S = 2.72$ ); available at the institution to answer questions ( $X = 4.20$ ;  $S = 2.29$ ); Exposes matter clearly ( $X = 4.61$ ;  $S = 2.51$ ); Evaluation Methodology ( $X = 4.79$ ;  $S = 2.88$ ) and Has mastery of the subject ( $X = 4.96$ ;  $S = 2.70$ ).



Figure 4 - Performance of teacher that taught Probability &amp; Statistic

Source: Author

On the other hand, the strengths were: (1) It is assiduousness ( $X = 9.25$ ;  $S = 1.14$ ); Complies with the teaching plan ( $X = 7.75$ ;  $S = 3.52$ ); Quality of material (slides and handouts) presented to students ( $X = 7.64$ ;  $S = 1.70$ ); Reveals partial grades/frequencies prior to Final Exam ( $X = 7.14$ ;  $S = 2.12$ ).

When analyzing the Probability and Statistics discipline (Figure 4), the points the teacher needs to improve on are: Assiduousness ( $X = 3.85$ ;  $S = 3.35$ ); Presentation of partial notes and frequencies before the Final Exam ( $X = 4.52$ ;  $S = 3.33$ ); Availability at the institution to answer questions ( $X = 4.59$ ;  $S = 2.22$ ); Ability to motivate students ( $X = 4.67$ ;  $S = 2.57$ ); Comply with the teaching plan ( $X = 5.85$ ;  $S =$



2.30).

On the other hand, the subject's teacher presented as strengths: Evaluation methodology ( $X = 8.07$ ;  $S = 2.24$ ) and mastery of the subject ( $X = 7.44$ ;  $S = 2.68$ ).

#### 4.2 Analysis of student satisfaction with 4th grade subjects

Six subjects were offered to students from this period (Figure 5), namely: Sanitation Applied to Production, Special Topics in Industrial Engineering I, Special Topics in Industrial Engineering II, Transport Phenomena, Analog Electronics, Sociology of Labor and Ethics.

In the second semester there were 41 students enrolled, of which 28 (68.3%) answered the questionnaire correctly.

Analyzing the results of Figure 5, it is observed that in general the students are satisfied with all the subjects taught. Sanitation Applied to Production ( $X = 9.18$ ;  $S = 1.16$ ), Special Topics in Industrial Engineering II ( $X = 9.14$ ;  $S = 0.19$ ), Special Topics in Industrial Engineering I ( $X = 9.05$ ;  $S = 1.07$ ), Transport Phenomena ( $X = 8.26$ ;  $S = 2.05$ ), Analog Electronics ( $X = 8.24$ ;  $S = 1.64$ ) were the best evaluated by students, while Sociology of Labor and Ethics ( $X = 7.90$ ;  $S = 1.63$ ) was which presented lower performance.

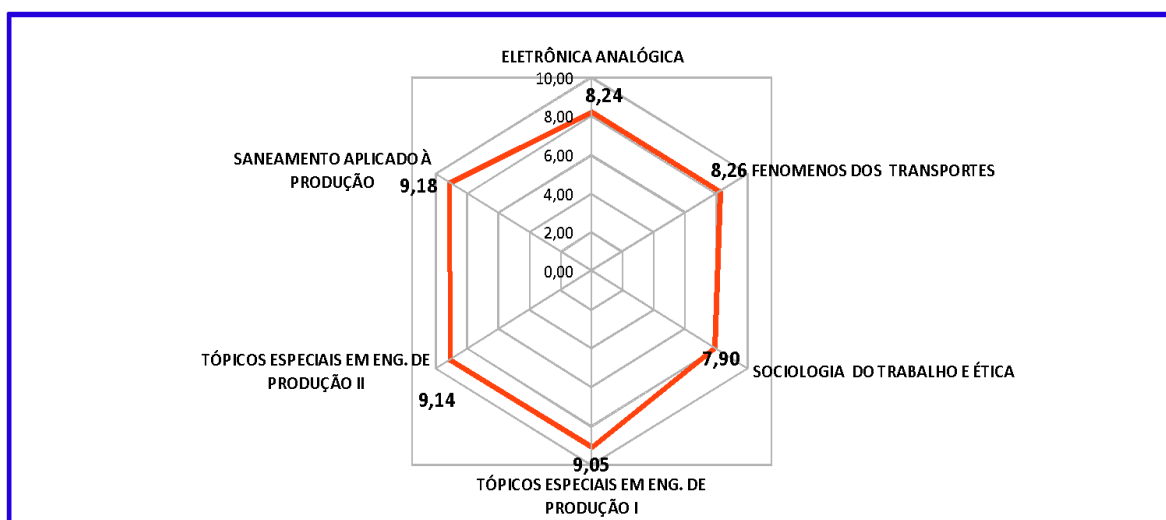


Figure 5 - Students' level of satisfaction with subjects taught in the fourth period of 2011

Source: Author

Regarding the discipline of Sociology of Labor and Ethics (Figure 6), the points that need to be improved are: Presenting partial grades and frequencies before the Final Exam ( $X = 7.00$ ;  $S = 2.94$ ) and Presenting more real cases of knowledge application ( $X = 7.52$ ;  $S = 1.67$ ).



Figure 6 - Performance of teacher that taught Work Sociology and Ethic

Source: Author

#### 4.3 Analysis of student satisfaction with 6th semester subjects

About 35 students were enrolled to study 6th grade subjects, of which 28 (80%) answered the questionnaire. Regularly, students in the sixth period studied six subjects, two of which (Special Topics in EP I and II) did not enter the analysis because both are special and less than 8 students answered the question, which could influence the overall results of the period. Analyzing the respondent data, there is a high level of dissatisfaction with teachers from the Fundamentals of Industrial Automation, Metrology & Standardization, Industrial Electrical Installations, and Materials.

Analyzing the results of Figure 7, it is observed that the teachers of the Materials ( $X = 5.48$ ;  $S = 2.10$ ); Industrial Electrical Installations ( $X = 5.69$ ;  $S = 1.90$ ) and Metrology & Standardization ( $X = 5.84$ ;  $S = 2.46$ ) achieved regular performance, while Fundamentals of Industrial Automation ( $X = 6.45$ ;  $S = 1.96$ ) was better evaluated, but staying between regular and satisfied.

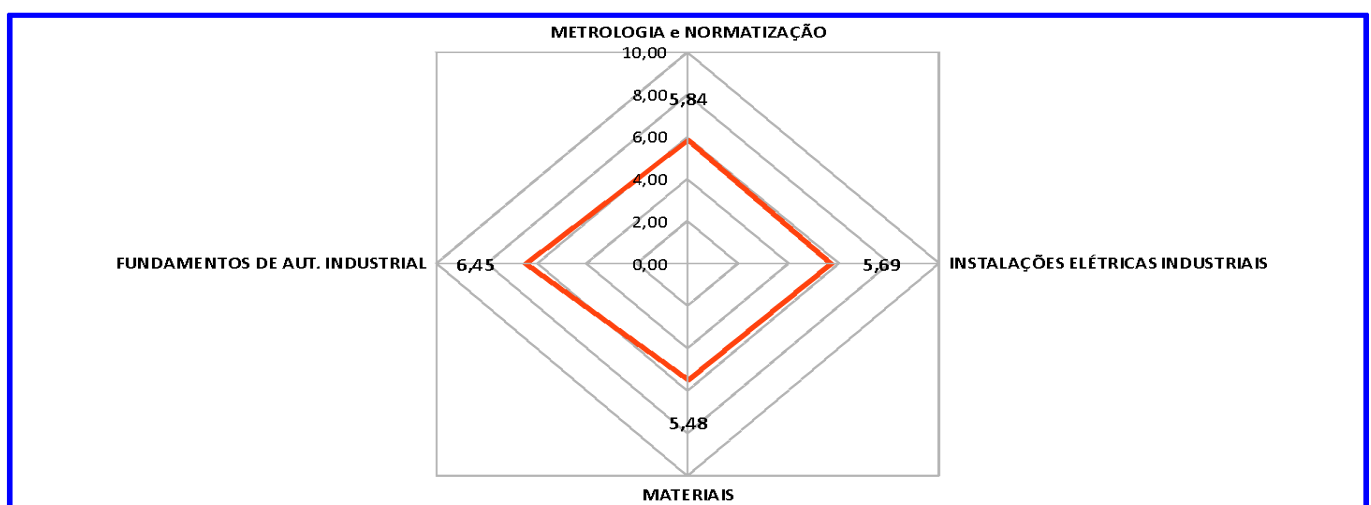


Figure 7 – Students' level of satisfaction with subjects taught in the sixth period of 2011

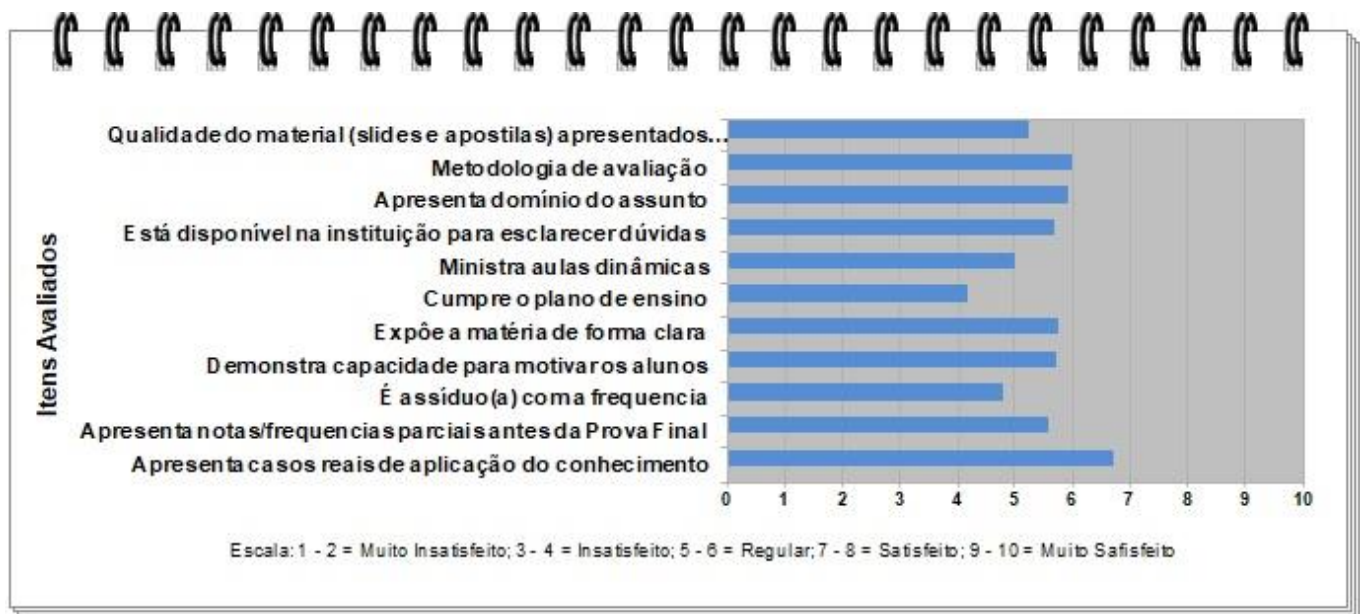


Figure 8 – Performance of teacher that taught Material

Source: Author

The worst performing subject was Materials (Figure 8) and the points with the highest level of dissatisfaction were: Does not comply with the teaching plan ( $X = 4.15$ ;  $S = 2.46$ ); Low attendance with frequency ( $X = 4.77$ ;  $S = 2.61$ ); Class dynamics ( $X = 4.96$ ;  $S = 1.98$ ); Poor quality of material (slides and handouts) presented to students ( $X = 5.23$ ;  $S = 2.23$ ); Failure to present partial grades and frequencies before the Final Exam ( $X = 5.56$ ;  $S = 1.73$ ); Unavailability at the institution to answer questions ( $X = 5.65$ ;  $S = 2.20$ ); Ability to motivate students ( $X = 5.69$ ;  $S = 1.71$ ); Exposure of matter clearly ( $X = 5.73$ ;  $S = 1.95$ ); Subject domain ( $X = 5.92$ ;  $S = 2.27$ ) and Evaluation Methodology ( $X = 5.96$ ;  $S = 2.52$ ). On the other hand, the presentation of real cases of knowledge application ( $X = 6.69$ ;  $S = 1.40$ ) was the only item with a certain student satisfaction index.

Regarding the Industrial Electrical Installations (Figure 9), most of the evaluated items are below the regular level of student satisfaction, except for the subject domain item ( $X = 6.81$ ;  $S = 1.71$ ).



Figure 9 - Performance of teacher that taught Electric Installations

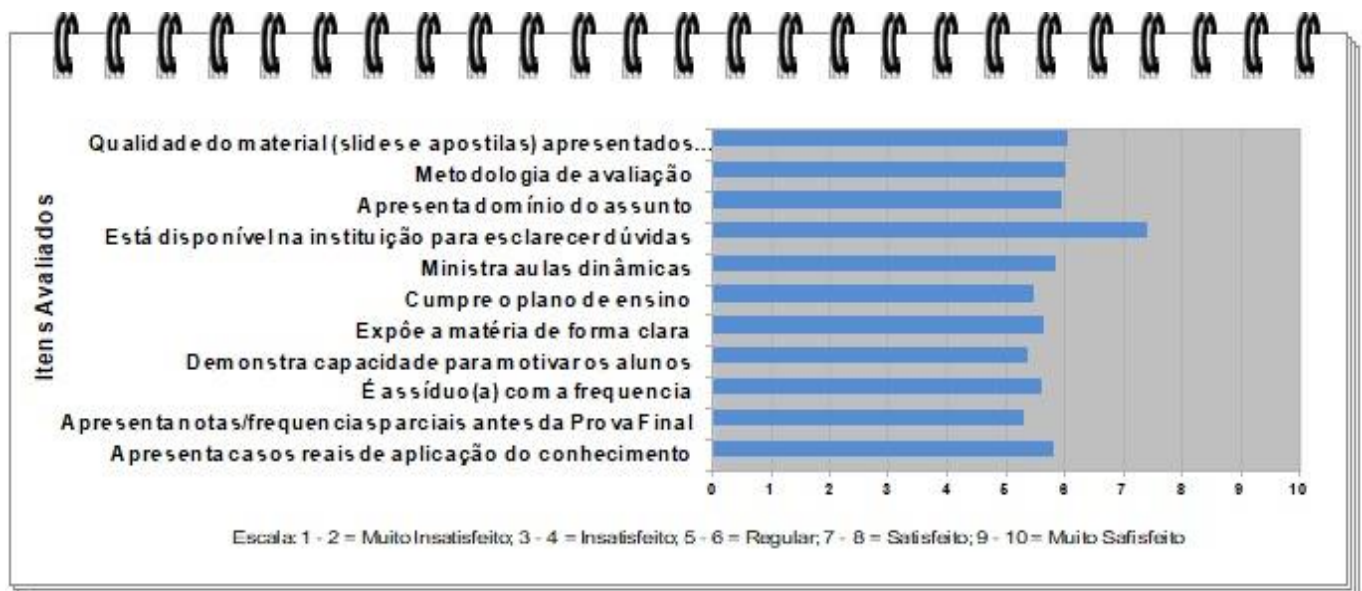


Fig. 10 - Performance of teacher that taught Metrology and Standardization

Source: Author

About Metrology & Standardization (Figure 10), it is clear that although the teacher is available at the institution to answer questions ( $X = 7.37$ ;  $S = 2.20$ ), most of the evaluated items had equal performance or below regular.

Although the discipline of Fundamentals of Industrial Automation (Figure 11) presented a better performance concerning the other three evaluated, most of the teacher's items were between regular and satisfactory, highlighting only the mastery of the subject by the teacher ( $X = 7.47$ ;  $S = 1.58$ ).

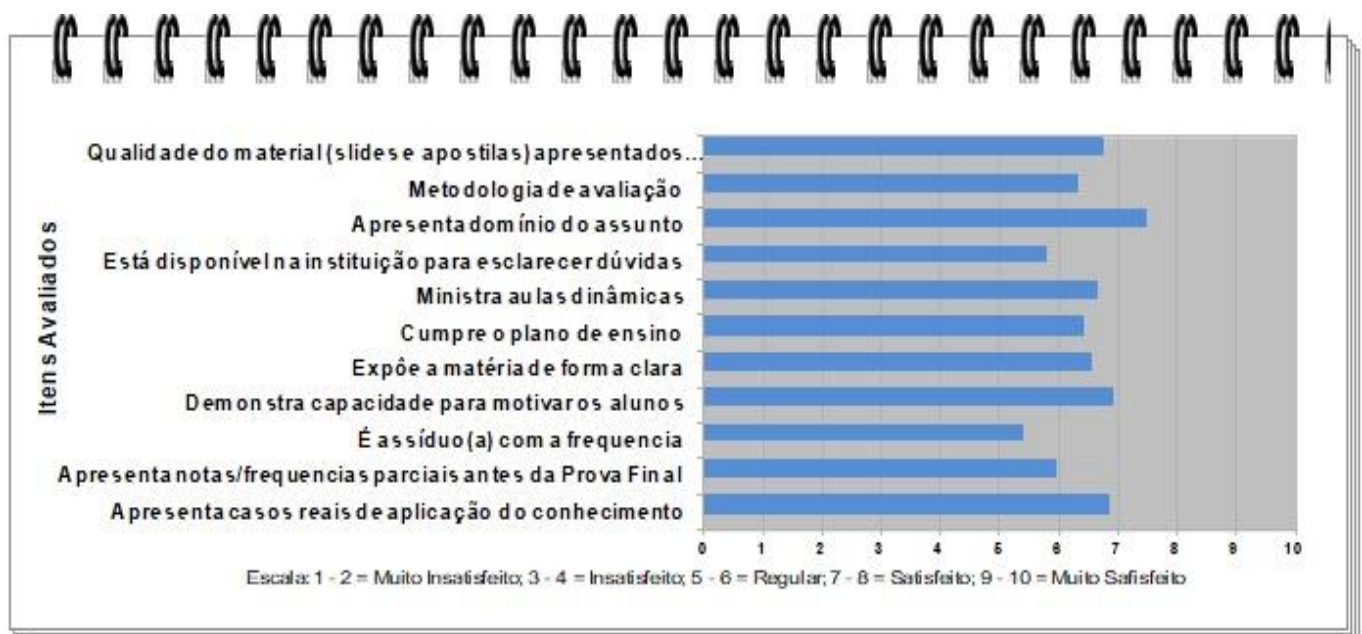


Figure 11 – Performance of teacher that taught Industrial Automation Fundamentals

Source: Author



#### 4.4 Analysis of student satisfaction with 8th grade subjects

About 38 students enrolled in the subjects offered for the eighth period, 28 (73.7%) answered the questionnaire correctly.

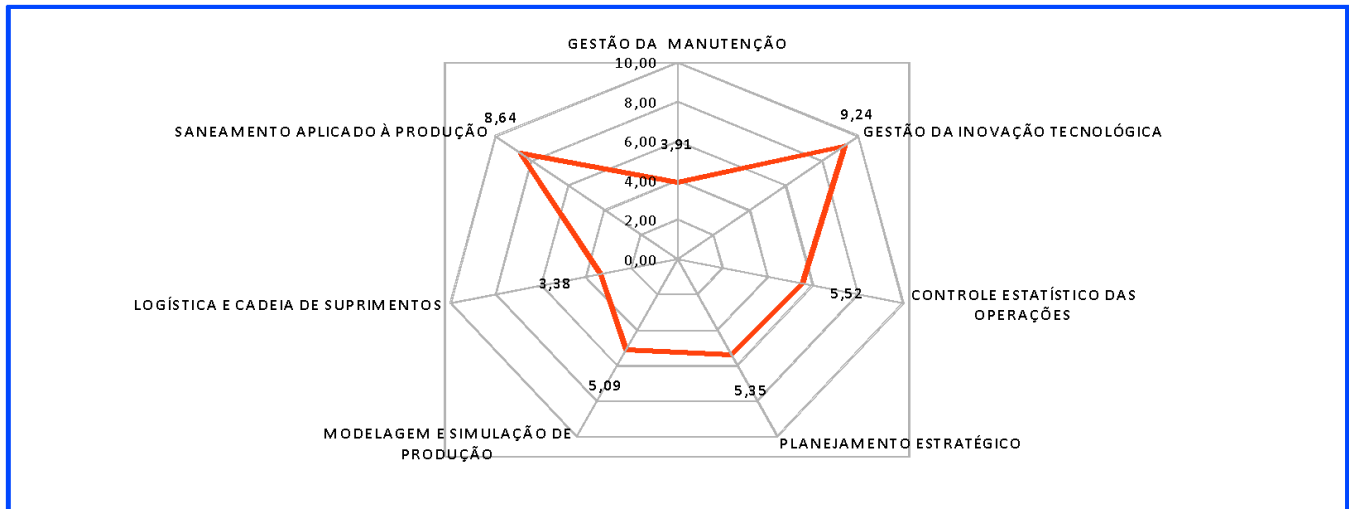


Figure 12 – Students' level of satisfaction with subjects taught in the eighth period of 2011

Source: Author

Seven subjects were evaluated in this period (Figure 12). Technological Innovation Management ( $X = 9.24$ ;  $S = 0.90$ ) and Sanitation Applied to Production ( $X = 8.64$ ;  $S = 1.19$ ) obtained good satisfaction level, while Logistics and Supply Chain ( $X = 3.38$ ;  $S = 2.16$ ), Maintenance Management ( $X = 3.91$ ;  $S = 2.59$ ), Production Modeling and Simulation ( $X = 5.09$ ;  $S = 2.43$ ), Strategic Planning ( $X = 5.35$ ;  $S = 2.13$ ) and Statistical Control of Operations ( $X = 5.52$ ;  $S = 2.16$ ) achieved a level equal to or below to regulate.



Figure 13 - Performance of teacher that taught Logistic and Supply Chain

Source: Author

The underperforming discipline was Logistics and Supply Chain (Figure 13). It was observed that all items had below-regular satisfaction indices: Assiduousness ( $X = 2.67$ ;  $S = 1.78$ ); Presentation of partial

grades and frequencies before the Final Exam ( $X = 2.85$ ;  $S = 1.83$ ); Quality of material (slides and handouts) presented to students ( $X = 2.89$ ;  $S = 2.06$ ); Class dynamics ( $X = 3.19$ ;  $S = 2.13$ ); Ability to motivate students ( $X = 3.33$ ;  $S = 2.29$ ); Exposure of matter clearly ( $X = 3.33$ ;  $S = 2.18$ ); Availability at the institution to answer questions ( $X = 3.33$ ;  $S = 1.93$ ); Evaluation Methodology ( $X = 3.89$ ;  $S = 2.26$ ); It presents real cases of knowledge application ( $X = 3.93$ ;  $S = 2.50$ ); and Subject domain ( $X = 4.52$ ;  $S = 2.68$ ).



Figure 14 - Performance of teacher that taught Maintenance Management

Source: Author

Regarding the Maintenance Management discipline (Figure 14), all items need to be improved as they are below the regular level of satisfaction: Quality of material (slides and handouts) presented to students ( $X = 3.45$ ;  $S = 2.52$ ); Ability to motivate students ( $X = 3.47$ ;  $S = 2.34$ ); Presentation of partial grades and frequencies before the Final Exam ( $X = 3.67$ ;  $S = 2.82$ ); Assiduousness ( $X = 3.80$ ;  $S = 2.74$ ); Compliance with the teaching plan ( $X = 3.80$ ;  $S = 2.50$ ); Dynamic classes ( $X = 3.84$ ;  $S = 2.43$ ); Availability at the institution to answer questions ( $X = 4.00$ ;  $S = 2.35$ ); Exposure of matter clearly ( $X = 4.10$ ;  $S = 2.75$ ); Subject domain ( $X = 4.25$ ;  $S = 2.73$ ); Evaluation Methodology ( $X = 4.30$ ;  $S = 2.90$ ); and Presentation of real cases of knowledge application ( $X = 4.30$ ;  $S = 2.34$ ).

About Production Modeling and Simulation (Figure 15), all items are at or below the regular satisfaction level: Exposure of the subject clearly ( $X = 4.24$ ;  $S = 2.02$ ); Ability to motivate students ( $X = 4.62$ ;  $S = 2.22$ ); Presentation of real cases of knowledge application ( $X = 4.86$ ;  $S = 2.73$ ); Presentation of partial grades and frequencies before the Final Exam ( $X = 5.00$ ;  $S = 2.81$ ); Subject domain ( $X = 5.05$ ;  $S = 2.54$ ); assiduousness ( $X = 5.10$ ;  $S = 2.55$ ); Quality of material (slides and handouts) presented to students ( $X = 5.10$ ;  $S = 2.28$ ); Dynamic classes ( $X = 5.43$ ;  $S = 2.40$ ); Evaluation Methodology ( $X = 5.52$ ;  $S = 2.62$ ); Compliance with the teaching plan ( $X = 5.71$ ;  $S = 2.72$ ), Availability at the institution to answer questions ( $X = 5.95$ ;  $S = 2.39$ ).

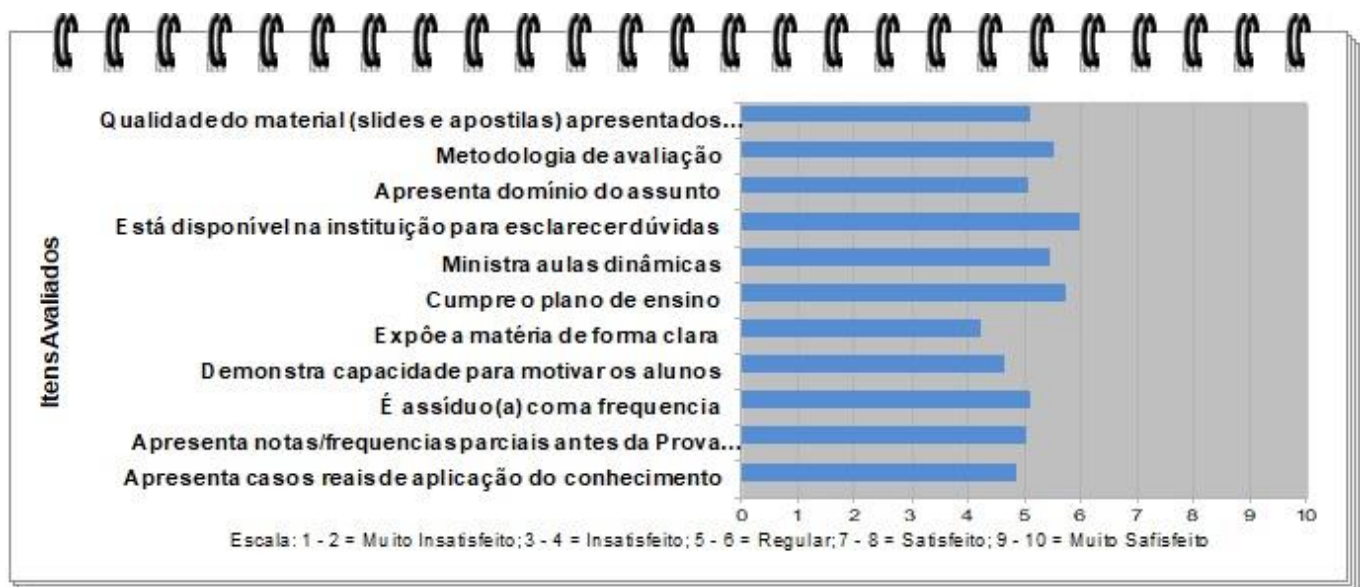


Figure 15 - Performance of teacher that taught Modeling and Simulation

Source: Author

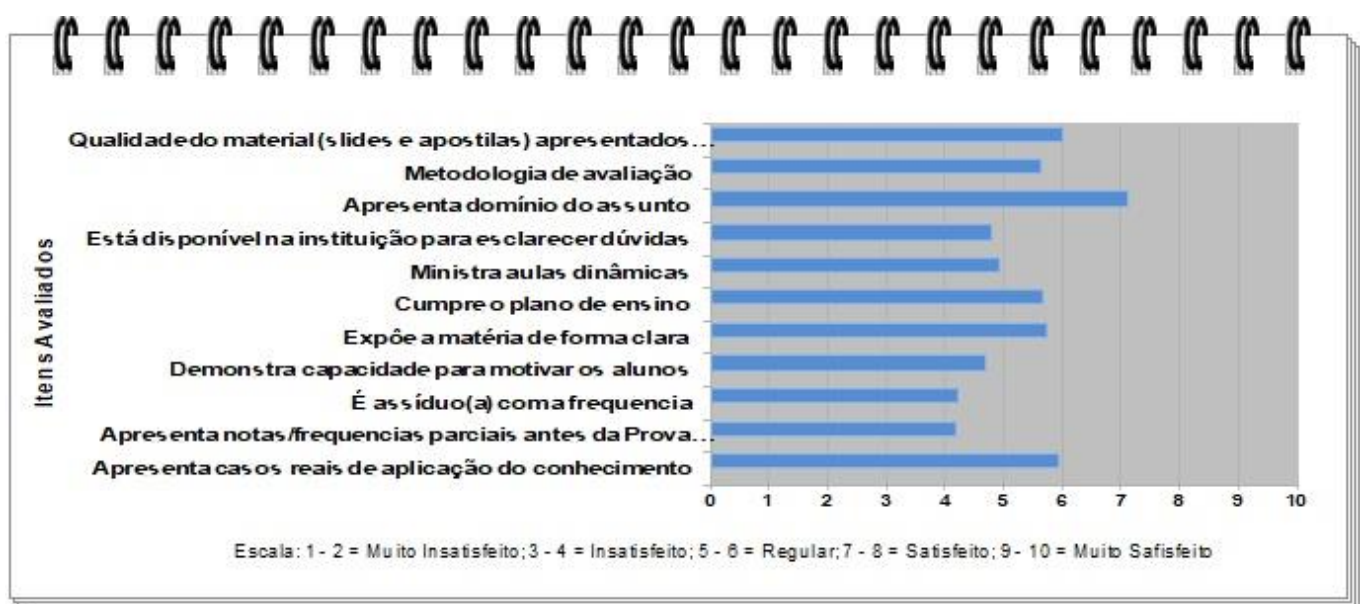


Figure 16 - Performance of teacher that taught Strategic Planning

Source: Author

Concerning Strategic Planning (Figure 16), most of the evaluated items were between dissatisfied and regular. The teacher's best assessment was his mastery of the subject ( $X = 7.13$ ;  $S = 1.54$ ).

Finally, the results in Figure 17 show that most of the evaluated items of the professor who teaches the discipline Statistical Control of Operations were between dissatisfied and regular. The teacher's best evaluation was the Mastery of the subject ( $X = 7.23$ ;  $S = 1.57$ ).



Figure 17 - Performance of teacher that taught Operations Statistic Control

Source: Author

#### 4.5 Student satisfaction analysis with UFAM teacher evaluation portal

At the end of the interview, each student was asked to answer an open-ended question “What do you think of the teacher assessment made on the student portal?”.

Of the 112 students interviewed, 33 (29%) declined to respond but 34% evaluated as negative, another 27% considered it positive, while only 10% considered the site as positive but with aspects to improve.

Regarding students who expressed NEGATIVE opinion, the following arguments were identified: first) students do not see practical results, no improvement over time; second) there is no feedback and no action plan for improvement is presented; third) it is not possible to evaluate teachers correctly because it is a mandatory option; fourth) the quiz is tiring and it is not clear if anyone really evaluates that.

#### 4.6 Student suggestions for other performance indicators

Finally, the interview ended with the question "What other indicator do you consider relevant to measure the quality of teacher service?"

After systematizing the responses, it was observed (Figure 18) that half of the students did not respond to the request. Respondents expressed their concern (12%) to develop some indicators that would allow real-time monitoring of the teacher's presence at the university to help find them more efficiently over time, as shown by a portion of the teachers presented a lower than the expected index concerning its availability at the university.

Next, it was suggested to create an indicator related to the student approval rate (11%) to measure the success of the professor teaching the discipline.

Some indicators focus on their ability to approve (Student Approval Rate) and Managing Research Projects (5%), Number of Monthly Meetings between students and FT/UFAM managers to solve student problems, as well as an indicator of Self-assessment to be made by the teacher.



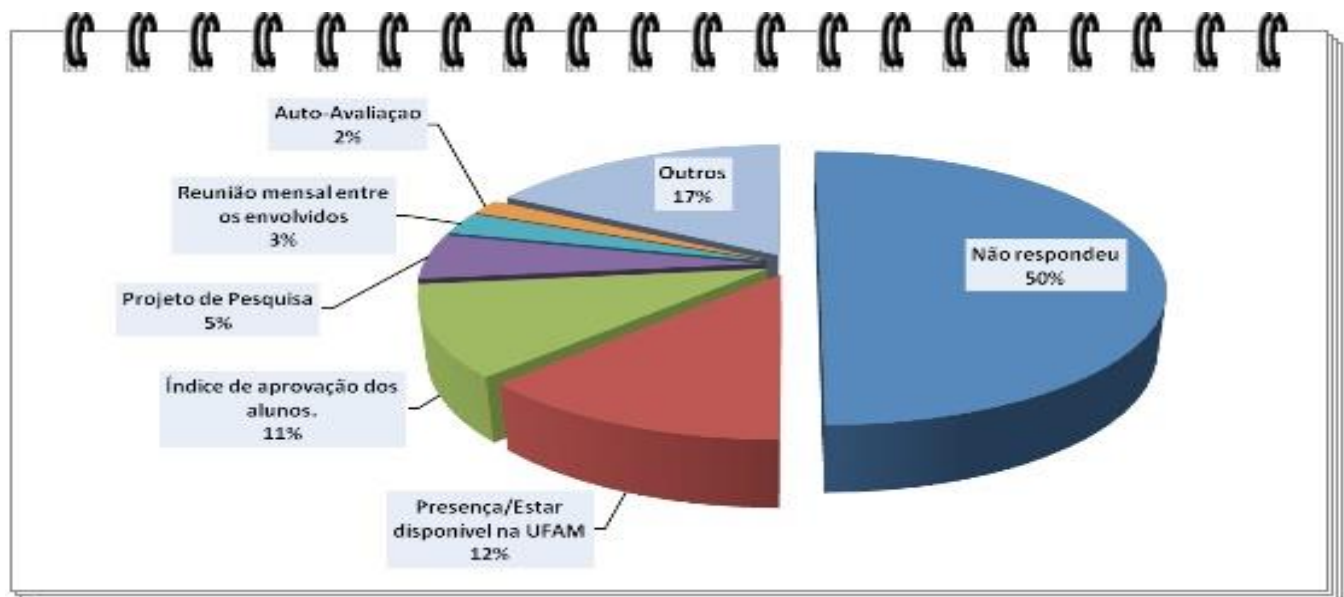


Figure 18: Other relevant indicators proposed by the respondents

Source: Author

## 5. Conclusions

This article aimed to evaluate the level of satisfaction of students from the 2nd to 8th period of the Industrial Engineering course at FT-UFAM, in order to propose improvements for the university.

To this end, a questionnaire consisting of 11 evaluative items and two open-ended questions was applied to 112 students during October and November 2011.

After analyzing the data, the following conclusions and suggestions for improvements were made:

First, the UFAM portal for students to rate teachers was considered negative by just over a third of respondents, with obligatory, too many questions, lack of feedback and improvement actions being the main reasons whereby a good proportion of students are not motivated to express their opinions seriously. As a suggestion for improvement, UFAM managers are recommended to a) make the assessment a voluntary act; b) students and teachers have online access to the actions being taken to disseminate the good teaching and learning methods of the best teachers, as well as to improve the weaknesses of those teachers identified in the assessment; c) as with Anhanguera University, the results could be statistically treated and published in the form of teacher performance percentage indices, called the Student Satisfaction Level (NSD); d) designate a team composed of the course coordinator, class representatives, and teachers to perform bimonthly improvement actions identified in the evaluations of the previous semester; e) recognize and reward the best performing teachers over time;

Second) The evaluation questionnaire performed well concerning the closed questions, but about the open questions, the students found it difficult to position themselves critically to what was asked. Through this data collection instrument, it was found that the best-evaluated teachers were responsible for the disciplines Special Topics of EP I and II, Management of Technological Innovation, Sanitation Applied to Production, Calculus II, Linear Algebra, Transport Phenomena, and Digital Electronics. As a suggestion for improvement, a benchmark study could be done to identify in more detail the methodologies developed by these teachers to hold seminars to discuss and disseminate best teaching practices;

Third) In general, about the 11 proposed items, it was observed that the non-presentation of grades and frequencies before the final exam, the low ability to motivate students, the low attendance, the availability of teachers to answer questions and poor classroom dynamics are the top five items that need to be improved with the teaching community. As a suggestion, it is necessary to conduct periodic training for teachers, improve communication and coordination performance with those who teach classes in the Industrial Engineering course;

Fourth) For a successful teacher evaluation process to be implemented, a change of culture must be made among all involved, as for the faculty teachers, the objective of the evaluation should be viewed as a process of continuous improvement and not a punishment, whereas for students, this process should voluntarily reflect their interest in contributing to making their teaching and learning process as effective as possible, which is why their efforts together with the teacher help them achieve the goals of the Pedagogical Project of the course;

Fifth) There is a need to update this research to compare with the results obtained eight years ago. Besides, it is advisable to make assessments more periodically involving course coordination, student representatives and teachers. As a suggestion, it is proposed that this questionnaire be applied twice throughout the semester and that meetings be held between teachers and student representatives to analyze the results and perform improvement actions, thus contributing to the course grade reaching 5 in the year 2021.

## 6. Acknowledgement

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## Appendix 1. Questionnaire to evaluate teachers who taught in the UFAM/Industrial Engineering Course

Pesquisa para avaliar o nível de satisfação dos alunos com os serviços prestados pelos professores que ensinaram disciplinas para o curso engenharia de produção da FT/UFAM – Segundo semestre de 2011

1) Para cada item, informe de 0 a 10, o seu nível de satisfação com os serviços prestados pelos professores

Escala: 1 a 2 – Muito insatisfeito; 3 a 4 – Insatisfeito; 5 a 6 – Regular; 7 a 8 – Bom; 9 a 10 – Excelente

ITENS AVALIATIVOS	Professor e Disciplina	Professor e Disciplina	Professor e Disciplina	Professor e Disciplina	Professor e Disciplina
A qualidade do material apresentado nas aulas					
Metodologia de avaliação					
Apresenta domínio do assunto					
Está disponível na UFAM para esclarecer dúvidas					
Ministra aulas dinâmicas					
Cumpre o plano de ensino					
Expõe a matéria de forma clara					
Demonstra capacidade para motivar os alunos					
É assíduo com a frequência					
Apresenta as notas e frequências parciais antes da prova					
Apresenta casos reais de aplicação dos conhecimentos					
2) O que você acha da avaliação do professor feita pelo portal da UFAM?					
3) Que outro indicador você considera revelante para avaliar os professores?					

Source: Author (2011)

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## Variability reduction in Manaus' beer process production

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### Abstract

*Defined as the favorite drink to celebrate good times, beer has been making the drink market one of the most competitive in the Brazilian industry. Given this scenario, brewery industries need to maintain quality standards to gain consumer preference. In the company under study, located in Manaus Industrial Pole, it was found that in the beer production process, the brewhouse stage was not satisfying the brewery wort manufacturing time requirements, which is why it became the focus of this study. This paper aims to investigate and standardize a method to reduce the variability of beer time production in the brewhouse area. The data were collected from the monitoring of the wort production process, raising each time of the equipment of that stage, both before and after the application of the method. After data collection and analysis, it was concluded that it is possible to significantly reduce the variability in the wort production process by treating critical brewhouse equipment.*

**Keywords:** Variability; Quality; Beer;

### 1. Introduction

The beer market in Brazil is one of the most traditional, has a sector that is present in all cities of the country.

According to the Brazilian Beer Industry Association (ABIC, 2016):

The CervBrasil associates have 50 factories, operate a fleet of about 38 thousand vehicles and supply more than 1,2 million points of sale throughout the national territory. The sector is one of the most relevant in the Brazilian economy, with an investment close to \$12 billion between 2014 and 2016.

The Brazilian beer industry mobilizes thousands of suppliers of goods and services, as well as reaching professionals from the most diverse areas of activity. Thus, it involves a contingent of people and can reach 99% of Brazilian homes. CervBrasil revealed that in 2016 Brazil's beer sector kept 2.7 million jobs and produced about 14.1 billion liters in the year.

A survey conducted in 2013 by the Strategic Management Advisory Office of the Ministry of Agriculture, Livestock and Supply (MAPA) revealed that the increase in income of the Brazilian population in recent years has led to the consumption of higher value-added foods, such as beer, which has had an increase in its sales in recent years.

In this scenario, there is the focus of the research, a case study applied in the production process of a brewery that will be called brewery M for teaching purposes, located in the state of Amazonas with a productive sector divided into three macro stages:

**Brewhouse:** responsible for receiving, stocking, processing, and management of feedstock (malt, aromatic hop cone, bitterness hop cone, among others). This stage produces an average of 4,000 L of wort per day that is cold for the fermenting process, and it is necessary to ensure optimal conditions that do not cause problems in the following steps;

**Cellar:** It is responsible for the fermentation, centrifugation, and maturation of concentrated beer. This step also manages yeast and ensures that it is used efficiently during fermentations;

**Filtering:** Responsible for filtering and diluting matured beer from cellars. The filtration area has a large interface with the beer bottling area, as this is the last step of the process before transportation to the fill lines.

During the stages of beer production, several variables can impact the process, leading to a change in the taste of the product. Each equipment of the brewhouse process plays a crucial role in the production of the wort, so it is necessary to have an accurate permanence time in each of them. Thus, managers at Brewery M saw the need to ensure that all production batches had the same wort time, resulting in the standardization of production batches to ensure optimum physicochemical and sensory results. However, the brewery's brewhouse was failing to achieve homogeneity in brewery wort times.

Thus, the main question of the research is “how to standardize a method to reduce the variability of wort manufacturing time located in the brewhouse area of Brewery M?”

### ***1.1 Main objectives and relevance***

Given this context, the general objective of the research is to investigate and standardize a method to reduce the variability of wort manufacturing time within the brewhouse area.

To this end, it is intended to achieve the following specific objectives:

Obj1) identify methodologies to reduce variability in related brewery production processes;

Obj2) develop and test a method to reduce the variability of wort fabrication time in the brewhouse step;

Obj3) propose suggestions for improvements to the managers of this process.

This study is relevant for the following reasons:

R1) For the company: it will add knowledge about the causes and ways of treating variability for this type of process and can be applied in other units;

R2) For customers: the consumer is the biggest beneficiary of the reduction in beer production variability, as it ensures that they are not surprised when consuming the product, as they will have the acceptable profile and characteristics;

R3) For workers: the process without high variability results in better production performance, avoiding the need for unplanned work compensation. In addition to avoiding rework in the following process steps, because when a quality problem occurs in the brewhouse process it is only corrected in the following steps of the beer process;

R4) For the academy: the theme involves a product of high world consumption, and the study will contribute to the reflection of the subject, as well as to propose new research.

### **1.2 Feedstock and stages of the production process**

According to Ordinance No. 1/96 of January 3, 1996, of the Ministry of Agriculture, Livestock and Supply (MAPA, 1997), beer is understood to be the drink obtained by alcoholic fermentation through the yeast of the genus *Saccharomyces*, from a prepared malt wort, especially barley, where hop cone's flowers and drinking water are added. When talking about the beer production process it is crucial to start the approach from the feedstock beneficiation stage to the final filling process.

Regarding the raw material, water corresponds to 93% of the beer formulation, this water must be free of contamination and hard, ie, high in calcium and magnesium, as it serves as a nutrient for fermentative yeasts. Moreover, the water should be chlorinated and without iron.

The type of malt has a decisive influence on the characteristics of beer, its combination determines the final color, flavor, body, and aroma of beer (REINOLD, 2010). In the process, malt can be replaced by additives classified as starchy and sugary, such as rice, corn, and wheat. This practice is allowed in many countries, Brazilian legislation (MAPA, 1997) allows the partial substitution of malt by additives.

The Pilsen malt, which is used in light beers; Chocolate malt which is characterized by its toast and the strong color is widely used in dark beers; and caramel malt which is obtained from the caramelization of sugars during malting (CABRITA et al., 1985).

Another feedstock added in the wort manufacturing process is hop cone. The bitter resins and oils in the hop cone will give the beer the bitter aroma. It can be added as granulate, extract or plant itself (CABRITA et al., 1985).

In the fermentation process, yeast is added. As mentioned earlier, the yeast must be of the genus *Saccharomyces*. After fermentation, some additives may also be added, such as caramel extract that intensifies beer color and isomerized hop cone to increase beer spume stability and bitterness (CABRITA et al., 1985).

During the production of beer, there are several processes from the germination of barley to bottling of liquid. The main stages of beer processing can be divided into wort preparation, fermentation, maturation, filtration and bottling.

During the preparation of the wort happens the malt milling, which consists in the preparation of malt for mashing. According to Morado (2009), the purpose of milling is to break the grain and expose the starch contained inside. The process of mashing is considered the transformation of the feedstock into the wort, it is added water to the milled malt, where they are subjected to certain times and temperatures, resulting in a sweet solution called wort and still containing malt pomace.

Because it contains malt pomace, the wort is subjected to the filtration process, which consists of separating the pomace from the liquid wort (JUNIOR et al., 2009). This stage is very important because it gives the wort its first liquid form without malt pomace.

After filtration, wort boiling occurs which is responsible for the inactivation of enzymes, protein coagulation, and precipitation, concentration, and sterilization of the wort. Also, hop cone, caramel, and sugar, among others are added. At the end of the boiling, the wort is submitted to the decantation process, where a solid residue called trub is removed (SANTOS et al., 2005). Consequently, the wort is cooled to the correct temperature to start fermentation and in some cases, oxygen is added to favor the fermentation process (BOTELHO, 2009).



According to Morado (2009), fermentation is responsible for the transformation of fermentable sugars from wort into alcohol, carbon dioxide, and heat through chemical reactions within yeast cells. In this process, byproducts are formed which may provide pleasant or off flavors to the beer. The main compounds formed in fermentation are higher alcohols and esters, which are responsible for the fruity characteristics that some beers have.

During fermentation, another important byproduct is diacetyl, which plays an important role in the formation and elimination of off flavors, which is formed by yeast throughout the process. The high concentration of this substance develops a flavor reminiscent of rancid butter. After 7 to 12 days, the fermentation is completed, and after the yeast is removed through the decantation process. Then the beer maturation process begins, usually at the temperature below fermentation. In this phase, most sugars have already been metabolized and transformed.

After the beer has achieved the desired characteristics, a clarification is necessary to eliminate the particles that will give the beer turbidity. These particles are essentially yeast cells that have not been previously removed.

The clarification of the beer is achieved through centrifugation and the use of several types of filters, among them: the leaf, candle and press filters. According to Santos et al. (2005), the most widely used method is filtration with diatomaceous earth or diatomite. Botelho (2009) explains that the filtration stage beyond the objectives mentioned above has the function of microbiological stability.

At the end of the production process, the beer is kept under controlled conditions of pressure and temperature, to guarantee the taste and CO<sub>2</sub> content until filling. The filling stage is a critical moment, strict oxygen level control is required to ensure that the O<sub>2</sub> concentration is as low as possible, thus avoiding oxidation reactions as they lead to its deterioration and change of taste.

To ensure that microorganisms are not present and to extend the shelf life of the product, except for draught beer, bottled beer is subjected to the pasteurization process. Because it is a very sensitive drink, subject to rapid deterioration, it is necessary to have this process to make the beer more stable, allowing its distribution to places far from the brewery (MORADO, 2009).

The pasteurization process consists of heating the beer to approximately 60°C and then cooling to 4°C, generating a thermal shock in the microorganisms present in the product.

Figure 1 shows the flow of the beer process.

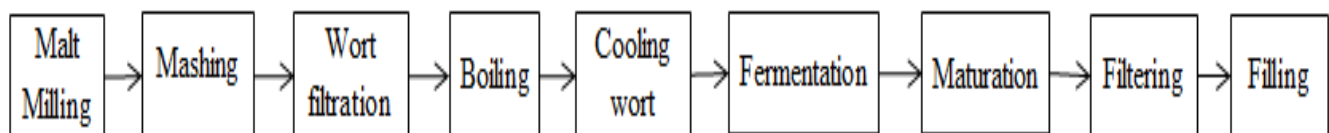


Figure 1: Beer production flow

Source: Author (2016)

### 1.3 Methodologies for reducing process variability

To improve the understanding of the concepts used in the problem-solving method of this article, the concept of PDCA will be approached with a presentation of its steps and tools used in each of them. Also, statistical concepts of process variability analysis will be used.

### 1.3.1 PDCA

The PDCA cycle is associated with the process model used by NBR ISO 9001 (ABNT, 2000) which defines the cycle as follows:

Plan: Establish the objectives and processes required to deliver results following customer requirements and organizational policies. Do: Implement the processes. Check: Monitor and measure processes and products according to product policies, objectives, and requirements and report results. Act: Take action to continually improve process performance (NBR ISO 9001, 2000).

According to Liker (2004), this problem-solving system can also be classified as developing critical thinking, as it encourages those involved to think critically in the investigation of causes and the analysis of process phenomena. Figure 2 summarizes the steps of this methodology.

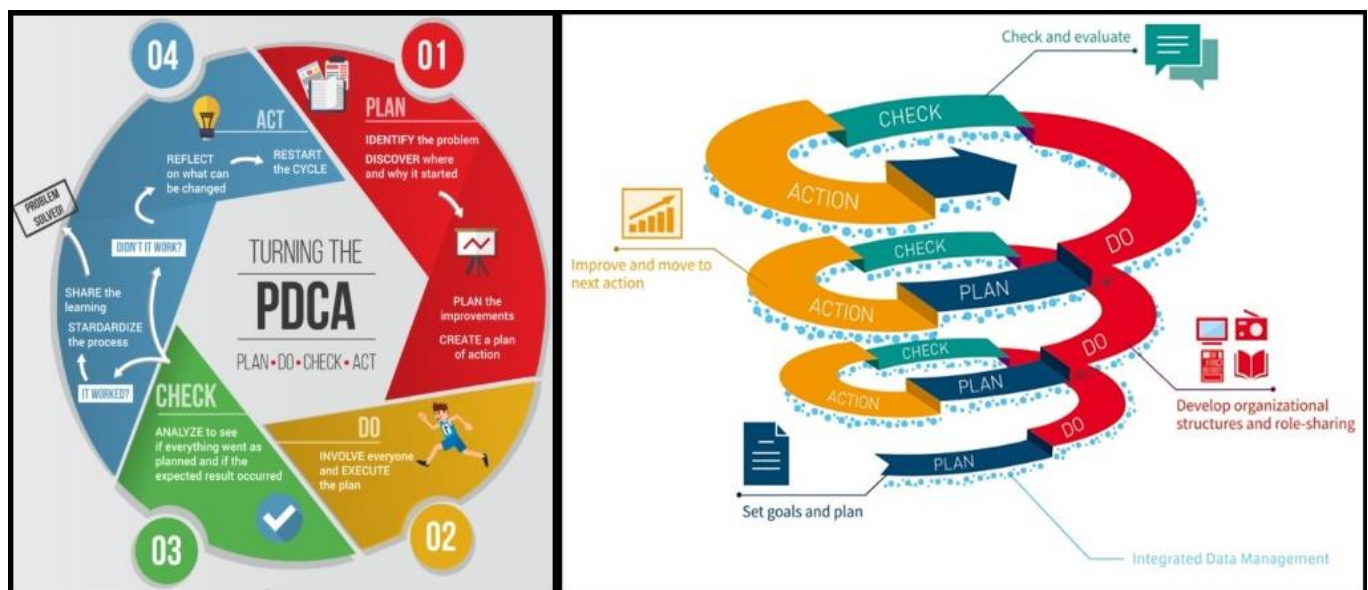


Figure 2: PDCA Cycle componentes and rotation

Sources: Siteware < <https://www.siteware.com.br/en> > and Asahi advertising < [asakonet.co.jp](http://asakonet.co.jp) >

According to Werkema (1995), PDCA is a decision-making method that seeks to ensure the achievement of the goals necessary for the survival of an organization. This method was developed by the American Shewhart but became known through Dr. Edward Deming when he went to Japan in the 1950s to teach Statistical Process Control.

The *Statistical Method from the Viewpoint of Quality Control*, published in 1939 by Dr. Walter A. Shewhart, is presented as the first publication on the PDCA. Known as a problem-solving method, it is mostly investigative and is implemented in steps.

The first step of the PDCA cycle is described by the letter P or *Plan*, it is considered the most important step as it triggers the entire subsequent cycle process. The success of applying this method to solve the

problem depends on the level of criticality employed in this step, as it will provide information for the rest of the process (BADIRU et al., 1993).

According to Badiru et al. (1993), important issues for understanding the purpose should be discussed, such as: the specific objective to be achieved by the organization, the people involved in this process, the timeframe for drawing up the action plan, the resources for completing the plan, the data to be collected during the process and any issues that may result in detailed process planning to be improved.

To analyze the problem in detail, some resources are used to detail the analysis. A popular tool used to perform stratification of the problem is the Pareto chart, it informs that most of the problems happen due to a few causes. Presented in the form of a cumulative frequency diagram, it ranks occurrences from highest to lowest percent, enabling you to determine priorities that help direct efforts to tackle really important problems.

Another tool used to understand the problem is process mapping, which is nothing more than a way to systematize information throughout the processes so it can be understood by other interested people. It provides an overview of the process and enables you to identify, analyze and develop improvements for the object of study. Visually shows how inputs, outputs, and tasks are related and include key process steps. Process analysis using maps helps improve customer satisfaction by identifying actions to eliminate defects, reduce costs, eliminate non-value-added steps, and increase productivity.

The visual representation of the process mapping can be accomplished through the elaboration of flowcharts. Intended for the description of processes, it is represented through graphic symbols the sequence of steps of work to facilitate its analysis. According to Oliveira (2002), a flowchart is a form of representation that uses conventional symbols and allows a clear and precise description of the flow or sequence of a process, as well as its analysis and redesign.

It is a resource used to analyze production systems, seeks to identify opportunities to improve process efficiency (PEINADO et al, 2007). The process is the combination of equipment, people, methods and tools that generate a product or service.

The most relevant points of a flowchart, according to Oliveira (2002), are: a) standardize the representation of methods and procedures; b) faster description of the methods; c) better reading and understanding of the production system; d) facilitate the location and identification of the most important aspects within the process; e) greater flexibility; f) better degree of analysis.

The Ishikawa diagram should be used to understand the causes of the problem (Figure 3). The tool consists of a diagram with a record of the various causes from the analysis of probable origins (SOUZA, 1997).

At the end of all analysis of the planning stage, an action plan should be created to achieve the proposed problem identification objective. For Campos (1996), the action plan enables management action through delegation to all involved. During the creation of the plan, the company must consider its available resources, its characteristics and the prioritization of the causes that will suffer interference.

To ensure that the action plan achieves the expected success, actions should be developed for each priority cause elected in the previous step. There will be measures for each cause, benefiting the control of the action to be taken. The process of elaboration of the actions should be carried out through group

discussions with the same people involved in the previous steps. After the action plan creation, the planning step of the PDCA cycle is completed and you can proceed to the next step called execute or *Do*.

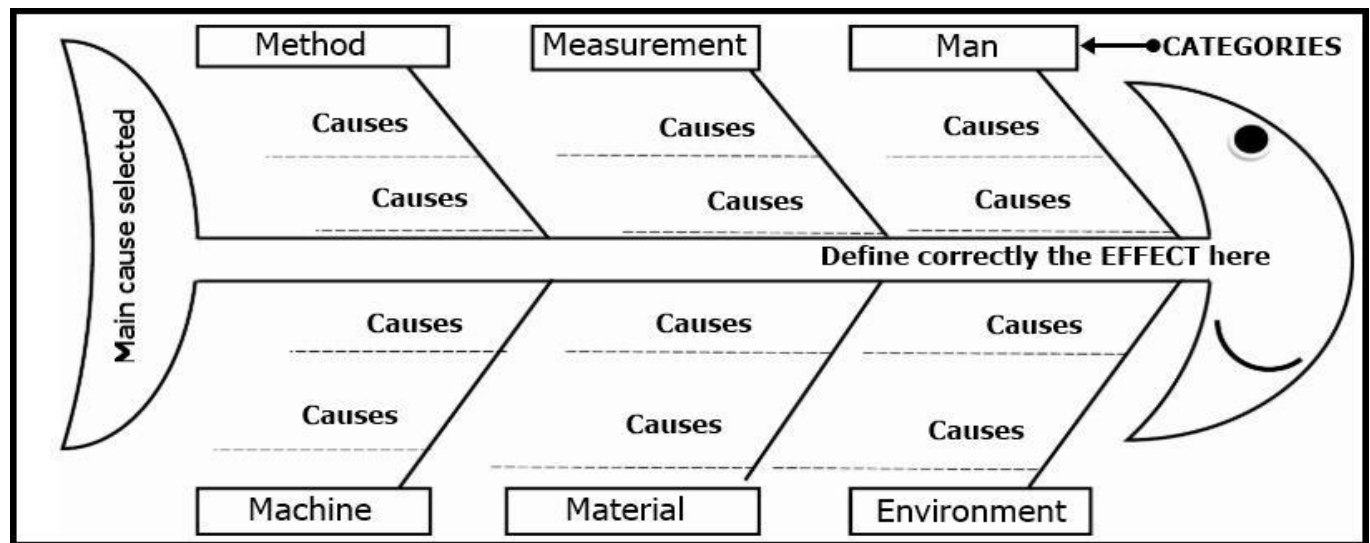


Figure 3: Cause and Effect Diagram components

Source: Author

The second step of the cycle is called execute, in this step, all actions planned in the previous step must be performed. This step will make it visible if the action plan was well structured in the plan step. It will allow the plan to be implemented in a gradual, organized manner and the measures to be taken will be more effective (BADIRU, 1993).

To achieve the desired effectiveness, Campos (2001) subdivides the process into two main steps: the knowledge stage and the action execution stage. At the knowledge stage, the organization should disclose the plan to all involved and emphasize so that it can be carried out to the best of its ability. Such disclosure should be done through participatory meetings where the tasks will be presented.

In the second stage defined by Campos (2001), after the disclosure of the plan and due understanding by all involved, the actions should be implemented. Control of the points present in the plan should be done to keep focus and eliminate any doubts that may appear during execution.

Attention should be paid to actions with good or bad results, as they serve as the information base to feed the next stage of the cycle, called *Check* (Campos, 2001).

The third step of the PDCA cycle is the verification phase of the actions performed in the previous step. This phase will verify the results of the actions coming from the planning phase. Considered the second most important part of the cycle, the phase in question, according to Clark (2001), should be emphasized by the organization to obtain a satisfactory result at the end of the cycle. "In a strong PDCA cycle, the check step is emphasized" (CLARK, 2001, p.2).

To monitor the results of actions taken from the action plan, indicators should be listed to monitor and identify the actions that have obtained the best and worst results.

To ensure a good application of the check step, Melo (2001) suggests three steps: first) compare the results; second) list the side effects; third) check the continuity of the problem.

In the first step, the data collected before and after the actions performed in the previous phase should be used to verify the effectiveness of the actions and the level of problem reduction.

In the second, there is a listing of side effects. Some actions taken in the previous step can cause positive or negative side effects to the organization. In the case of negative effects, it is up to the organization to take appropriate action.

The last step is to check the continuity of the problem. When undesirable effects continue to occur after the actions are taken, they reflect that the solutions presented were flawed. In this case, the PDCA cycle must be restarted so that the causes of the problems can be found and corrective actions can be set to block such causes. However, in the case of non-continuity of the problem, the PDCA cycle will be able to proceed to the next step, the action step.

The last step of the PDCA cycle is responsible for standardizing the actions taken that have yielded satisfactory results throughout the cycle to ensure that problems do not return over time. Such standardization process, according to Melo (2001), consists in modifying existing standards or, failing that, elaborating a new standard.

After standards are drafted or modified, they must be disclosed in the company. The disclosure process should be accompanied by training of all employees involved in changing standards. According to Melo (2001), training should preferably be carried out at the workplace with adequate resources. These standards should be regularly monitored to verify their compliance correctly. For Melo (2001), the company must ensure that a problem solved does not reappear due to the lack of compliance with the standards.

With the completion of this step, the cycle comes to an end.

### 1.3.2 DMAIC

This methodology is a specific model for continuous improvement by reducing variability with proper control of the production process. Similar to the PDCA cycle, DMAIC is a set of steps that lead to the solution of a given problem through the use of methods that guarantee the reduction of the failure rate in products, processes or services.

Penczkoski et al (2008), conceptualizes DMAIC as follows:

A methodology that aims at continuous improvement based on process optimization and control, seeking to identify and analyze undesirable results prioritizing the resolution of problems, for this the work team should count from people with technical knowledge to people who only perform the operationalization of the processes tasks.

As mentioned earlier, this cycle is structured in steps. These steps are represented by the letters that complete the name of the methodology, as follows: define, measure, analyze, improve and control. This method was developed at Motorola following as an evolution of the PDCA cycle (SLACK, 2002).

The first step of this method is to define, similar to the first step of the PDCA cycle as it is also necessary to clearly define the problem that will be solved. Considering various factors that may influence the decision and especially the wishes of customers. For Knowles et al (2005) this definition process can be done by answering some questions, such as: What are the client requirements? How is the work currently being done? and what are the benefits of an improvement?

In the next step, the cause of the problem is founded. Called measure, this step is to analyze the process through the use of quality and statistical tools. With this it is possible to situate the company in the scenario it is in and then outline the strategies to reach the desired level of perfection.

After measuring the scenario that the company is in, it is possible to go to the next step, called analyze. The goal of this step is to determine the root cause of problems and look for opportunities for improvement. Using the Pareto diagram, it is possible to prioritize the most relevant causes in the problem and then treat the others further (KNOWLES et al, 2005).

The next step is called improve, this is a step of both designing and implementing ideas that will solve the problem. The most appropriate technique for this type of approach is brainstorm or benchmark in other companies or units of the same company to identify opportunities for implementing a process or product improvements (KNOWLES et al, 2005).

Similar to the PDCA cycle, the DMAIC cycle method also has a step to estimate and control the quality achieved with anomaly treatment. Calling step control, in addition to the mentioned goals allows you to identify new deviations and open gaps for new corrective actions. In reaching a sustainable outcome, we proceed to the standardization of procedures.

### 1.3.3 Capability study

Process capability study aims to identify if the process is capable of producing to specification and under control. For Montgomery (2004) there are three essential techniques for the analysis of process capacity: histogram, control graphs, and planned experiments. For this, data must be reliably estimated, Montgomery (1997) recommends to have at least 100 observations for the histogram to be moderately stable to obtain a reliable estimate of the process' capacity. The figure 4 shows an example of a histogram for analyzing the capability of a process.

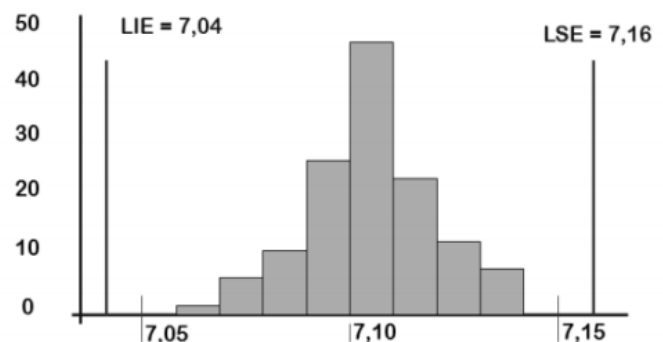


Figure 4: Process Capability

Source: Werkema (1995)

Capacity indices assess whether a process is capable of satisfying defined specifications. To use the indices, the process must be under statistical control and the variable of interest has a distribution close to normal. According to Montgomery (2004) and Deleryd (1999), there are four capacity indices for normally distributed data. These indices are Cp, Cpk, Cpm, and Cpmk.

The Cpk index is a variant of the Cp index, it is defined as the smallest between lower bound Cp and upper bound Cp. Thus, this index indicates the position of the curve relative to the target. Cp, called the process potential capacity index, considers that the process is centered on the nominal value of the specification. The higher the Cp value, the greater the process's ability to reach specifications, provided the average is centered on the nominal value.

A rule of thumb, according to Montgomery (2004) for analyzing this index is to define three reference ranges, shown in Table 1.

Table 1: Analysis Reference

Cp	Nonconforming Items	Interpretation
$C_p < 1$	Above 2700	Unable Process
$1 \leq C_p \leq 1.33$	64 to 2700	Acceptable process
$C_p > 1.33$	Below 64	Potentially capable process

Source: Montgomery (2004)

## 2. Methodology

The research has an applied nature since it will contribute in a practical way to the improvement of one of the brewery's production processes M.

As for the objectives, the study is descriptive with a quantitative approach. Regarding the procedures, it used bibliographic research about beer and methodologies to reduce variability.

Also, the research is a case study conducted between 2016 and 2017 with the following phases:

Phase 1) Study of brewing processes: In September 2016, it was studied the beer production processes in a practical and theoretical way to understand all the necessary steps to the brewing process;

Phase 2) Literature review: In October 2016, methodologies aimed at reducing variety in production processes were identified;

Phase 3) Development of a method to reduce variability: In November 2016, the method to reduce the variability of the brewhouse process was developed.

To apply this method the following steps were performed:

Step 1) Goal context: In the first week of November 2016, the data collected from the wort manufacturing times in the brewhouse stage was analyzed and compared the values obtained with the desired by the company, so the goal for the search was chosen.

Step 2) Process Mapping: In the second week of November 2016, a flowchart was elaborated with all the stages of brewhouse production.

Step 3) Time and variability analysis: In the third week of November 2016, the individual times of each stage of the production process were calculated with their respective capability indices.

Step 4) Definition of IV: Still in November 2016, by choosing critical steps, check items were chosen to monitor the effectiveness of the treatment of the problems.

Step 5) Cause analysis: At the end of November 2016, based on the data analyzed in the previous step, a process of investigation of the causes that led to the anomalies found was initiated.

Step 6) Definition of the action plan: During the cause analysis, corrective and preventive actions were defined to ensure that the problems did not happen again.

Stage 7) Treatment of anomalies: at the beginning of December 2016, corrective actions were performed and follow-up of preventive actions was carried out.

Step 8) IR verification: In January 2017, the data about December 2016 and the first half of January 2017 were collected to check the evolution of the verification items.

Stage 9) Standardization: During the second half of January 2017, the stage of standardization of positive practices during the implementation of improvement actions was initiated.

Regarding data collection, it was performed in November 2016 during the development of the variability reduction method and in January 2017 after the application of the method. Data were collected through time records of each stage of the brewhouse process, tabulated using spreadsheets, histograms, and calculations of capability indices obtained by Minitab version 17.1, a statistical software available for use in the studied company.

The analysis and discussion of the results were taken in February 2017 from the analysis of three variables: the total wort manufacturing time, the equipment capability indices.

### 3. Discussion

The discussion of the results will be made with the following topics: diagnosis of the production time variation in the brewhouse, analysis of the time variability after the application of the method and comparison of the obtained results.

#### 3.1 Diagnosis of the variation in wort production time

To diagnose the variation in wort production time, data from 100 production batches were used with the appropriate removal of out-of-curve values, called “outliers”, as they represent sporadic events.

First, the variation in the total wort manufacturing time was identified through the out-of-range percentage analysis according to the following calculation:

$$\% \text{ batches out-of-range} = (\text{batch off time} / \text{total batch number}) \times 100$$

Calculating out-of-range batches it was identified that 71% of the production batches had total wort production time outside the specification time. Thus, the goal of reducing the out-of-range percentage to 40% by December 2017 was set.

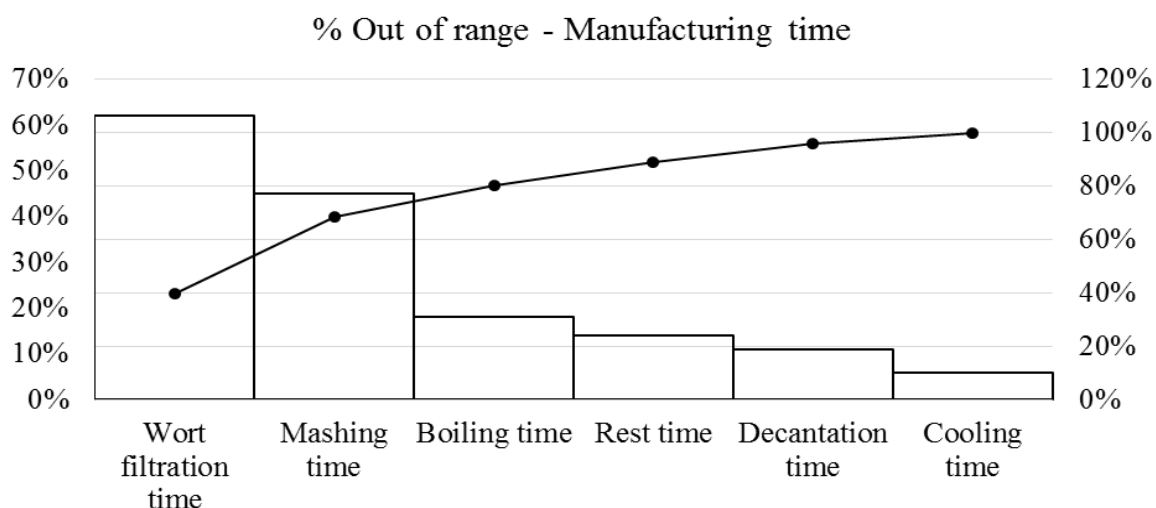


Figure 5: Variation analysis in brewhouse

Source: Author (2016)



The first analysis of the steps that most impacted the total manufacturing time was through the elaboration of a Pareto graph (Figure 5), which can identify the steps with the highest out-of-range percentages of the total manufacturing time steps.

To analyze all the stages involved in the must production, a diagnosis of the critical points of variability was carried out utilizing the capability analysis of each process point. Capability is represented by indices that show how much the process is capable of reaching the desired specifications. In the study, two indices were used: the Cp which is the potential capacity index and the Cpk which is the capacity index relative to the location.

For this analysis, Minitab version 17.1.0 (a statistical software) was used to calculate the Cp and Cpk indices and to construct histograms, as shown in Table 2.

Table 2: Cp e Cpk before problem resolution

Stage	Cp	Cpk
Mashing time (min)	0.34	0.25
Wort filtration time (min)	1.15	-0.19
Rest time (min)	1.82	1.76
Boiling time (min)	1.61	1.47
Decantation time (min)	1.4	1.19
Cooling time (min)	1.57	1.51

Source : Author (2016)

Comparing the statistical indices it is concluded that the equipment with the greatest variability in the wort production was the mashing and the filtration. According to Juran and Gryna (1980), the ideal index recommendations are  $Cp = 1.67$  and  $Cpk = 1.33$ .

Showing the worst index in terms of variability, the mashing step had a potential capacity index  $Cp = 0,34$  and a relative capacity index  $Cpk = 0.25$ . Showing that this step negatively influenced meeting the total time specifications.

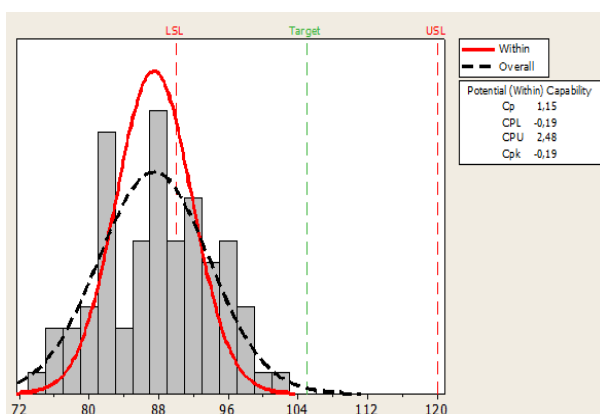


Figure 6: Histogram of wort filtration time before  
Source: Author (2016)

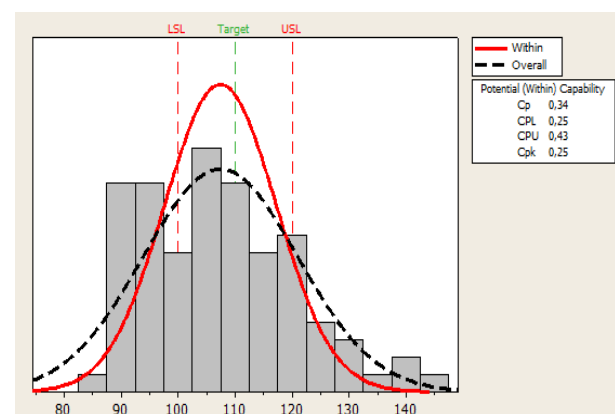


Figure 7: Histogram of mashing time before  
Source: Author (2016)

The wort filtration step had a  $Cp = 1.15$  index, but its  $Cpk = -0.19$  index was very low, leading to the conclusion that the data are positioned at the lower limit of the specification, which reflects filtration time

suboptimal, hampering the following stages of wort production, and not satisfactorily answering the time specified in the technical production standard. Figures 6 and 7 show the histogram of the residence time in mashing and filtration.

To monitor the result of interference in the production process, two verification items were defined.

Based on the information, a cause and effect diagram was prepared through the participation of those involved in the production process to identify the causes of the anomalies. The main causes found were: communication problem between the collaborators during the wort dispatch to the fermentation stage, delay in the opening and closing of valves transfer between one equipment and another by mechanical locking and the fast wort filtration due to the failure of the filtration collectors.

### 3.2 Time variability analysis after method application

From the proposed method, an action plan was elaborated to eliminate the causes found for each anomaly. The main actions were:

For Cause 1) To solve the problem of communication between the collaborators, a checklist was elaborated so that the operators of the brewhouse stage made sure that the ready wort could be sent for fermentation;

For cause 2) regarding valve locking, a defective valve treatment plan was prepared and an operator training was conducted to perform maintenance;

For Cause 3) To reduce the fast wort filtration, the company's automation team performed an adjustment on the modulating valve of the wort filtration manifold.

Table 3: Cp e Cpk for critical equipment

Stage	Cp	Cpk
Mashing time (min)	0.54	0.28
Wort filtration time (min)	1.55	1.40

Source: Author (2017)

After discussing the problems, the percentage of out-of-specification batches of total work manufacturing time increased to 31%. With this improvement, the capability indices Cp and Cpk of the mashing and filtration steps were changed. The results show that the best-impacted stage was the filtration because it was the closest to the ideal proposed by Juran and Fryna (1980), as shown in the Table 3.

To visually analyze the change in mashing and filtration results, the respective histograms were elaborated using the Minitab statistical software. In the histograms, it is possible to see that the filtration times are mostly located in the center of the graph.

This reflects the correction of the capacity index Cpk that corresponds to the actual values concerning the center of the ideal specification range. Below are the images of the two histograms with results after the interventions.

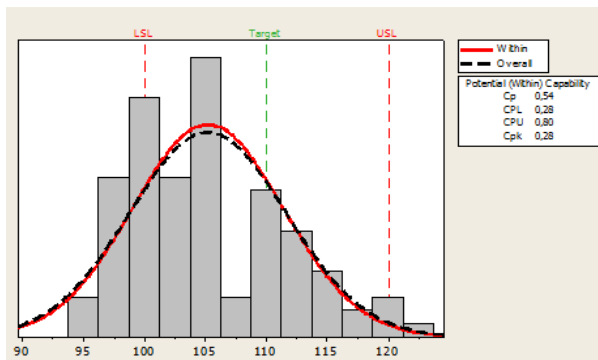


Figure 8: Histogram of wort filtration time after  
Source: Author (2017)

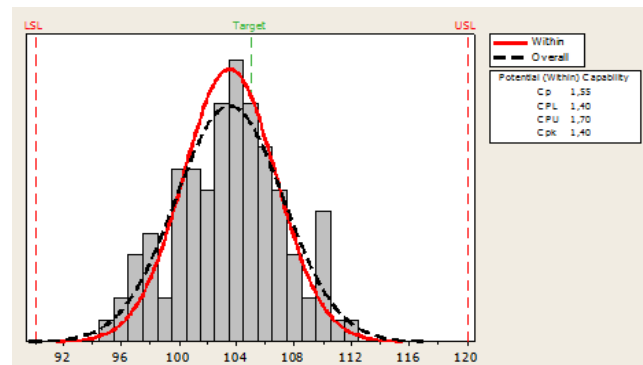


Figure 9: Histogram of mashing time after  
Source: Author (2017)

### 3.3 Comparison of Results

With the application of the method improvements were obtained in all the variables analyzed in the proposed study, the total wort manufacturing time decreased from 71% of out of range batches to 31% of out of range times.

Figure 10 shows the comparison between before and after the out-of-range percentage for each step of the production process, where it is possible to perceive improvement in all steps individually.

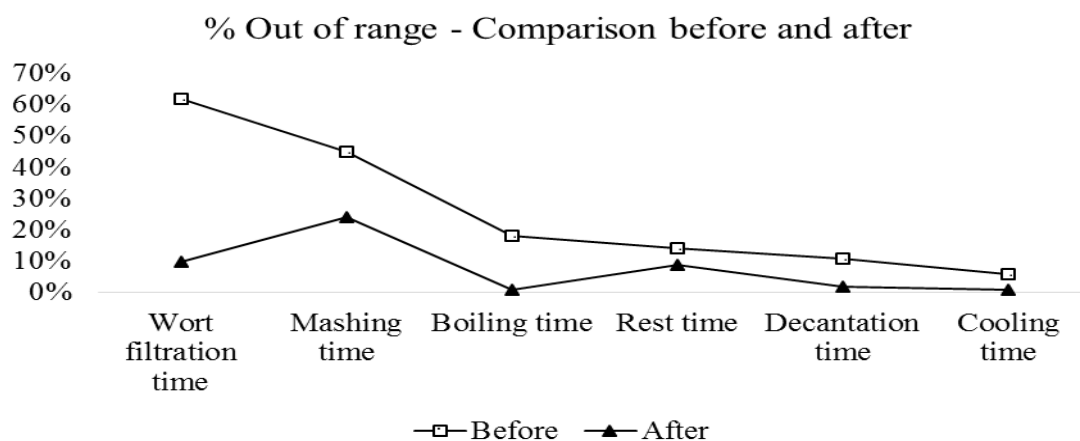


Figure 10 - Comparison before and after – Brewhouse stages  
Source: Author (2017)

To compare the capacity index results of the mashing and filtration steps, below there is a comparative table of the results obtained at the beginning of the study and after the corrective actions.

Table 5 - Comparison between Cp and Cpk		
Índex	Before	After
Cp of mashing	0.34	0.54
Cp of wort filtration	1.15	1.55
Cpk of mashing	0.25	0.28
Cpk of wort filtration	-0,19	1,40

Source: Author (2017)

The evolution of  $C_p$  from 0.34 to 0.54 and  $C_{pk}$  from 0.25 to 0.28 of mashing means that there was an improvement in its ability to produce to specification, although it was minimal and not close to recommended as ideal for the index. Since the evolution of the filtration indices was much more significant, the  $C_{pk}$  from -0.19 went to 1.40 meaning that the values of the filtration time left the lower margin of the desired limit and moved towards the center, besides being close to the recommended  $C_{pk}$  value for companies by Juran and Fryna (1980) which is  $C_{pk}$  equal to 1.33. Another significant result of this step was the  $C_p$  which was 1.15 and became 1.55.

#### 4. Conclusions

The study aimed to investigate and standardize a method to reduce the variability of brewing wort manufacturing time. Data collection and analysis were performed in the brewhouse process of a brewery at the Manaus Industrial Pole in 2016 and early 2017. It was found that this production process had variability in almost all stages, and was necessary to classify the most critical to starting the problem treatment process.

Regarding the identification in the literature of methodologies aimed at reducing variability in brewery processes, a lack of this theme was identified for this type of application. The materials found aimed at reducing the variability of production processes in several branches of the industrial area, except in beer. Besides, scientific and literature materials for brewing processes are related to manufacturing methods with biochemical rather than control analyzes.

Regarding the improvement and testing of a method for reducing the variability of wort manufacturing time, the method based on the PDCA and DMAIC cycle coupled with the use of a statistical tool was satisfactory due to its simplicity and objectivity in each step. Thus, the problem-solving process was fast and accurate. In addition to being effective, since the variability in the total wort manufacturing time was reduced from 71% to 31%, it achieved satisfactory results with the positive evolution of the indices of the two critical stages of the process.

Nevertheless, proposals were made to improve the process based on investigating the causes and ideas resulting from *Brainstorming* performed with the team involved. Thus, the proposals were also present in the action plan for the treatment of the problem.

The main learning obtained was regarding the flexibility of the PDCA cycle in the application in work to reduce variability, not using the DMAIC method that is commonly used for this type of application.

The limitations of the research are related to the disclosure of the reference parameters for the limits of the production stages, factors restricted due to the organization's confidentiality policy.

For the managers of the organization are suggested to disseminate the model used in this article to other units of the company to assist the process of treating variability within the production process of the brewhouse.

For the academy, it is suggested to analyze the relationship between the variability problems of this process and the possible defects present in the beer sensory and to identify which flavor changes happen according to the variation in the equipment used to perform the brewhouse process.

## 5. Acknowledgments

We would like to thank the Brewery M managers for their support and also Doctors Nilson Rodrigues Barreiros and Joaquim Maciel da Costa Craveiro for their contributions during the Industrial Engineering Course Examining Board when the article was defended in 2017.

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## Participative approach to graduate students evaluate FT/UFAM Services

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### Abstract

*It has a participatory approach to continuously evaluate the level of satisfaction of Industrial Engineering students with the main services provided at the Faculty of Technology of the Federal University of Amazonas (FT/UFAM). To this end, studies were conducted to learn about existing services at the Faculty and to identify methodologies to assess customer satisfaction, resulting in the creation of a seven-step methodology that allowed veteran students of the Quality Management discipline to develop a questionnaire model with seven requirements and forty-nine items, which was applied to 122 students of the Industrial Engineering Course in June 2010. After the analysis of the results, conclusions and recommendations were generated, among them, it can be stated that the methodology and its data collection model can serve as evaluation tools to contribute to the process of continuous improvement of the services provided at FT/UFAM. Moreover, the methodology proved to be efficient in its application and also to motivate the students, once they felt valued and could understand the importance of participative management in the planning of any organization.*

**Keywords:** Evaluation; Methodology; Model; Participation; Requirement; Items;

### 1. Introduction

The research was conducted in 2010 at the Federal University of Amazonas (UFAM), located in the city of Manaus, capital of Amazonas, Brazil. At that time, the University had completed 102 years of existence with the mission of “Cultivating knowledge in all areas of knowledge through teaching, research, and extension, contributing to the formation of citizens and the development of the Amazon.”

According to its strategic planning, its vision was: (a) to be recognized for the excellence achieved in public education, scientific production and contribution to social development; (b) have qualified, valued and committed functionary with the Mission; (c) have adequate infrastructure to reach the mission; (d) have effective management supported by information from administrative, academic and technical processes.

To achieve the mission and vision proposed above, UFAM had 14 units in Manaus and 5 units in the municipalities of Benjamin Constant, Coari, Humaitá, Itacoatiara and Parintins, which offered about 96 undergraduate courses for 20,000 students and 39 postgraduate courses for 2000 "stricto sensu" students certified by Capes. Among these units, there is the Faculty of Technology (FT), composed in 2010 by five departments (Department of Design and Graphic Expression; Construction; Electronics and Telecommunications; Electricity; Hydraulics and Sanitation; Geotechnics and Transportation), which in

second semester of 2010 offered 10 undergraduate courses for 1429 undergraduates, as demonstrated below:

- Course 1) Architecture and Urbanism = 129 students
- Course 2) Design and Graphic Expression = 148 students;
- Course 3) Civil Engineering = 245 students;
- Course 4) Computer Engineering = 205 students;
- Course 5) Gas and Oil Engineering = 49 students;
- Course 6) Electrical Engineering = 217 students;
- Course 7) Materials Engineering = 78 students;
- Course 8) Mechanical Engineering = 87 students;
- Course 9) Industrial Engineering = 223 students;
- Course 10) Chemical Engineering = 48 students).

Over the years, considerable investments were made to expand FT's infrastructure, but a low investment to systematically improve the management of services provided at FT, among them: the Direction Management; Course coordination; the restaurant; the library; Graphic Services; Teachers' Services, etc. The problem with the research is that even with 52 years of existence, there is no model in this unit to continuously evaluate the services provided, from the perspective of most of its users, undergraduate students. Thus, the main question of this research is "How to develop a participatory methodology for undergraduate students to continuously evaluate the services provided at FT/UFAM?"

Given the above, the general objective of the research is to develop, in a participatory way, a methodology to continuously evaluate the level of satisfaction of students of the Industrial Engineering course with the main services provided at FT/UFAM.

To this end, the following specific objectives were set: (a) To identify the best way to build a participatory approach from the students' perspective; (b) test the approach and its data collection and analysis model to identify key points for improvement; (c) Propose a procedure to improve FT/UFAM's methodology and key services.

The creation of a participatory methodology to systematically evaluate service performance is relevant:

- a) as it helps to know which requirements and items students consider relevant to be evaluated for the faculty to be considered excellent in providing their services;
- b) contribute to the development of a culture focused on continuous improvement in FT/UFAM;
- c) contributes to achieving UFAM's mission and vision over time;
- d) help in academic reflection on the subject to generate criticism and new research;
- e) may be used as a case study in classrooms;
- f) may be a benchmark for other UFAM units;
- g) may serve as a guide for FT/UFAM managers to improve their management over time.



## **2. Theoretical Referential**

To accomplish UFAM's mission and vision, academic unit managers need to diagnose the reality to improve objectives, goals, action plans and indicators to measure how excellent each service offered at their units is.

According to Albrecht (1993), something is measured so that it can be done better because of the knowledge gained from a measurement. For quality improvement, it is needed to identify opportunities, establish a basis or verify the implemented actions.

According to Whiteley (1996), these are the five principles to follow to measure customer satisfaction:

- a) know measuring reason;
- b) let customers tell which results to measure;
- c) constantly ask about the performance and of the competitors;
- d) follow up on the internal procedures that should produce the results the clients want as well as the final results;
- e) inform staff of all discoveries.

According to Harrington (1993), measurements are the starting point for improvement because it allows to set and track goals. Measurements are critical since if it cannot measure the process, nothing can control it, no one cannot manage it or improve it because the decision-making process is compromised.

For Albecht (1993) there is no “right” way to measure all aspects of quality. A range of measurement strategies is required depending on how the customer defines each aspect.

Denton (1990) says that the key to any assessment is to understand what one wants to measure and then act upon the results. Each organization or administrator who wants to improve services needs to decide how many and what measurement to use.

According to Neely et al. (1995) apud Corrêa (2009), performance measurement can be understood as the technique used to quantify the efficiency and effectiveness of business activities. Efficiency will discuss the use of resources without waste, the relationship between economic use of resources, taking into account a certain level of satisfaction. In turn, effectiveness evaluates the achievement of the goal, the result of a process where the expectations of various customers are met or not.

Rezende (2003) adds that a performance measurement system not only provides data necessary for management to control the various activities of organizations but also impacts decisions and organizational behavior.

A balanced measurement is as a dialectical process that leads to the continual discovery of focuses and sources of improvement in the organization's set of intangible assets, rather than a simple comparison of predictions and achievements over a period (adapted from CARVALHO et al., 2005).

There are several studies focused on organizational performance indicators, such as Van Bellen (2002), Fernandes (2005), Merchant (2006), Machado, Machado and Holanda (2007), Callado, Callado and Almeida (2008), etc.

A broad study of the characteristics of performance indicators used in surveys conducted in the fields of Administration, Accounting and Tourism from 2000 to 2008 revealed 24 terminologies (page 381) used involving performance indicators (Chart 1) as well as 21 concepts (page 382) extracted from the authors

researched by Nascimento et al. (2011).

For this research, the indicators are considered flags that seek to express and demonstrate the reality in a way that is possible to observe and obtain more concrete data to improve the evaluation (COELHO, 2004), are considered supportive tools to evaluate processes (FREIRE; CHRISÓSTOME; CASTRO, 2007) and performance indicators are qualitative or quantitative elements used to detail the extent to which the objectives or goals were achieved, observing the deadline and the resources used.

Also, to create a good system of performance indicators, it needs to know some types of measurement, there is the measurement of individual performance in which, based on criteria defined by Human Resources, measure employee performance. Besides, there is also the measurement of processes, products, departments, systems and organizations, the last being of most interest for this research, by valuing the perception of those who use the services, the customers.

Several authors in the literature have sought to develop models for assessing customer satisfaction (ENGEL and KOLLAT, 1968; HOWARD, 1974; DAY, 1977; LATOUR and PEAT, 1979; OLANDER, 1977; OLIVER 1977, OLIVER, 1980, GRONROOS, 1984, PARASURAMAN et al., 1985, CRONIN and TAYLOR, 1992; BARROS, 2013, etc.), and far from wanting to debate the controversial points of each model, the approach to measuring the most interesting satisfaction for this research was that adopted by Cronin and Taylor (1993), focused on assessing customer perceptions based on the analysis of the quality of services received. They created a model called SERVPERF with 5 dimensions and 22 items applied to ascertain through a Likert scale, the real performance of the service organization.

In summary, Miguel and Salomi (2004) reviewed the main models for measuring quality in services and concluded that there is no consensus in the literature on the most appropriate model to measure it from the clients' point of view.

Artigo Investigado	Definição Apresentada	Autores em que é Apoiada a Definição Apresentada
Duran e Batocchio (2003)	As medidas de desempenho devem direcionar os esforços de melhoria contínua e cumprir uma série de requisitos. Hudson <i>et al.</i> (2001), baseando-se numa exaustiva revisão na literatura feita por Neely <i>et al.</i> (1997), listaram características que todo sistema de medição de desempenho deveria possuir: estar diretamente relacionados com a estratégia da empresa; claramente definidos e com um propósito específico; ser relevantes e fáceis de manter.	Hudson <i>et al.</i> (2001) e Neely <i>et al.</i> (1997) ( <i>apud</i> DURAN e BATOCCHIO, 2003)
Machado Júnior e Rotondaro (2003)	Para Takashina e Flores (1996), são formas de representar numericamente características de produtos e processos. Para Muscat e Fleury (1993), indicadores de desempenho de qualidade são mecanismos que apontam se a organização está sendo competitiva em relação às demandas de seus clientes. Na visão desses autores, os indicadores da qualidade devem orientar a melhoria do desempenho operacional e competitivo.	Takashina e Flores (1996) e Muscat e Fleury (1993) ( <i>apud</i> MACHADO JÚNIOR e ROTONDARO, 2003, p.1)
Siqueira, Rosa e Oliveira (2003)	O conjunto de indicadores de desempenho permite, por meio de medições previamente estipuladas, concluir ou questionar como está o desempenho da empresa. A implantação desses indicadores é de suma importância para que as empresas perpetuem suas atividades no mercado, propiciando um gerenciamento mais realista de seus recursos.	Definição dos autores
Coelho (2004)	Indicadores são parâmetros qualificados e/ou quantificados que servem para detalhar em que medida os objetivos de um projeto foram alcançados, dentro de um prazo delimitado de tempo e numa localidade específica. Os indicadores são marcas ou sinalizadores que buscam expressar e demonstrar a realidade sob uma forma que seja possível observar e obter dados mais concretos para melhorar a avaliação.	Valarelli (1999, <i>apud</i> COELHO, 2004, p.434)
Sá, Claro e Caixeta Filho (2004)	Indicadores de desempenho são características de processos operacionais que comparam a eficiência e/ou a efetividade da cadeia estudada com cadeias-alvo ou com cadeias-modelo. Os indicadores são usados para medir características da cadeia em questão, tais como: grau de utilização, produtividade, tempo e prazos de entrega, disponibilidade e condições de qualidade dos produtos ofertados, entre outros.	Van der Vorst (2000, <i>apud</i> SÁ, CLARO e CAIXETA FILHO, 2004, p.41)

Chart 1 – Some definitions found about performance indicators

Source: Nascimento et. Al. (2011 p. 382)

Another interesting approach to measuring organizational performance that differs from the above is called 10M, used to verify the strengths and weaknesses of an organization, proposed by Costa (2007 p. 115), as shown in Figure 1.

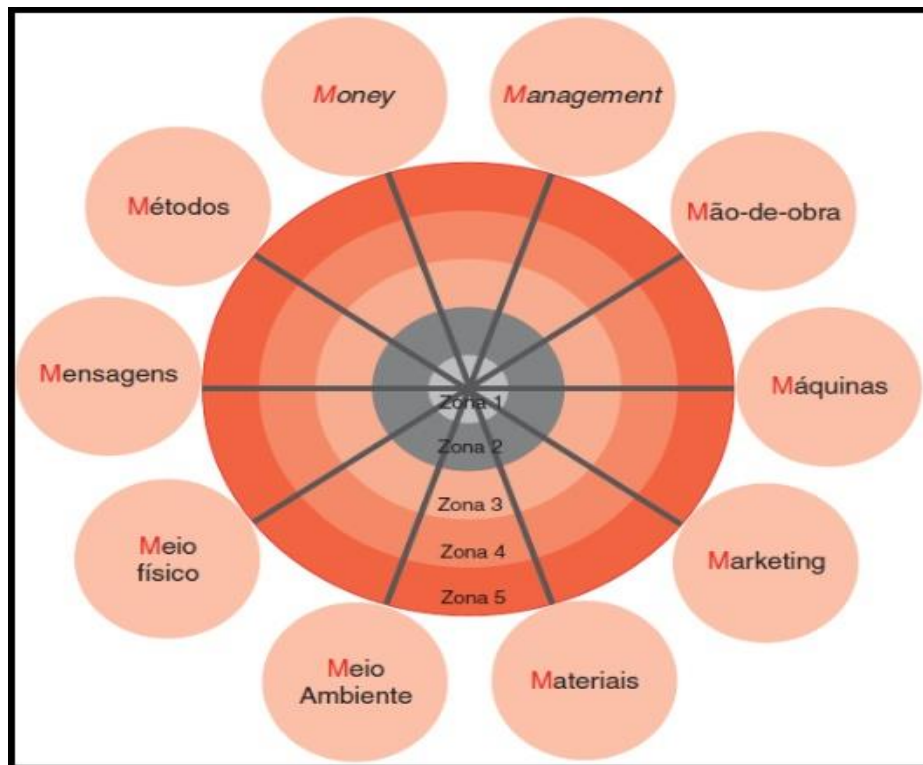


Figure 1 – 10M s of self-diagnosis proposed by Costa (2007 p.119)

For Costa (2007), organizational analysis is structured into ten areas categorized by the letter M, which cover the relevant internal points of any organization: Management, Manpower, Machines, Marketing, Materials, Environment, Infrastructure, Message, Methods, and Money.

According to Costa (2007), the points to be evaluated should be classified in these ten categories and if there are points that are difficult to classify, they should always be placed in Management, since any relevant internal matters of the institution that has no clear allocation, it is ultimately, the responsibility of management.

For Costa (2007 page 116), in each of the 10Ms (categories that will now be called requirements), some items to be analyzed can be constructed, as illustrated by Chart 2.

Although Costa (2007 p. 118) presents the proposal for an Institution radar chart with a scale of 1 to 5 represented by Zones (Figure 1), it is recommended that the team who is planning the assessment, choose the number of requirements and items, as well as the choice of scale to use, as it depends on the resources available to develop internal organizational analysis.

Another point to consider is that the more participative the process of constructing requirements and items, the greater the chance of engaging stakeholders during measurement and organizational improvement.

10 Ms (Requirement)	Items to investigate
Management	Relationship with employees; Relationship with partners and donors; Fundraising Capacity; Project management; Decision-making process; Leadership; Technology Management, etc.
Manpower	Recruitment; Selection; Employee Development; Motivation; Employee and manager satisfaction, etc ...
Machines	Equipment; Machines; Electrical installations; Maintenance of machinery/equipment; Intranet networks, internet, etc.
Message	Internal communication between managers and employees; Bulletin boards; Verbal communication; Provisions and responses to customer complaints; Communication with customers, etc.
Marketing	Market knowledge; Institutional marketing plan; Launch of products or services, Guarantee, and Technical Assistance; Treatment of customer satisfaction; Relationship with the media, etc ...
Materials	Quality of teaching material; Availability of consumables; Availability of permanent material, Supply Chain; Stocks, etc ...
Environment	Energy-saving program; Water saving program; Environmental Awareness of employees, etc ...
Infrastructure	Internal circulation; Parking; Lighting; Cooling; Cleaning; Safety; Visual signage, etc ...
Methods	Process flowchart; Methodology for project management; Methodology for the development of new products or services; Methodology to capture and maintain partners/donors; Standards; Standardization, etc ...
Money	Cash flow; Bills to pay; Bills to receive; Accountability; Financial management; Fundraising plan, etc ...

Chart 2 – Examples of Requisites and Items for internal assessment

Source: Costa (p. 116 and 117)

For Zajac and Bruhn (1999 apud FILHO, 2007, p. 96), participation allows people greater opportunity to have a voice within the organization, to express their opinions on various subjects, whether of self-interest or the organization itself. The authors consider the perception of the opportunity to participate more important than the participation itself.

Silva (2018, p. 54-93) presents several experiences of communities that have developed by valuing participation to obtain good practices of community governance, like in Brazil, the USA, and Japan. The author recommends understanding the concept of community and its functions, as well as the responsibility and tools that can be used to develop participatory diagnostics that can be used with adaptations in business and academic environments.

### 3. Methodology

The research is applied since UFAM/FT managers will use the knowledge generated. Regarding the

objectives, the research is descriptive, since it will use descriptive statistics to present the results without change variable values.

Data were collected and analyzed using a combined (qualitative and quantitative) approach through the case study, bibliographic research, benchmark, brainstorming, panel groups with graduate students during Quality Management subject classes given by the author during the first semester of 2010.

Also, it was used a voting process, part of 10Ms categories and SERVPERF approach, as well as a survey with a questionnaire, applied to graduate students of the Industrial Engineering course of FT/UFAM.

The proposed methodology model has seven steps showed in Figure 2.



Figure 2 – Methodology to graduate students evaluate main services supplied at FT/UFAM

Source: Author

### 3.1 Step 1 - Identify main services

In 2010, the FT / UFAM was made up of five departments serving about 1,429 undergraduate students and hundreds of postgraduate students. Therefore, the first step was at the beginning of May 2010, to identify the main services provided at FT/UFAM that could be targets of the evaluation.

There were the following services:

a) Sectorial Library of Exact Sciences and Engineering; b) Laboratories and classrooms; c) Services provided by the FT/UFAM Direction, Headship and Course Coordination; d) Restaurant; e) professors; f) support services; g) Reprography.

### 3.2 Step 2 – Identify the main Methodologies

Between May and June 2010, as part of the planning, was examined a comprehensive literature review (ENGEL and KOLLAT, 1968; HOWARD, 1974; DAY, 1977; LATOUR and PEAT, 1979; OLANDER, 1977; OLIVER 1977, OLIVER, 1980, GRONROOS, 1984, PARASURAMAN et al., 1985, CRONIN and TAYLOR, 1992; BARROS, 2013; COSTA, 2007, etc.) to identify methodologies or methods of

organizational performance evaluation, as well as to study the best way to involve students in the construction process. Then it was defined that the best way would be by sampling, choosing FT's Industrial Engineering course and developing the methodology together with a group of more experienced students during the Quality Management course taught by the author that year.

### **3.3 Step 3 – Plan the Survey instrument model**

In June 2010, the survey planning was carried out collectively, observing the following actions:

- a) definition of the class of planners: students who helped in the conception and implementation of the model: 21 veteran students of the 9th period of the Industrial Engineering course, since they already have more than 4 years studying at the university and know the services provided at FT/UFAM. The planning took place during the Quality Management classes and their participation was worth applying the knowledge acquired throughout the classes, as well as partial score in the form of a report;
- b) definition of the target audience: given the limited time and resources available, it was defined that the target audience would be only the students of the Industrial Engineering course, regardless of the period they were in the course. At the time, there were about 223 students, which represent about 16% of the total students enrolled in FT. So the goal was to interview at least 112 students, which would represent more than half of them;
- c) survey planning strategies:
  - c1) during the classes, the 10Ms methodology was explained as a way to analyze the internal environment of an organization, proposed by Costa (2007), and it was presented to the students, ways on how they could create a participatory methodology to evaluate their work environment;
  - c2) then, after presenting the main services provided at FT/UFAM, by voting, it was defined that the number of requirements to be evaluated would be seven: Library, Communication, Facilities, Management, Teachers, Restaurant and Pedagogical Methods;
  - c3) for each requirement, the number of 7 items to be evaluated was defined, totaling 49 items to be considered as standards to evaluate performance;
  - c4) after defining the Requirements and how many items there would be in each one, then five groups were formed, which received a matrix with the selected requirements and within them seven empty fields for brainstorming to survey what would be the items, which should be measurable to help FT/UFAM be a benchmark for excellence in service delivery;
  - c5) after the brainstorming and voting sessions, each group presented their proposals generating a total of 67 items, which were systematized on the board to identify the similar (15 common items) and non-common items. Then each group defended their proposals, which went through the process of improvement and voting until all 49 items were consensually chosen, as can be seen in Figure 3;
  - c6) once the requirements and items were defined, the Likert Scale (1 = Very Dissatisfied; 2 = Dissatisfied; 3 = Fair; 4 = Satisfied and 5 = Very Satisfied) was chosen to measure students' satisfaction with each item set as performance standard;
  - c7) each group then received copies of the questionnaire (Appendix 1) and guidance for conducting the pilot test, as well as the number of students to interview.



### 3.4 Step 4 – Perform the Pilot Test

The pilot test was performed with about 20 randomly selected students to simulate the interview, as well as to identify the clarity of the requirements and items of the questionnaire. The definitive test was performed because there was no need to adjust.

### 3.5 Step 5 – Perform the Definitive Test

Each group of Quality Management students was responsible for interviewing a minimum number of 1st, 3rd, 5th, 7th, and 9th-grade students.

Chart 3 shows the teams, members, periods, minimum number of interviewed, days and times, all for June 2010.

Teams	Member1	Member2	Member3	Member4	Member5	Period	Minimum	Days/Time 1	Days/Time 2
1 (R1 A R23)	Jean	Leonan	José	Ricardo	-	1o	30	3a e 5a/18-19h50	Sábado 8h-11h30
2	Welesson	Luiz	Carlos	Inaldo	-	3o e 5o	24	3a e 5a/18-19h50	2a e 5a/18h-19h50
3	Roberta	Daniele	Sabrina	Cristiano	Jun	3o e 5o	28	3a e 5a/18-19h50	2a e 5a/18h-19h50
4	Marcelo	Samir	Eliane	Jurandy	-	7o e 9o	25 do 7o	2a e 6a/18h-19h50	
5	Josevaldo	Thiago	Rogério	Natasha	-	7o e 9o	20 do 9o	2a e 6a/18h-19h50	

Chart 3 – Distribution of tasks to each team and member to collect data in June 2010

Source: Author

Data collection, verification, and data entry took place from June 13 to 29, 2010. Each team received their planning and entered into a standard spreadsheet, all responses from their survey was entered in a single spreadsheet and then passed to all groups to study and report as part of obtaining partial grades in the Quality Management discipline.

The pilot and final test interviewed 122 students who represented about 55% of all students of the Industrial Engineering course or 8.53% of all students of the courses enrolled in the first semester, 2010.

### 3.6 Step 6 – Collective analysis and discussion

Between July and August 2010, the groups presented their analysis and suggestions for improvement in the classroom.

They then refined their reports and completed it in August. The partial results of these reports were reported to the Industrial Engineering teachers for their contribution in the following months.

### 3.7 Step 7 – Dissemination of the Results

Between August and September of the following year (2011), all data were reanalyzed using CALC spreadsheets and descriptive statistics.

Through the Edraw Max Software (version 5), the questionnaire modeling (Figure 3) was completed to assess students' level of satisfaction with the main services offered at FT/UFAM.

To disseminate the results widely, between 7 and 17 October 2011 an article was prepared, which was presented and discussed on 30 November 2011 during a local event, the VI Amazonian Symposium on Industrial Engineering, organized by the Department of Industrial Engineering at FT/UFAM.

Improvement recommendations were incorporated and the model was presented to FT/UFAM managers, including Course Directors, Heads, and Coordinators, for analysis and administrative arrangements.

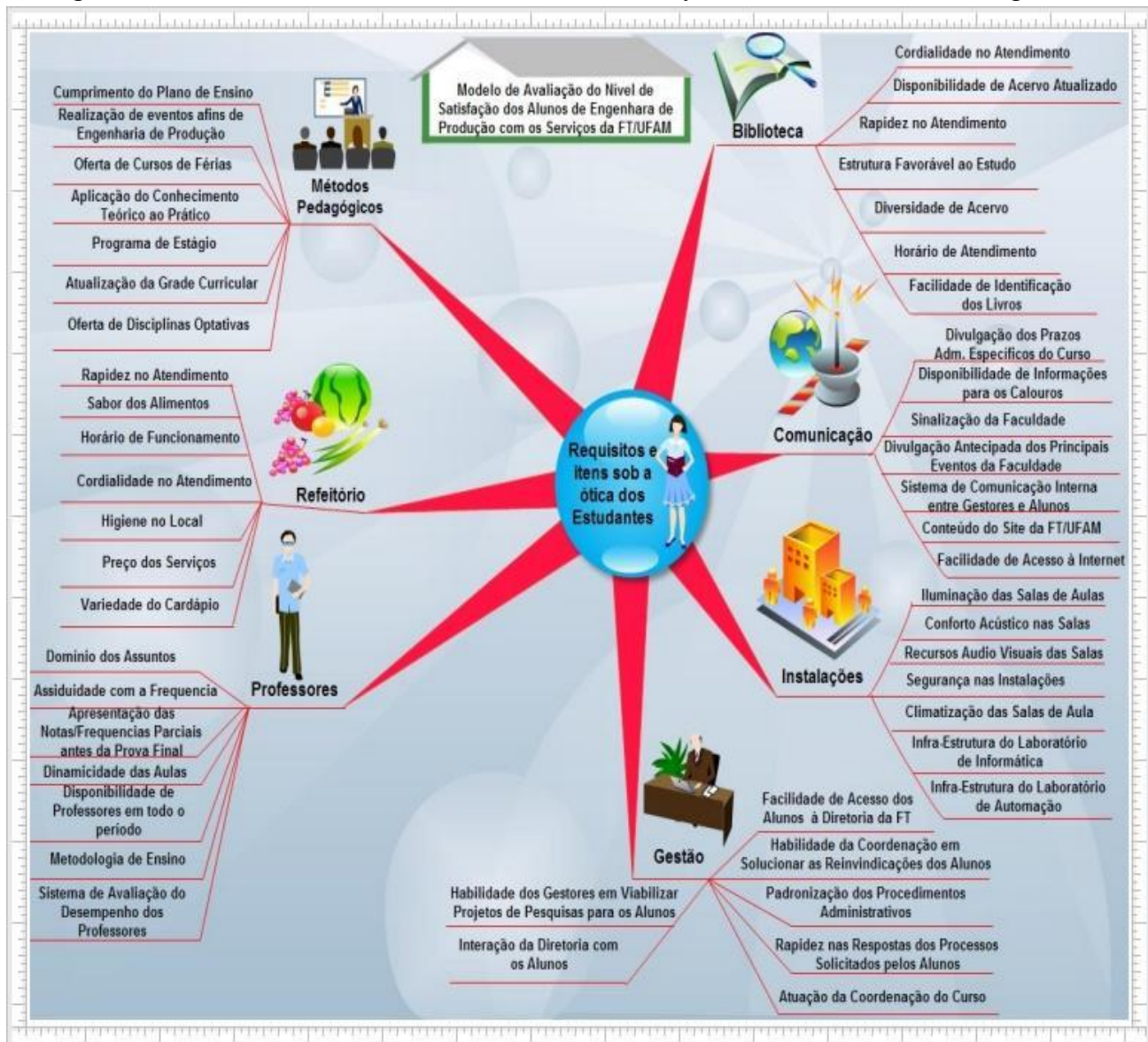


Figure 3 – Survey questionnaire model composed by seven Requirements and 49 items.

Source: Author

#### 4. Main Results

The results will focus on step 6 of the Methodology proposed in this research, as the main details of the previous steps were covered in section 3.

Concerning the responses of the 122 students of the FT/UFAM Industrial Engineering course, initially, the general analysis of the results was made observing the average of each requirement (Figure 4) and then observing the performance of the items of each requirement.



#### 4.1 Score of Main Requirements

The main requirements analyzed were: Library, Communication, Infrastructure, Management, Teachers, Restaurant, and Pedagogical Methods.

After analyzing the data (Figure 4), it was observed that only the services offered by the Library ( $X = 3.01$ ) performed better, however, meaning that a good portion of the respondents considered the services as Regular, as adopted by the Likert Scale.

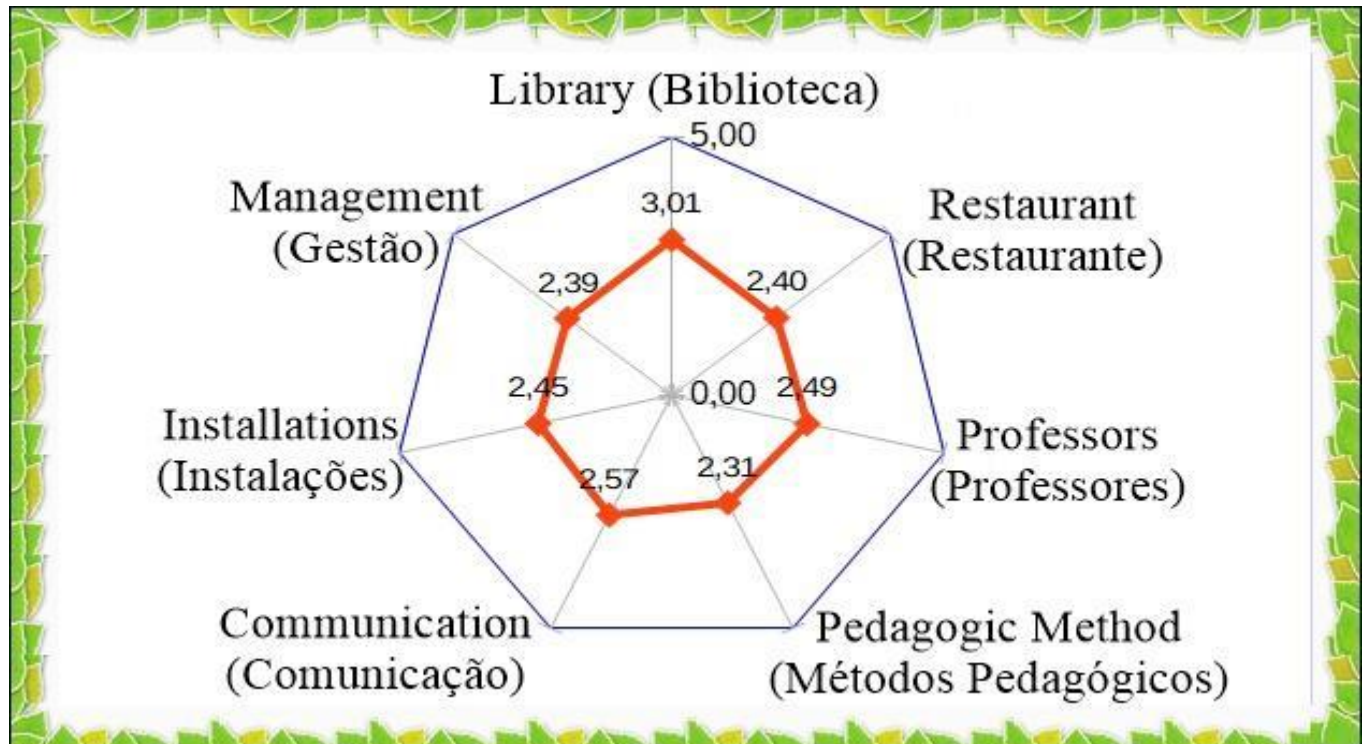


Figure 4 – Average score of the five Requirements

Source: Author

When analyzing responses about Library Requirement, 119 students reported their level of satisfaction. The results of Figure 5 indicate that on average no service was considered Satisfactory or Very Satisfactory. The services considered between Regular and Satisfactory were: Cordiality of Attendance, Speed of Attendance, Hours of Operation, Structure of study space, and Ease to locate books on shelves. On the other hand, the diversification and availability of updated collections are items that urgently need to receive investments from the University.

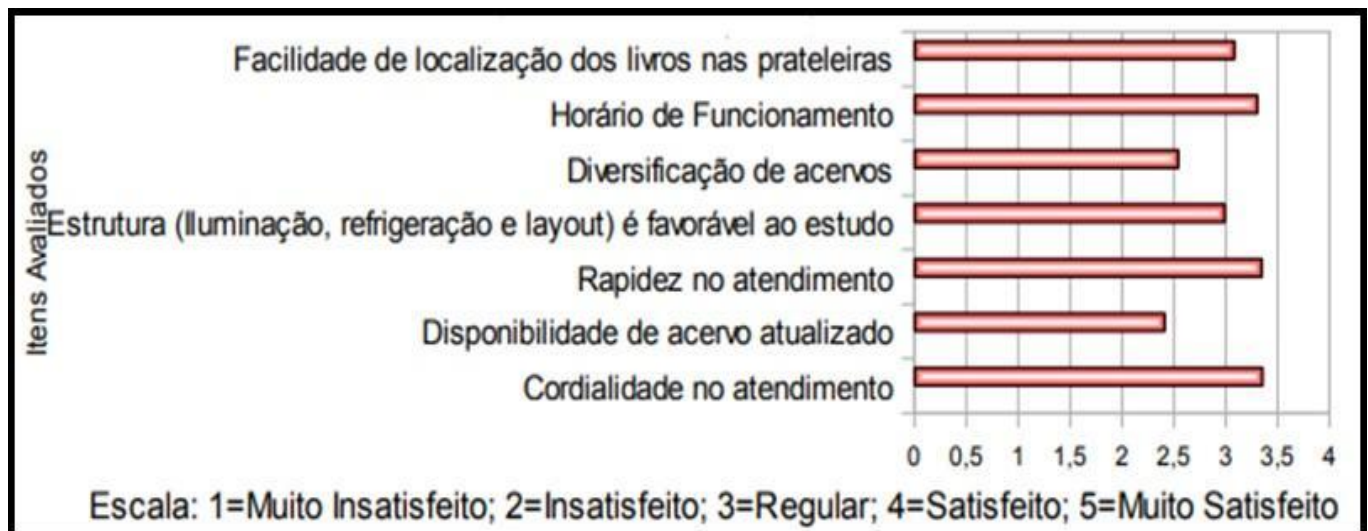


Figure 5 – Average Score of seven items of the Library Requirement

Source: Author

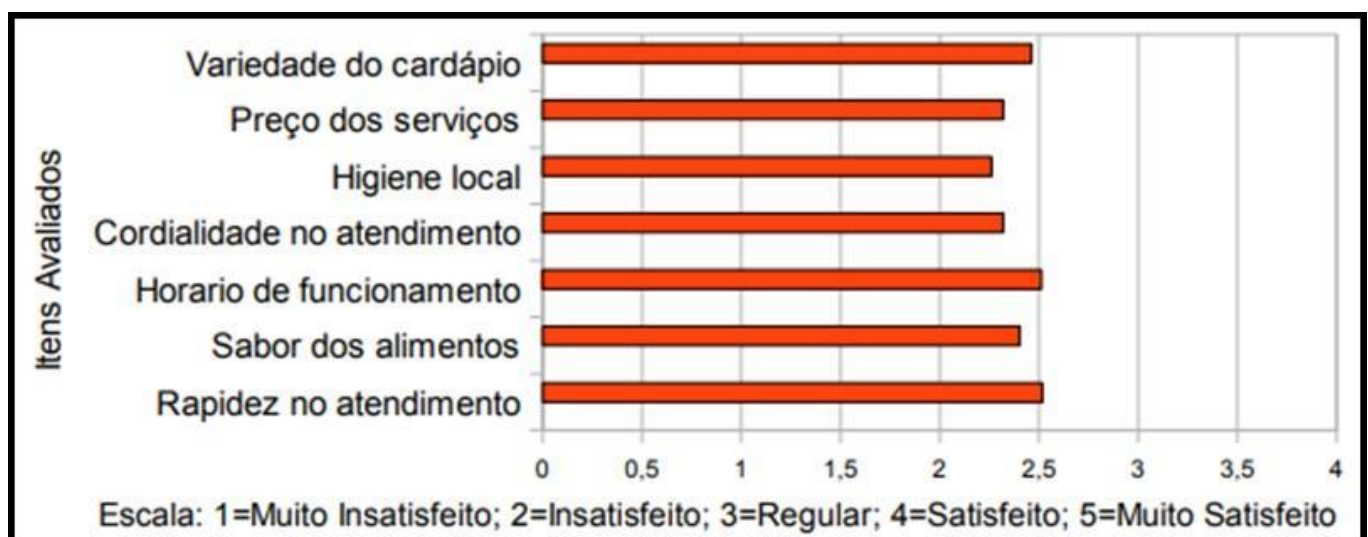


Figure 6 – Average Score of seven items of the Restaurant Requirement

Source: Author

Regarding the Restaurant (Figure 4), the 118 students who answered this question are not satisfied with the services offered (Average = 2.4), as all 7 items had an average below Regular, worrying about the items hygiene in the place, the friendliness of the service, the prices and the taste of the food (Figure 6).

Regarding Teachers (See Figure 4), the 119 students are not satisfied with the services (Average = 2.49) offered by the teachers who teach Industrial Engineering subjects.

Looking more carefully at the items related to the Teachers (Figure 7), most of them had an average below Regular, and the dissatisfaction is bigger because the teachers did not present partial grades and frequencies before the final exam, not available at all period; not being assiduous with their frequencies; not have a continuous system of evaluation of their performances.

Also, the students, in general, were not satisfied with the teaching methodology and the dynamics of the classes. The only item that had general approval was the mastery of subjects.

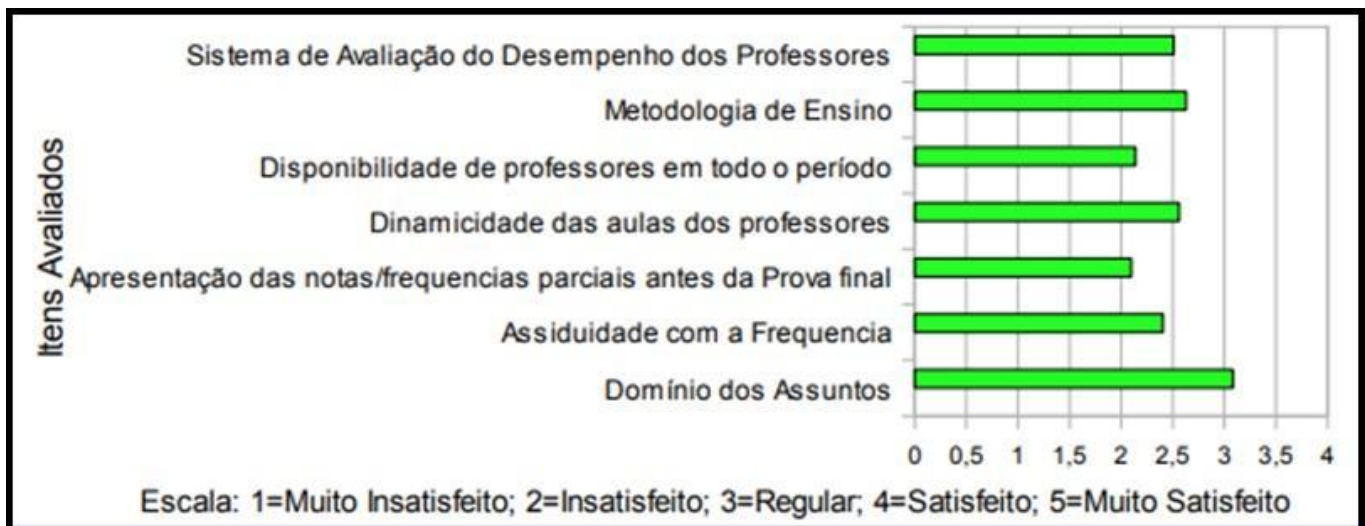


Figure 7 – Average Score of seven items of the Professors Requirement

Source: Author

Regarding the Pedagogical Methods (Figure 4), the 117 respondents were not satisfied (Average = 2.31) with the pedagogical methods adopted in the FT/UFAM.

The items related to the Pedagogical Methods (Figure 8) had an average below Regular, and dissatisfaction is observed in the following order: 1a) offer of summer courses; 2a) conducting related Industrial Engineering events; 3rd) the internship program; 4th) application of theory to practical knowledge; 5th) offer of optional subjects; 6th) update of the curriculum and the 7th) compliance with the teaching plan.

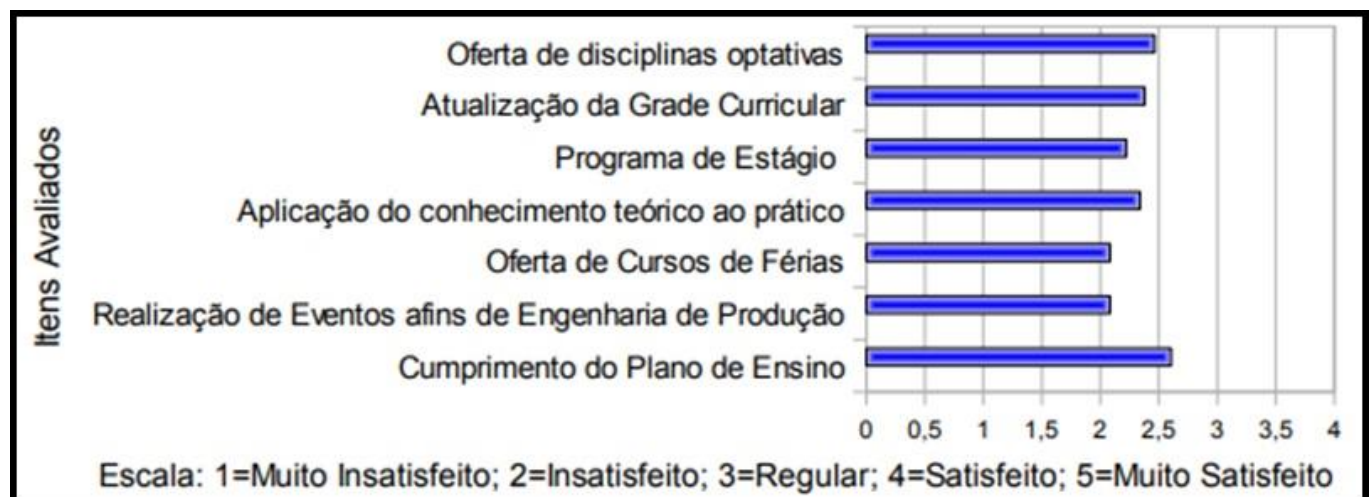


Figure 8 – Average Score of seven items of the Pedagogical Method Requirement

Source: Author



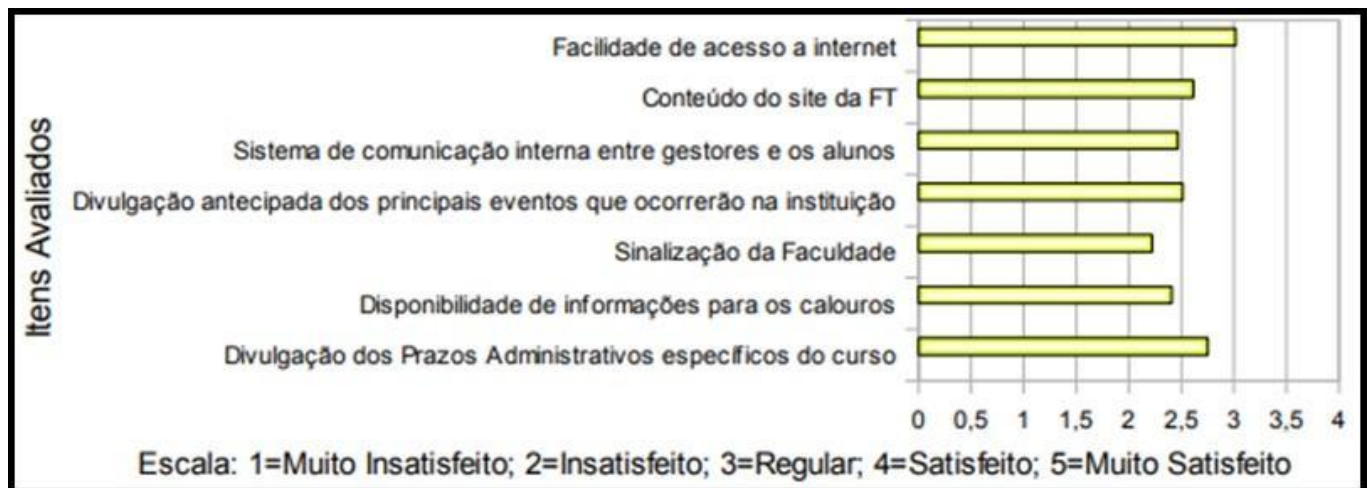


Figure 9 – Average Score of seven items of the Communication Requirement

Source: Author

Analyzing the Communication Requirement (Figure 4), the 118 students who answered the question are not satisfied with the existing Communication process at FT (Average = 2.57).

With the exception of the item "ease of access to the Internet" (Figure 9), considered on average as Regular, students' dissatisfaction is with: the Faculty's signaling; the availability of information for freshmen; the communication system between managers and students; early disclosure of the main events that will take place at the institution; the site content and the disclosure of the specific administrative deadlines of the Industrial Engineering course.

Regarding the infrastructure of the FT/UFAM (Figure 4) the satisfaction level of the 114 students who answered the question is between Dissatisfied and Regular (Average = 2.45).

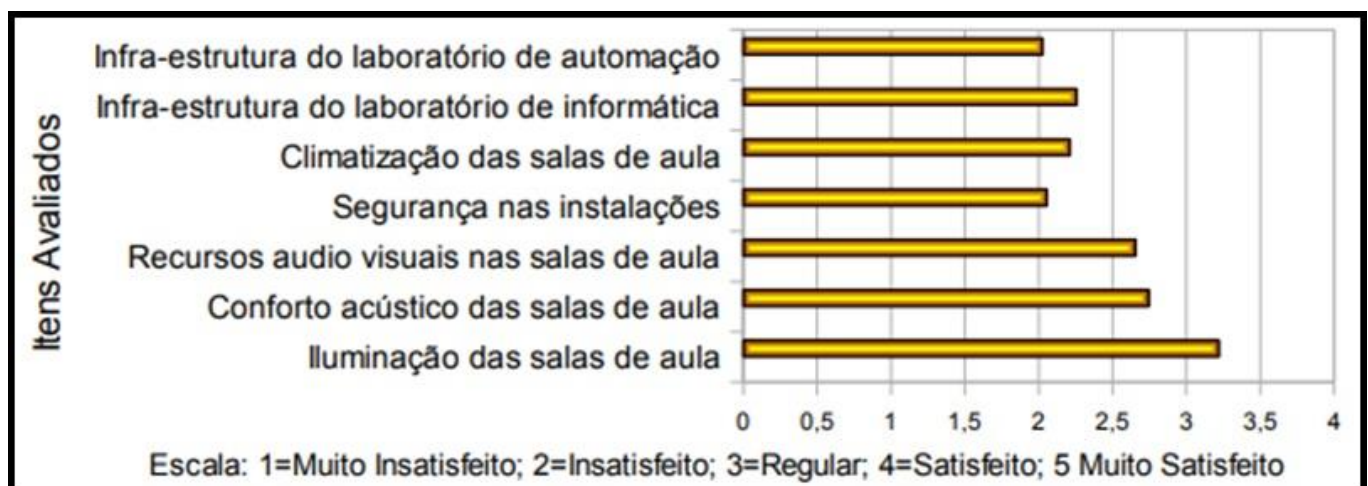


Figure 10 – Average Score of seven items of the Installations Requirement

Source: Author

Except for classroom lighting (Figure 10), considered between Regular and Satisfied, students' dissatisfaction is worrying with their safety in the Faculty; climate control of classrooms; the infrastructure of the automation and computer labs; the audio-visual capacities and acoustic comfort of classrooms.

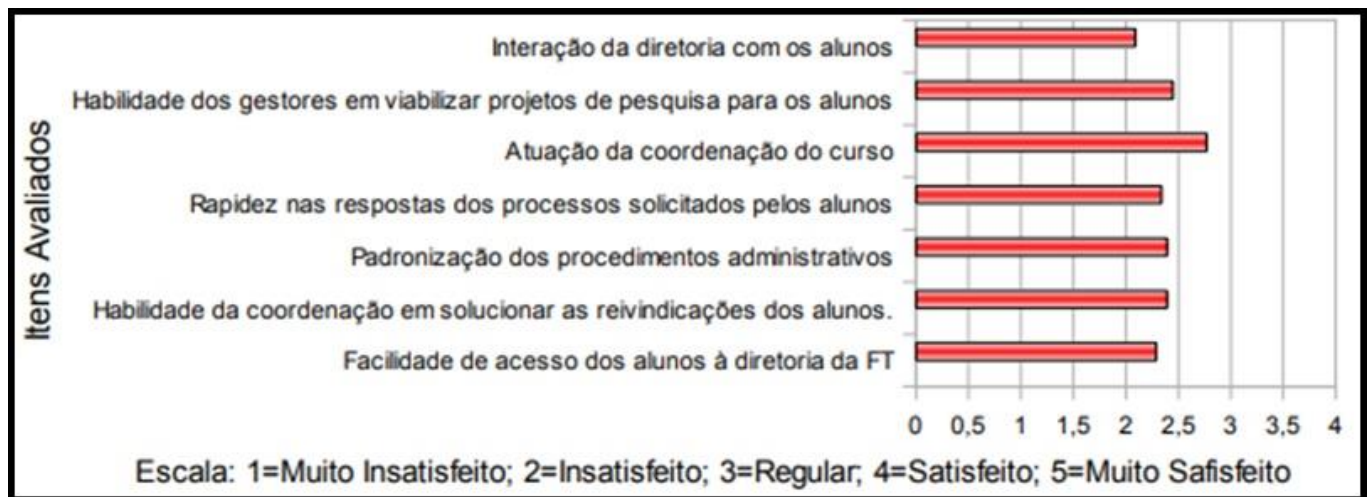


Figure 11 – Average Score of seven items of the Management Requirement

Source: Author

Finally, when analyzing the FT/UFAM Management Requirement (Figure 4), it is observed that, in general, the level of satisfaction of 118 respondents is between Dissatisfied and Regular (Average = 2.39).

A closer look at the performance of FT/UFAM Management items (Figure 11) reveals that students feel dissatisfied with: the low interaction between the Board and students; low level of ease of student access to the FT Board; delay to respond to processes requested by students; the need to standardize administrative procedures; poor ability of course coordination to discuss student claims; low ability of managers to enable research projects for students and the performance of the course coordinator.

## 5. Conclusions and recommendations

The general objective of the research is to develop in a participatory way a methodology to continuously evaluate the level of satisfaction of the students of the Industrial Engineering course with the main services provided at FT/UFAM.

From the analysis of the results, the following conclusions and recommendations were reached:

- It is possible to develop a participatory methodology with students using as strategy the application of their knowledge in professional subjects such as Quality Management, Strategic Planning, Entrepreneurship or Marketing. In this sense, to develop the best data collection instrument, it is recommended that older students be chosen since they already know the reality of the university, as well as have more theoretical bases to better contribute to the development of the stages;
- The participatory methodology with its data collection model can serve as evaluation tools to contribute to the process of continuous improvement of the services provided at FT/UFAM. Moreover, the methodology proved to be efficient in its application and to motivate the students, once they felt valued and could understand the importance of participative management in the planning of any organization. To be successful, each step needs to be well planned by the teacher or manager interested in applying it in your organization, especially step 3, which involves planning the Survey with developing the questionnaire and applying it over time. The limitation of this research was no existence of a more

rigorous test involving more advanced techniques of inferential statistics to approve the questionnaire, as well as to project what happens to the student population. Besides, the questionnaire was not applied to the teachers, technicians, and managers of FT/UFAM, leaving the suggestion of new research to update the one conducted in 2010;

c) In 2010 there was a high rate of student dissatisfaction (overall average = 3.044) with most of the requirements and items evaluated, and it was necessary to identify ways to develop cross-functional teams to urgently improve the top ten worst items: Automation Lab Infrastructure (Average 2.03); Safety (Average = 2.06); Realization of related events of Industrial Engineering (Average = 2.08); Offer of summer courses (Average = 2.08); FT Board interaction with students (Average = 2.09); Presentation by teachers of grades and partial frequencies before the Final Exam (Average = 2.1); Availability of teachers throughout the period (Average = 2.14); Internship Program (Average = 2.22) and College Signaling (Average = 2.22). Another recommendation would be to adopt collective problem analysis and solution tools presented by Silva (2018), some of which have already been tested in a community and academic environment by the author;

d) Finally, for the proper use and improvement of the methodology, the following procedure is proposed for FT/UFAM managers: to increase student participation in the college management process; where appropriate, revise and refine the methodology with stakeholders; elect the representative of each group; present the data collection model (questionnaire) to the parties involved; at the end of each two months, the representative can make the assessment with the users, compiling the data in a standard spreadsheet and sending it to the manager, boss or coordinator; this person can compile all data from the spreadsheets received and generate a general report. At a quarterly meeting, stakeholders could study the results and make the work plan to refine the points identified as needing improvement. In this sense, with the advancement of technologies, a research and development project could develop applications to adapt the methodology and/or model proposed in this article.

## 6. Acknowledgment

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## Internships of FT/UFAM Industrial Engineering student

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### Abstract

*The article identifies the profile of paid internships developed in the last two and a half years by the students of the Industrial Engineering course of the Faculty of Technology of the Federal University of Amazonas. To this end, consulting the records of the Department of Student Assistance (DAEST) of UFAM, responsible for the trainees' contracts, revealed the existence of 107 students who signed contracts to perform internship during this period. Besides, a questionnaire with 3-section and 15-questions was applied to students via email, classroom, event, and virtual groups to collect internship information. After collecting and analyzing the data, the following conclusions were reached: more than half of the interns are male, most of them interned in the industrial sector; the average monthly value of the internship scholarships is R \$ 1,265, and it was identified Honda and other nine companies that best remunerate their interns; most develop their roles in Operations and Process Engineering, Quality Engineering, Product Engineering or Logistics; the course subjects that most assisted during the internship were: planning and production control, quality management, production system, maintenance management and statistical control operation.*

**Keywords:** Industrial Engineering, Internship, professional profile.

### 1. Introduction

The Federal University of Amazonas (UFAM) began its academic activities in 1909 intending to stimulate the development of the professional career of its members. Over time, courses have been created in various areas of teaching the biological, agrarian, social and exact sciences.

The Faculty of Technology (FT) unit has courses in the exact sciences, composed of the following departments: Architecture and Urbanism, Graphic Designer and Expression, Civil Engineering, Computer Engineering, Electronic Engineering, Electrical Engineering - Electro technical and Telecommunications, Mechanical Engineering, Materials Engineering, Oil and Gas Engineering, Industrial Engineering and Chemical Engineering.

According to data analysis (Table 1) obtained from the Rectory of Teaching and Graduation (PROEG), in the second semester of 2019, 2222 students were enrolled in 12 undergraduate courses at FT/UFAM. Among the 12 undergraduate courses, there is the Industrial Engineering, which in the second semester enrolled 240 students. However, it is remarkable that the course began its activities in 2004 and by the first half of 2019, about 837 were enrolled, of which 272 (32.5%) have already graduated.

Table 1 - Number of students enrolled in FT/UFAM courses in 2019/2

COURSES	Nº	COURSES	Nº
Architecture and Urbanism	248	Industrial Engineering	240
Design	207	Electrical Engineering - Electronic	93
Civil Engineering	262	Electrical Engineering - Electro technical	95
Computer Engineering	232	Elect. Engineering - Telecommunications	90
Materials Engineering	171	Mechanical Engineering	189
Oil and Gas Engineering	179	Chemical Engineering	189
Total students enrolled	2222	-	-

Source: Rectory of Teaching and Graduation/UFAM

The research problem is the fact that until 2018, the Industrial Engineering department had not yet carried out any methodological study to know the reality of the remunerate internship experienced by its students in the market. This gap contributes little to the department's improvement process.

Thus, since 2019/1 (semester in which the course completed 15 years), it was started a work of collecting data on the profile of paid trainees of the course in the last two years. After consulting the records of the department of UFAM responsible for the internship, DAEST, it was found that of the 240 students enrolled in the Industrial Engineering course, 148 (61.66%) students achieved a paid internship from 2017 until the first semester of 2019. It is noteworthy that of this 148, 33 (22.29%) had their contractors renewed or changed companies in the following years. In all, 107 students have had or are having the experience of performing paid internships in the market.

The general objective of this paper is to identify the profile of paid internships developed by FT/UFAM Industrial Engineering students in the market over the last two and a half years, to provide useful information for managers, teachers, and students of course.

To this end, the following specific objectives were formulated: a) to update the database of Industrial Engineering students who are undergoing internships from the first semester of 2017 until the first semester of 2019; b) identify the internship profile (average amount paid by the companies, the companies where the internships take place, the sectors where the students work, the most demanded areas of Industrial Engineering, the hiring prospects and the course subjects that more contributed to the internship); c) propose suggestions for improvements to the managers of DAEST and the Industrial Engineering course.

The theme is relevant because it can show that the internship has great importance in the student's life, allowing to have a clearer and broader view and what will be required in the job market. Also, it is important for course managers, as it points out the most demanded areas of Industrial Engineering and the disciplines most applied during the internship. The research is also relevant to the students of the course, as it points to the average salary and the companies that are providing a better payment to the interns. For DAEST managers, the research is important because of the suggestions for improvements to be pointed to the process of organizing the trainee records. For the academy, the research will bring new knowledge on how to analyze the profile of the internships, as well as reflections and suggestions for new research.

## 2. Theoretical Referential

### 2.1 Internship Law in Brazil

Law No. 11,788, created on September 25, 2008, provides for Student Internship. According to Art. 1, the Internship is a supervised school educational activities, its main objective is to prepare students of the final years of elementary, high school, college, and vocational education for the job market.

This law defines the parameters that regulate the hiring of interns as listed below:

- The maximum workload of 4 hours per day and 20 hours per week for students of the final years of elementary school, in the professional mode of youth and adult education, six hours per day and 30 hours per week for higher education students, vocational education of regular average level;
- It may be mandatory and non-mandatory, as determined by the curricular guidelines of the teaching and the pedagogical project of the course, where the mandatory internship is the one defined as such in the course project, whose workload is an indispensable requirement for approval and obtaining a diploma. On the other hand, the non-mandatory stage is developed as an optional activity;
- The probationary period may not exceed two years, except for a trainee with an incapacity. It is important to highlight that in the case of internship contracts lasting one year or more, the trainee will be entitled to 30 days off, preferably during the school holidays;
- Unlike what is defined by the laws of the Labor Law Consolidation (CLT), the legislation stipulates a minimum floor for the internship remuneration, considering that the amount is defined in common between the parties to the internship agreement.

In addition, the maximum number of interns in relation to the staff of the internship granting entities shall be in the following proportions: from 1 to 5 employees: 1 intern; from 6 to 10 employees: up to 2 interns; from 11 to 25 employees: up to 5 interns; over 25 employees: up to 20% on the number of employees.

It is important to emphasize that the internship in the companies does not create an employment relationship, that is, the remuneration must be paid without labor law charges, therefore they do not have any discount charges by the companies.

### 2.2 The Internship importance

The internship can develop the student's professional identity through their experiences and real situations that they promote. It is the first contact that students have as their future area of activity, becoming more important when these experiences are shared in the classroom, producing discussions, enabling a new view on the profession (LINHARES et. al., 2015).

Helping the student to have the opportunity to put into practice the academic teachings, for the best professional development, it is important to emphasize that the activities performed in the internship are directly related to the areas of the course and its formation. For many students, it is the gateway to the world of work (IEL, 2017).

Achieving a good internship is a key factor for enriching not only the curriculum but for gaining experience and it is these factors that contribute to the job market. The internship is a way to shorten the distance between students and the job market.

The apprenticeship, when properly conducted, targeted and evaluated, creates and enhances tangible and

intangible benefits for the student; improves academic qualification; evidence and enhance personal qualities; facilitates the transition from academic to professional life; provokes the exercise of vocational guidance; breaks the dichotomy of knowing and doing; breaks the umbilical cord with the school and provides an irreplaceable life experience. (BARROS; LIMONGI, 2003, p. 4)

Learning is more efficient when acquired through experience, so much so that it is more common for trainees to remember the activities during the internship than in activities that were developed in the classroom (SCALABRIN, MOLINARI, 2013).

For students who live the experience, the work is comprehensive and shows a professional reality that puts the front of those who do not an internship and will only work after completing the course (ROCIO, 2001).

Thus, an undergraduate course should contribute theoretical and practical resources for the performance of professional functions, according to each area of knowledge. Thus, it is in the undergraduate course that begins built the knowledge, skills, postures, and attitudes that form the professional. In internship periods, this knowledge is re-signified by the student intern from their personal experiences in direct contact with the field of work that, throughout their professional life, are being reconstructed in the exercise of their profession. (ALMEIDA and PIMENTA, 2014, p. 73)

According to the CEAT (Center for Advanced Studies and Training, 2015) internship offers the student the unique opportunity to assimilate and reconcile theory and practice, and learning is more effective when acquired by experience through frequent practice. It is important to emphasize that the experience of what has not been seen in the classroom increases curiosity about the classes, as new doubts arise. Practicing the internship makes it possible for the student to realize what they need to learn or even improve, as they show deficiencies and flaws. Practical difficulties will point to theoretical difficulties. By still being in the classroom, the intern can bring freshness and innovation to the company. Given the importance of the internship, the student should not seek to make money from experience, the main will not be the scholarship paid, but the knowledge acquired.

According to Rios (2003), the internship has some uses, such as awakening the professional vocation, obtaining knowledge of different types of companies, human relations, internship, classes, and qualification for the future professional career.

It is noteworthy that academic learning prepares students to achieve the maximum skills necessary to direct them to their career goals; from the beginning, it meets challenges, warnings, and opportunities (MISHIMA and BALESTRASSI, 2008).

### **2.3 ABRES and Internship Statistics in Brazil**

Created on June 08, 2004, the Brazilian Internship Association (ABRES), provides the insertion of young people in the labor market in Brazil, in addition to providing quantitative and qualitative statistical data of the “internship” activity to the national institutions. It also provides students and trainees with free lectures and courses for technical, scientific and cultural development.

According to research conducted by this association, the number of interns before the approval of Law No. 11,788 (2008) was 1.1 million. However, in 2017, this number increased to 1 million, where 740 thousand were from higher education and 260 thousand were from high school and technical. Besides, the

region with the greatest number of interns was the Southeast with 591,334, followed by the South with 233,978 interns, the Northeast with 89,314, the Midwest with 59,873, and the North with 25,511 students. The most of internships are for Business Administration (16.8%), Law (7.3%), Social Communication (6.2%), Computer Science (5.2%), Engineering (5.1%) and Pedagogy (4.2%). Nevertheless, in some careers, especially in engineering, candidates are lacking to fill the demand for opportunities offered.

#### **2.4 Industrial Engineering Profile and Areas**

In Brazil there is a Nacional Industrial Engineering Industrial Association called ABEPRO. According with them:

- a) Engineering aims to implement, operate and propose improvements and maintenance to integrated productive systems of goods and services, involving men, materials, technology, information and energy, and to predict and analyze the results obtained from these systems for society and for environment, seeking specialized knowledge in mathematics, physics, humanities and social sciences, together with the principles and methods of engineering analysis and design;
- b) This engineering stands out for its product and production system dimensions, is related to the ideas of designing, making viable and distributing products to society. These activities are viewed in an integrated manner by Industrial Engineering and are fundamental to the country's competitiveness;
- c) There are ten areas of knowledge of Industrial Engineering: Product Engineering; Operations Engineering and Production Processes; Logistics; Operational Research; Quality Engineering; Organizational engineering; Economic Engineering; Health and Safety Engineering; Sustainability Engineering; and Education in Industrial Engineering.

For the analysis of the professional profile in Industrial Engineering, some companies value three types of knowledge: the know-how, are the practical, technical and scientific dimensions acquired through professional experiences; knowing how to be is the personality that determines behavior in social work relations, such as initiative, productivity and competitiveness; knowing how to act is knowing how to work in teams, be able to solve problems and do new jobs.

In this context, learning can transform knowledge into skills in a specific professional situation, adding value to the individual and the organization. Thus, the production engineer must seek new knowledge to express autonomously and independently; must contribute to scientific and technological development; present creative and original solutions to production problems; develop good work in multidisciplinary teams; design, execute and manage engineering enterprises; to worry about the impacts of their work, especially regarding the ethical, environmental and political repercussions (OLIVEIRA and PINTO, 2006).

Taking into account the global context, the current model of economics requires knowledge of the Engineer to produce concepts, methods, and practices of industrial process responsibilities (KYPPER, 2014).

As it is a very ample area, this is one of the possible factors that has been causing the increase in the offer of Industrial Engineering courses, because the job market has a growing receptivity by the professional who is graduated in the course (SANTOS, 2008).

### 2.5 Average of Internship remuneration in Brazil

A salary survey conducted in March 2019 by Catho, a recruitment firm, indicates that an Industrial Engineer in Brazil has average compensation of R\$ 6,228 per month. An Industrial Engineering intern earns an average of R\$ 1,120 and a trainee earns an average of R\$ 2,185.

Table 2 - Ten highest paid internships in 5 Brazilian states in 2017

Areas	Salary average	Areas	Salary average
Industrial Engineering	R\$ 1,436.72	Mechanical Engineering	R\$ 1,051.48
Mechatronics Engineering	R\$ 1,259.23	Marketing	R\$ 1,030.29
Electronic Engineering	R\$ 1,204.50	Electrotechnical Engineering	R\$ 989.73
Economics	R\$ 1,163.58	Electrical Engineering	R\$ 924.83
Civil Engineering	R\$ 1,100.38	Hospital Administration	R\$ 916.33

Source: Student Guide (2017)

In 2017, the site <guiadoestudante.abril.com> surveyed trainees registered with residences in the states of Paraná, Rio Grande do Sul, Sao Paulo, Rio de Janeiro, and Minas Gerais. As can be seen in Table 2, the internship in Industrial Engineering (R\$ 1,436.72) has one of the highest-paid values in this region, followed by Mechatronic Engineering (R\$ 1,259.23) and Electronic Engineering (R\$ 1,204.50).

### 3. Methodology

The research has applied nature since the knowledge generated will contribute to the improvement of the services provided by the managers of the Industrial Engineering course.

Regarding the objectives, the research is descriptive because of the use of descriptive statistics of data without intervening in the variables involved in the study of the internship profile performed by students in the market.

The approach is quantitative using procedures that involve bibliographic research and Survey application along with questionnaires and interviews, as well as the application of descriptive statistics to analyze the collected data. The survey has a quantitative approach and can be described as obtaining data or information on characteristics, actions or opinions of a particular group of people, indicated as representative of a target population, through a survey instrument, usually a questionnaire (TANUR APPUD PINSONNEAUT & KRAEMER, 1993).

The research stages were: a) bibliographic survey; b) development of the data collection instrument with the application of questionnaires and interviews; c) target audience definition and sample size; d) conducting the pilot test; e) completion of the definitive test; f) data gathering and analysis.

For data collection, the target was 107 Industrial Engineering students from the UFAM Faculty of Technology who have been or are performing paid internships in the last 2 and half years, identified from the UFAM Student Assistance Department (DAEST) records, analyzing the data of the commitment term

of the interns registered in the sector.

A questionnaire was developed in Google Forms (Appendix 1), consisting of three sections:

Section 1 has ten questions about the Internship, 5 of which are open and another 5 with alternatives to mark. Section 2 has three open-ended questions for personal student information, such as name, registration, and year of course.

Section 3 has two open-ended questions designed to identify respondents' views on the course, as well as suggestions for future trainees.

To assess the comprehensibility level of the questionnaire, the pilot test was conducted in the first semester of 2019 with 41 (38.31%) students of the Industrial Engineering course at UFAM who began their internship in 2018, and the invitation was sent individually by email, of which 20 (48.47%) answered the questionnaire correctly.

After completing the pilot test, some adjustments were made to the questionnaire, and on October 14, 2019, the definitive test began by sending an online invitation to the other students, containing the access link to the questionnaire, which was available for 12 days.

The invitation was sent via email via Facebook and WhatsApp from the student group. Besides, from October 16 to 18, 2019, the questionnaire was applied during the XII Amazonense Engineering Symposium at the Federal University of Amazonas.

To encourage participation, two prizes were raffled for the students who completed the survey. As a result, of the 107 target students, 51 (47.66%) answered the questionnaire correctly, whose data were collected and registered in a spreadsheet editor, for analysis and discussion of results.

## **4. Discussion**

### **4.1 Respondent Profile**

The data collected along the terms of commitments in DAEST indicate that between 2017/1 and 2019/1 about 107 students of the course became interns, of which 24 (22.42%) completed the undergraduate and 83 (77.57%) remain enrolled in the course and have their internship contracts renewed or have changed companies.

Regarding the periods of the student interns, it was observed that 8 (7.48%) students are between the 2nd and 4th period, 30 (28.04%) between the 6th and 8th periods, 20 (18.69%) are in the 10th period, 25 (23.36%) have been in the institution for more than 5 years and 24 (22.43%) have already graduated. Concerning gender, it was observed that 54% of the sample is male, while 46% is female.

### **4.2 Internship Profile**

It was first observed the branch of activity of the companies in which students are performing internships. Of the 51 respondents, 38 (74.51%) are performing or have completed internships, most (86%) of them in the industrial sector, companies that manufacture everything from automotive parts to hygiene and cleaning products. Another 11% work in companies that provide services, such as consulting, IT support and technology, while only 2% interns work in commerce.

When analyzing the scholarship remuneration, it was necessary to make the frequency distribution of the

values informed by the students. Figure 1 shows the distribution, where 12 (23.53%) receive up to R\$ 913; 10 respondents (19.61%) receive between R\$ 913 and R\$ 1,126; 12 (23.53%) between R\$ 1,126 and R\$ 1,339; 7 (13.73%) students received between R\$ 1,339 and R\$ 1,552; 3 (5.88%) receive between R\$ 1552 and R\$ 1,765; only 1 (1.96%) receives between R\$ 1,765 and R\$ 1,978; 3 (5.88%) receive between R\$ 1978 and R\$ 2,191, while 3 (5.9%) receive over R\$ 2,191.

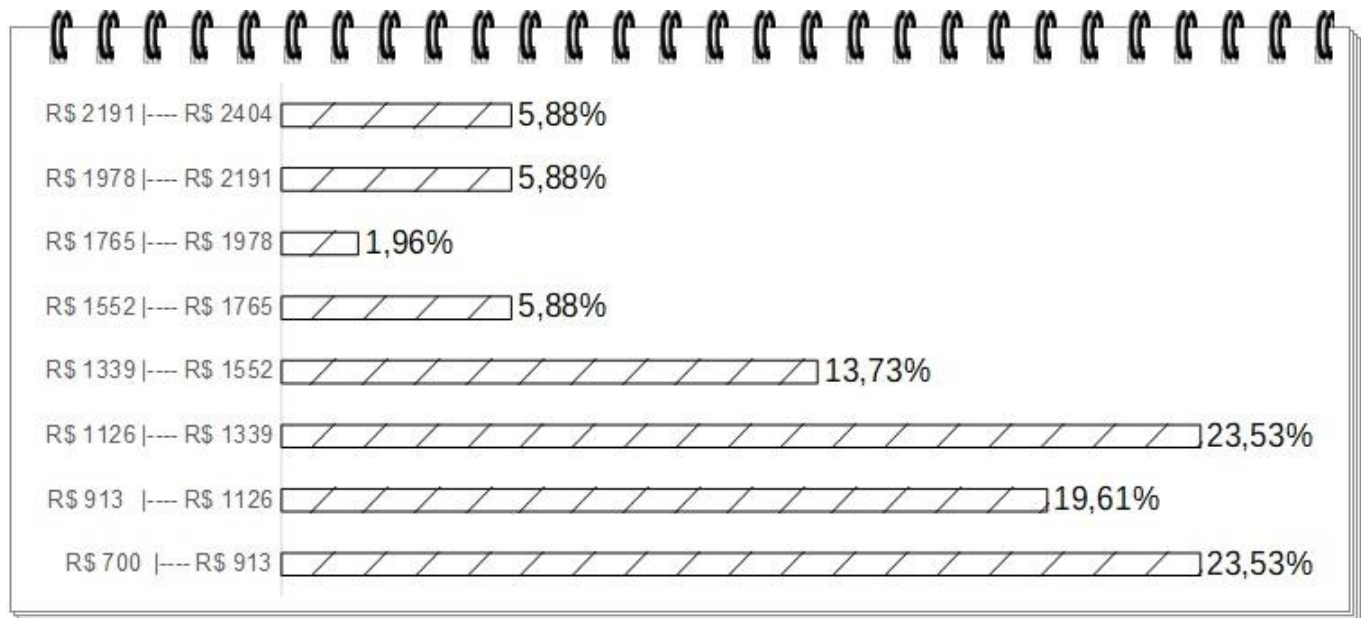


Figure 1 - Range of scholarship value received monthly by interns between 2017/1 and 2019/1

Source: Author

Table 3 - Ten companies from Manaus that pay well to Industrial Engineering interns

COMPANY	SCHOLARSHIP	COMPANY	SCHOLARSHIP
Honda	R\$ 2,400	Pepsico	R\$ 1,570
Breitener Energética S.A	R\$ 2,300	Bic	R\$ 1,500
P&G	R\$ 2,300	Faber Castell	R\$ 1,432
Visteon	R\$ 1,800	Sonoco	R\$ 1,425
Ambev	R\$ 1,600	LG Eletronics	R\$ 1,300

Source: Author

The average monthly value of the scholarship was around R\$ 1,265 with a standard variation of R\$ 425. An analysis was made to identify the total number of organizations receiving FT/UFAM Industrial Engineering interns, as well as those paying the above-average remuneration.

Companies in the industrial sector are the ones that make the best financial grants available to their interns. Table 3 presents the ten companies with the best scholarships, among them the multinational company Honda with monthly scholarship payment of R\$ 2,400 and Breitner Energética SA, a thermoelectric company that provides a salary of R\$ 2,300.

Regarding the areas of Industrial Engineering in which the intern works in companies (Figure 2), it was observed from the 51 respondents, the majority (30; 58.8%) perform their functions in the area of Operations and Process Engineering, while 7 (13.7%) work in Quality Engineering, 4 (7.8%) in Product Engineering, 3 (5.9%) in Logistics, 4 (7.8%) perform their duties in the operational Research and



Organizational Engineering, while the remainder (3; 6%) perform their functions in the areas of Health and Safety Engineering, Economic Engineering or Sustainability Engineering.

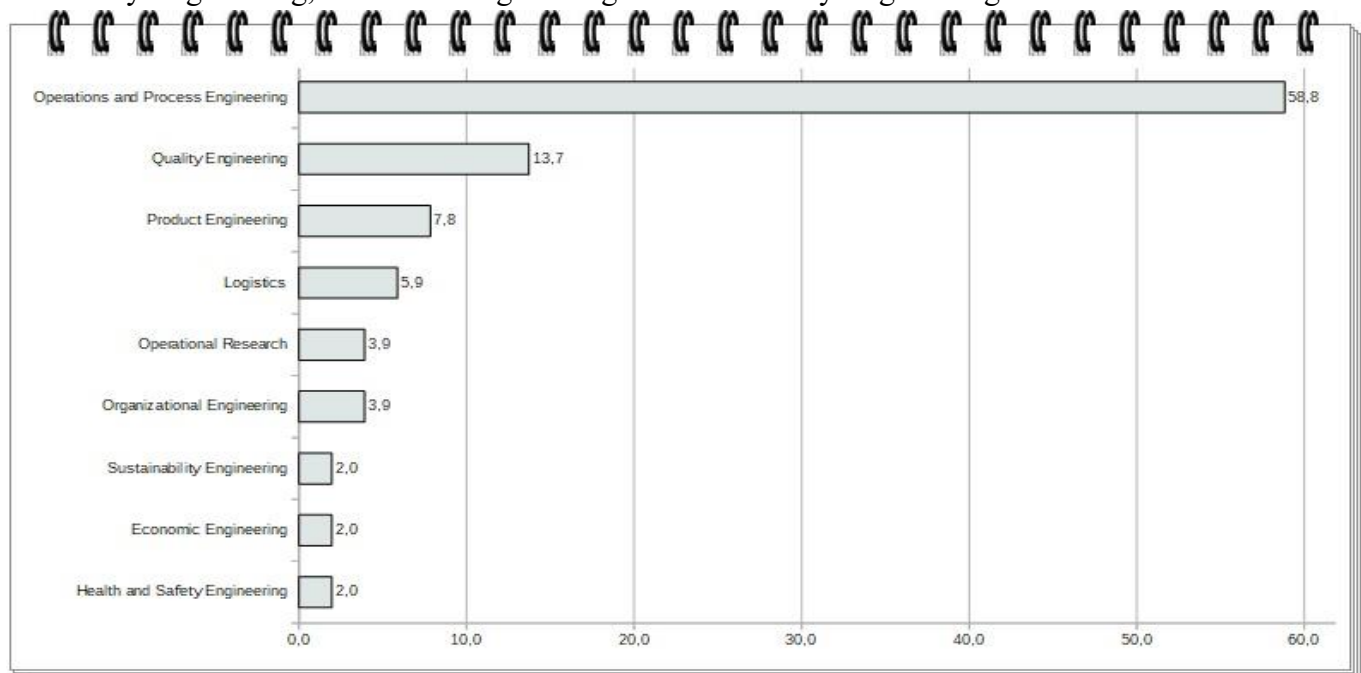


Figure 2 - Practice areas of the Industrial Engineering Course interns between 2017/1 and 2019/1

Source: Author

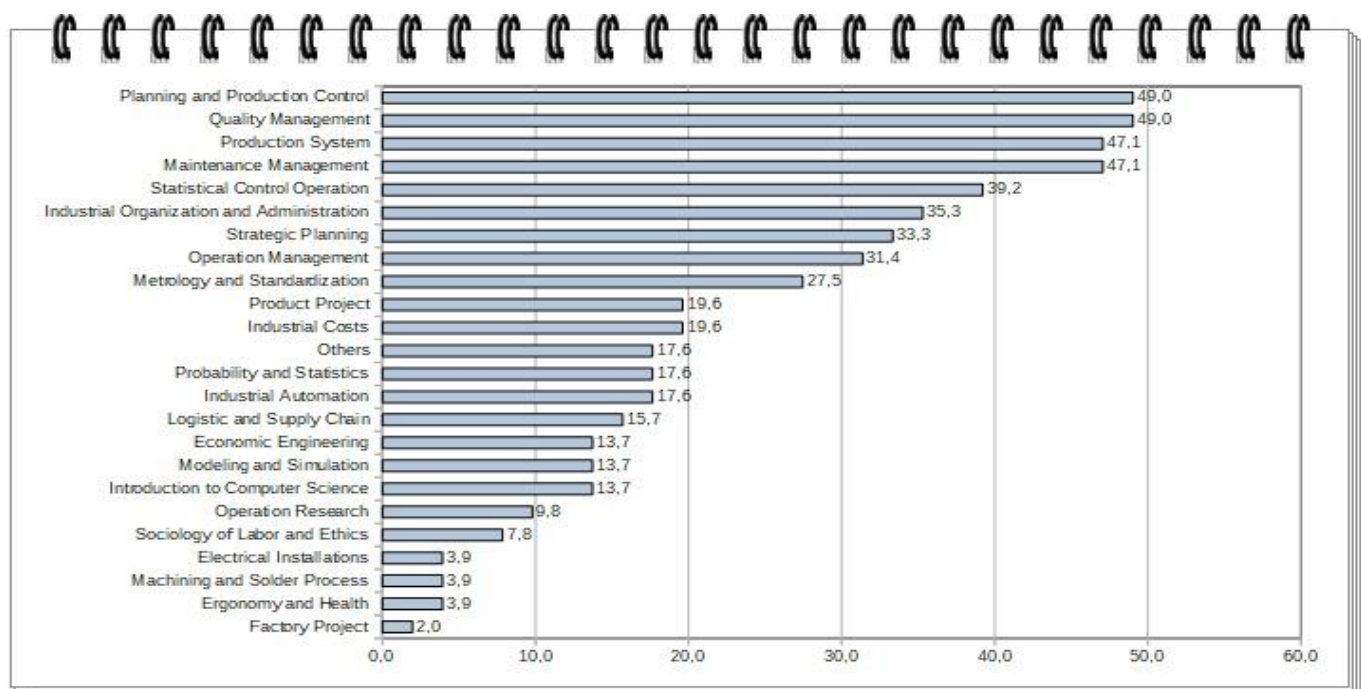


Figure 3 - Ten subjects that most helped students during the Internship

Source: Author

Respondents were asked which disciplines contributed to the professional development of their internship in the company. This question was a multiple choice and emphasized 24 subjects from the Industrial Engineering course.

All answered the question and Figure 3 shows that the ten disciplines that contributed the most were:

Production Planning and Control (49%); Quality Management (49%), Production System (47.1%), Management Maintenance (47.1%), Statistical Operations Control (39.2%), Industrial Organization and Administration (35.3%), Strategic Planning (33.3%), Operations Management (31.4%), Metrology and Standardization (27.5%) and Product Project (19.6%).

Regarding the internship situation in the company, more than half of the respondents (56.86%) reported that they are still doing the internship, while 17.65% were successful, concluding and being hired by the company. Also, around 16% of them reported that they have already completed their internship without being hired and almost one-tenth (9.80%) reported that they had other reasons for being dismissed from the company.

#### **4.3 Respondents suggestions for improvements**

At the end of the questionnaire, two open questions were proposed for the respondents to present suggestions for improvements for the Industrial Engineering course and for future trainees.

Regarding the question: "What suggestions would you give to the managers of the Industrial Engineering course at UFAM?", 45 students (88.23%) answered the question, of which 20 (39.21%) recommended to teachers the application of practical classes so that students had a better knowledge of the subject.

In general, the recommendations were:

- S1) Mandatory application of practical content in Internship I and II disciplines, as well as an indication of companies with the possibility of acting on the subject;
- S2) Improve the teaching methodology in the classroom, as there is a lot of repetition of activities in the subjects and teachers with limited didactics to teach;
- S3) Focus on the areas of the future and direct the student towards their learning. In this sense, it is advisable to develop stronger partnerships with PIM companies, as well as exchange programs;
- S4) Offer tools and develop actions that simulate situations that students will encounter in the job market;
- S5) Focus on exercises with real cases, to use Industrial Engineering tools;
- S6) Improve the content, update teaching plan, and classroom dynamics;
- S7) Invest in research and laboratories.

Regarding the question "What suggestions would respondents give to future students hoping to intern?", 48 answered (94.11%), with a good portion suggesting the training outside the university (English, Excel, etc.) as well as knowing the company before going to the interview, etc. Below are the suggestions:

- S8) Take courses in the area of Industrial Engineering to differentiate themselves in the market;
- S9) Seek to have experience in the first year of college;
- S10) Study English;
- S11) Improve your behavior;
- S12) Improve oral and written communication skills;
- S13) Always be honest in interviews;
- S14) Search for projects that involve academic activities to have management experience;
- S15) Be willing to learn, seeking to know the company, as well as finding ways to positively influence the organization;
- S16) Put the College disciplines into practice to get an overview and apply each area of Industrial

Engineering in the internship so that projects and jobs become more robust;

S17) Focus a lot at the beginning of college, learn and advance as many subjects as possible when the time comes to train, focus learning for work.

## **5. Conclusions and recommendations**

The objective was to identify the profile of paid internships developed by FT/UFAM Industrial Engineering students in the job market over the past two and a half years, to provide useful information for the course managers, teachers, and students.

To this end, the survey conducted with the DAEST records revealed the existence of 107 students who have been or are still doing paid internships since 2017/1, most of whom have been studying in the course for over 3 years and are male. During the records study process, it was noted that DAEST needs to develop a more accurate and up-to-date database to be able to provide real-time indicators from Industrial Engineering interns, and other courses, as it took a lot of time to organize the information, either by manual work or by entering the intern data. Thus, it is recommended that UFAM managers develop or acquire software that enables paper elimination and digital data management.

After analyzing the data of 51 respondents, the following conclusions and suggestions for improvements were made:

First) Most students of Industrial Engineering are working in the industrial sector, while the rest are in services or commercial. It would be advisable for Industrial Engineering course managers to partner with service sector organizations, as this sector accounts for almost half of the annual GDP of the State of Amazonas, meaning there are many opportunities to recruiting the talent of students in this segment;

Second) The average of the student internship salary is R\$ 1,265 and Honda is the company that pays the best scholarship to students. It is recommended to create an office at the Faculty of Technology to support DAEST and students, with professionals from the University visiting organizations to promote courses and to form partnerships, aiming at the creation of a talent bank, the identification of demands, and offering these talents to partner companies;

Third) Among ten areas, more than half of students act in Industrial Engineering, Operations, and Process Engineering, followed by Quality Engineering, Product Engineering, Logistics, Operational Research and Organizational Engineering. Further research needs to be done to identify the most demanded subareas, tools, and methods at these internship locations;

Fourth) The five disciplines that contributed most to the internship process were Production Planning and Control, Quality Management, Production Systems, Maintenance Management, and Statistical Control of Operations. Further research may be undertaken to analyze the most demanded tools and methods of these disciplines, as well as to obtain from the HR Manager of these companies a study on the level of utilization of the professional disciplines of the course in the company environment. Besides, it is recommended to conduct further research focused on the skills and attitudes that organizations want to find in Interns to contribute to their training and even hiring in the organization;

Fifth) Teachers play a relevant role in the professional development of students, so respondents recommended more practical classes throughout the course, training to improve teachers' services, as well

as greater involvement with existing organizations in the state;

Sixth) For future interns, greater dedication is recommended in the area in which they are following, continuing education, seeking to learn new courses related to Industrial Engineering, and communication, especially English, as it is a major differential in great companies.

One of the main difficulties encountered during the research was to contact some students who completed the course or students who were not enrolled in the course were not found, so it is recommended to course managers and student representatives to develop a job more effective with interns and alumni, to continue to maintain a good relationship with them over time and encourage them to participate in new training activities in the course.

## 6. Acknowledgments

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**APPENDIX 1 – Questionnaire on Industrial Eng. Internship Employability Level**

Objective: To analyze the level of employability of Industrial Engineering students, from the Internship.

**SECTION 1: ABOUT THE INTERNSHIP**

1.1 Enter the company name:

1.2 Enter the internship area:

1.3 Internship Start Date;

1.4 Internship End Date;

1.5 Salary:

1.6 Internship situation:

(a) Running; (b) completed and hired; (c) completed but not hired.

1.7 The internship is being performed in some area of Industrial Engineering:

(a) Yes; (b) No; (c) Maybe.

1.8 If yes, which area?

<input type="checkbox"/> Operations and Process Engineering	<input type="checkbox"/> Operational Research
<input type="checkbox"/> Logistics	<input type="checkbox"/> Quality Engineering
<input type="checkbox"/> Product Engineering	<input type="checkbox"/> Health and Safety Engineering
<input type="checkbox"/> Organizational Engineering	<input type="checkbox"/> Sustainability Engineering
<input type="checkbox"/> Economic Engineering	

1.9 Which disciplines of the Industrial Engineering course helped you with the knowledge to perform your internship well?

<input type="checkbox"/> Industrial Automation	<input type="checkbox"/> Modeling and Simulation
<input type="checkbox"/> Statistical Control of Operations	<input type="checkbox"/> Industrial Organization and Administration
<input type="checkbox"/> Industrial Costs	<input type="checkbox"/> Operational Research
<input type="checkbox"/> Economic Engineering	<input type="checkbox"/> Planning and Production Control
<input type="checkbox"/> Ergonomics and Health	<input type="checkbox"/> Estrategic Planning
<input type="checkbox"/> Maintenance Management	<input type="checkbox"/> Probability & Statistics
<input type="checkbox"/> Operations Management	<input type="checkbox"/> Factory Project
<input type="checkbox"/> Quality Management	<input type="checkbox"/> Product Projet
<input type="checkbox"/> Electrical Installations	<input type="checkbox"/> Machining and Solder Process
<input type="checkbox"/> Introduction to Computer Science	<input type="checkbox"/> Production System
<input type="checkbox"/> Logistics and Supply Chain	<input type="checkbox"/> Sociology of Labor and Ethics
<input type="checkbox"/> Metrology and Standardization	<input type="checkbox"/> Others

1.10 Does the company have the prospect of hiring you during or after the internship?

(a) Yes; (b) No; (c) Hired.

## SECTION 2: ABOUT STUDENT

2.1 Name:

2.2 Registration number:

2.3 Year you entered the Industrial Engineering Course:

## SECTION 3: SUGGESTIONS

3.1 What suggestions would you give to Industrial Engineering course managers

3.2 What suggestions would you give to prospective students wishing to intern?

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## Testing an Internal Supply System in a PIM's company

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### Abstract

*This article analyzes the implementation of an internal material supply system in an electronics company installed at the Manaus Industrial Pole (PIM). This system is a lean internal logistics model with the leveled replacement of materials and defined frequency, facilitating the communication of the people involved and ensuring the efficient use of the productive area. The method used was a practical application adapted from the one proposed by Harris et al. (2004) to control the internal movement of materials. As a result, this paper surveyed the key advantages of adopting the new supply system and identified potential opportunities for improvement.*

**Keywords:** Lean Manufacturing; Lean Logistics; Supply Route; Material Handling.

## 1. Introduction

### 1.1 Contextualization

Following the success of the Toyota Production System, other companies around the world have adopted the lean system to increase their performance by eliminating unnecessary processes and balancing activities to ensure continuous flow through production lines. Womack and Jones (1994), in an article seek to extend the concept of Lean Manufacturing to the entire organization, noting that all non-value-added processes can be worked to reduce waste.

Under this approach that all areas of the organization can be optimized, a new concept of logistics emerges. The combination of in-house logistics activities with the Lean Manufacturing philosophy focuses on the transition from mass sourcing logic to a lean system, ensuring what is needed, when it's needed and in the exact amount, and eliminating activities that don't add up. value to the process. In this system, there are well-sized routes to avoid the lack of raw material and the need for materials is expressed employing cards that signal the need for materials, better known as Kanban.

The Manaus Industrial Pole is one of the most modern in Latin America, bringing together about 700 industries comprising electro-electronic, two-wheel, computer, optical, chemical and other sectors.



Installed companies benefit from the exemption of various taxes, which attracts industries from the various segments mentioned. PIM's electro-electronic segment represents the largest manufacturing center for electro-electronic products in South America (SUFRAMA, 2016). According to the Manaus Industrial Pole Performance Indicators Report of September 9, 2015, the electronics sector is responsible for 40.5% of the jobs generated and 29.77% of PIM revenues.

The company object of this study hereinafter will be called as Z due the information security policy, is a multinational company active in the electronics sector, considered of medium size installed in Manaus since the '80s and that produces electrical protection devices for residential and industrial use. The research was done in the warehouse, which aims to meet the demands of internal customers, production and planning, storage and delivery of materials before the process of transformation into the finished product.

In an article published by Exame magazine (2011), Brazil had the 4th most expensive shed rental value in the world: R \$ 23.50 / m<sup>2</sup>, behind Tokyo, Zurich, and Hong Kong. When it comes to Latin America, São Paulo is the most expensive city. The current conditions of the macroeconomic scenario, however, present excellent opportunities for reviewing the manufacturing area needed to meet production demands.

In order to reduce the fixed cost of rent of the warehouse and, consequently, the amortization under the value of the products, Company Z started in April 2016 three front lines for reduction of manufacturing area: 1st) The layout of the production lines; 2) The increase in the warehouse occupation rate and expedition, and 3) The process of implementing an internal supply system, the latter being the main theme of this article.

Previously, each production line had two supply schedules per day, morning and afternoon. The production leader was responsible for ordering the materials according to the production orders to be executed and at the signal of the line supplier who is responsible for separating the materials for use on the production lines. The inventory team, made up of 10 warehouses, delivered, when the separation of the materials requested was completed, to one of the 4 line suppliers also responsible for keeping the production supermarket clean and organized.

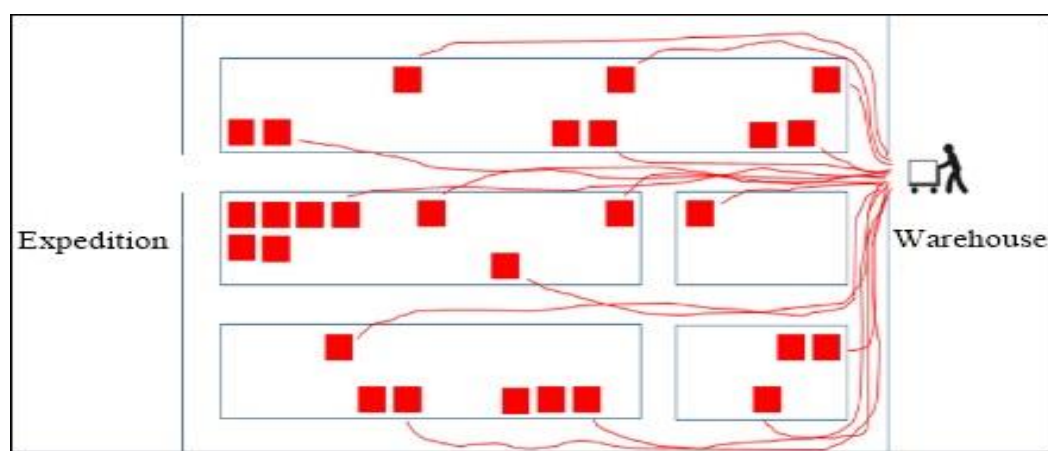


Figure 1- Layout before supply system deployment.

Source: Author (2016)

The transportation of materials, from the warehouse to point of use in production, arranged on pallets, were manually moved by hand pallet trucks, also known as transpalette. Figure 1 simulates the various supply points and the movement to reach these points. It can be observed system numerous disadvantages, such as:

- a) High level of stock in the process due to unreliability in the supply process;
- b) Supermarket areas of overproduction due to the high level of inventory;
- c) Excessive movement of people, both to make delivery and to request material to stock;
- d) The production leader and only he is responsible for requesting the necessary materials under the signal from the line supplier.

It was then from the above disadvantages that Company Z's senior management decided to invest and implement a new internal supply system. The planning and implementation phases took place between April and September 2016, having as main actions: a survey of the characteristics of all items in the Plan for each piece (PPCP) worksheet, need analysis of each job, transportation car purchase Kanban card development, the definition of supply routes, among others.

From the implementation of this system, there was a study to investigate the difficulties encountered, how they were overcome, the main results obtained and what can still be improved. Thus, the main questions are: what gains has the implementation of an internal supply system brought to company Z? what are the difficulties encountered and what improvements can be made to make the supply system even more efficient?

The main objective is to analyze the implementation of the internal supply system carried out in Company Z's Warehouse sector, to propose improvements to the organization's managers.

To this end, it was defined three specific objectives: 1) Describe how the process of implementation of the said system took place; 2) Compare the states before and after implantation; 3) Identify the main results obtained, difficulties encountered and propose suggestions for improvements to make the supply system more efficient.

The research project is relevant for the following reasons:

- a) For the company: analyze gains that the project brought to company Z, making the process more efficient, as well as suggesting improvements that can be studied for possible implementation;
- b) For customers (internal): loyalty in delivery and in less time;
- c) For academia: Marodin et al. (2012 p. 457) identified few research focused on internal logistics improvements after lean manufacturing methodology implementation, so this article could contribute for classroom discussions and its limitations generate further investigations;
- d) For society: an approach to a supply model that can be used in companies of various segments that want to optimize their internal logistics processes.

## **2. Theoretical Referential**

This topic will present a sequencing for a better understanding of the article. Here it will approach Lean Logistics, followed by the Kanban pull signal method and finally, the supply route according to the studied literature. The method proposed by Harris et al. (2004) for internal material handling.

## 2.1 Lean Logistics

A truly lean process is achieved when it is fully perceived and analyzed, from receiving raw materials to shipping finished products. Because of this, it becomes much more important to control and manage the entire logistics supply system for production lines (SHINGO, 1996). Logistics is one of the main aspects of the lean system operation (WOMACK, 2004).

Baudin (2004) conceptualizes lean logistics as the dimension of lean production about the delivery of materials, done repeatedly and in small batches, as opposed to a traditional supply system, made in high volume and infrequently.

Carrera (2008) states that some of the main gains that companies seek with lean vision in their logistics processes are: a) faster and more flexible deliveries from stock to point of use; b) The reduction of operational logistics costs; c) Increased labor productivity; d) Reduction in inventories and consequently increase in inventory turnover; e) The release of the internal manufacturing area.

## 2.2 Kanban System

The idea of Kanban arose in Japan from the observation of the operation of American supermarkets. Taiichi Ohno observed various activities of the supermarket, paying attention to the merchandise replacement system. Four characteristics were perceived: a) goods are withdrawn by the consumer himself: as in a self-service system; b) goods are distributed on shelves: the items with higher output are placed in larger quantities; c) Replacement is made according to demand: as items are consumed, they are replenished; d) The required information is presented on a card: the product identification and its price, and even if space is empty, it is dedicated to the item described on the card.

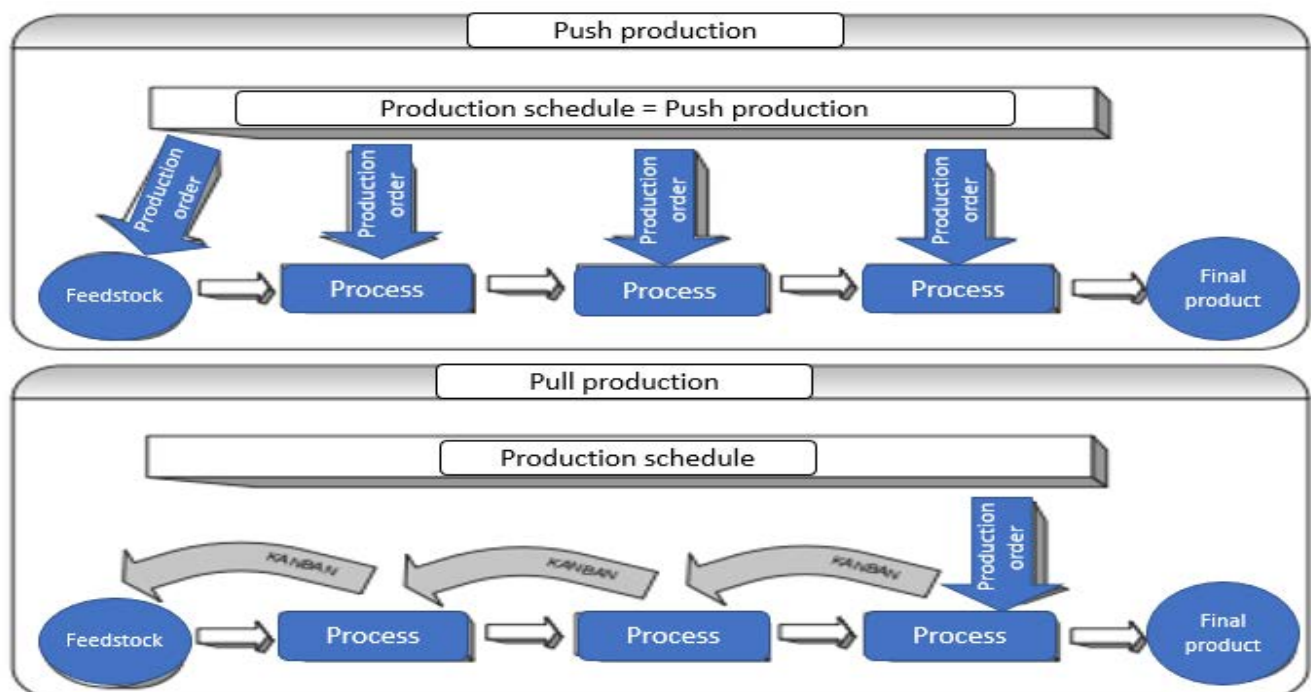


Figure 2 - Push production x Pull production.  
Source: Adapted from TUBINO (1997, p. 105).

In the Kanban system, there must always be a balance between the previous process and the later process, i.e. the previous process cannot produce more parts than the subsequent process needs to consume.

Figure 2 illustrates the difference between a pushed system, in which the master production plan prepares a production plan, issuing purchase orders and production orders, considering the remaining stocks as if stocks pushed production. In the pull system, however, production stocks only enter the company or are produced by an earlier process according to what subsequent processes can absorb as if production pulled the stock.

In general, it can be said that in the pushed system, the stock dominates production, while in the pulled system the opposite occurs, production dominates the stock. The vendor can only produce if he has a customer request kanban card.

For Peinado and Graeml (2007), the Kanban system seeks to move and supply production items only as they are consumed. Beyond simplicity, Kanban offers many other advantages over more traditional ways of controlling production. Although not necessarily contributing to the reduction of inventory levels, it generates a production environment within which improvements can be made in this regard.

### 2.3 Supply System

Where there is a transformation of raw material, at least one of the three necessary production resources - labor, machine or raw material, has to move for such transformation to occur, in most processes, the material is the moving element.

In choosing the most appropriate method, the company should focus on the most convenient solution that, within the constraints of each process, meets the required handling requirements and transport type capacity to reduce project costs. Figure 3 illustrates the difference between a conventional supply system and a lean supply system.

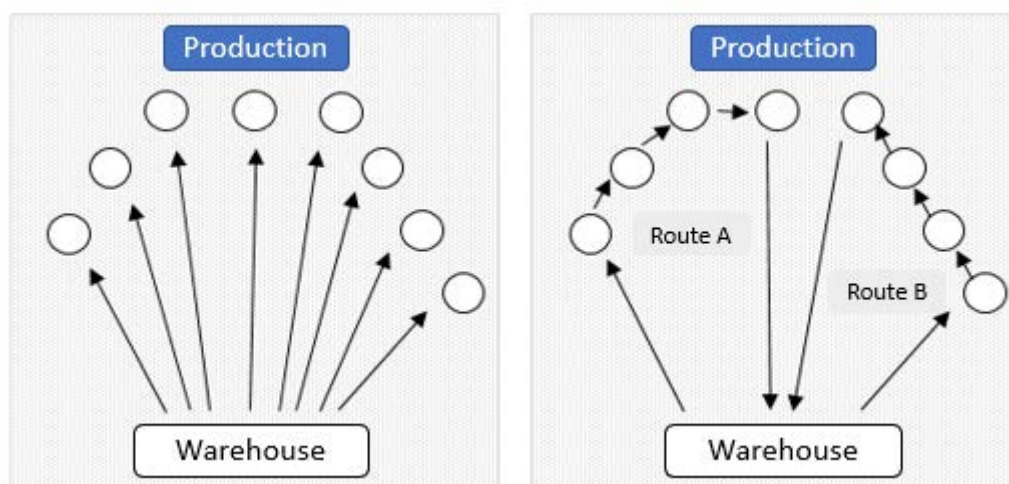


Figure 3 - Conventional supply system versus lean supply system.

Source: Author (2016).

In the first model shown in Figure 3, an analogy is made to a taxi race: the passenger embarks (material) and is taken to his final destination (production line). In the second system, an analogy is made to a bus: well-defined routes, with stopping points already determined, in which each point goes up (finished product) and passengers go down (raw material).

Harris et al. (2004) present the objectives for a lean supply system, which in addition to flowing materials more accurately and less costly, also highlight:

- A process for accurately describing how each part would be managed from the receiving dock to its point of use on the plant;
- A purchased parts market near the receiving dock to store and control the necessary parts;
- An accurate delivery system to get parts to their point of use;
- An accurate signaling system that each production area would use to pull only the necessary parts from the purchased parts market.

The deployment phases depend on the constraints and needs of each company. In his master's dissertation, Soares (2014) proposes seven phases of lean supply system implementation:

- a) Definition of the form of supply to be adopted: the system may have replenishment with fixed or variable interval, and fixed or variable quantity, depending on the need of the production lines;
- b) Characterization of the supply material: it is necessary to know all the information related to each part or material that will be moved;
- c) Definition of supply containers: which may be the supplier's packaging or the product packaging, which defines the type of container are the ergonomic aspects of access to the parts, the physical size and its occupation in the supermarket;
- d) Supermarket Supply Project: A location should be sought where materials are handled at a minimal cost and must take into account the maximum quantity that each item can occupy;
- e) Supply route: take into consideration the standardization of corridors, definition of the means of material movement;
- f) Define the communication in the supply: usually utilizing a kanban card that is sent to the warehouse to replenish the material;
- g) Supply schedule: synchronized supply (based on actual consumption) or kit supply (failure risk reduction).

## **2.4 Deployment Method**

Harris et al. (2004), propose a more generalized method in the guide of the implementation of internal logistics, citing four steps:

- Step 1) develop a Plan for Each Part (PPCP): database with part information, such as place of use, quantity, packaging, among others;
- Step 2) create a single purchased parts supermarket: create rules and manage all parts entering the plant in one place;
- Step 3) initiate accurate delivery routes: create and standardize the way materials arrive in the process;
- Step 4) support and improvement: Verify that the developed standards are being followed.

To transport materials, Harris et al. (2004) specify that the most efficient method is the use of electric trolleys that can pull multiple loads in one route, reducing the logistics operator's transportation and handling the waste.

### 3. Deployment

First was made the survey of the current situation by mapping all the items and maximum quantities in process. This concerns the elaboration of a Plan for Each Piece (PPCP), needs analysis of each job. Engineering and production team support was needed to study the capacity/hour of each line and to understand the flow of the manufacturing process. In the second stage, the planning and execution of activities necessary for the implementation were made: preparation of the PPCP-based Kanban card, as well as the preparation, under the responsibility of the maintenance team, of the wagons for the transportation of materials, among others. Also, a technical visit was made in another PIM electronics company that already has a stabilized supply system, to understand and verify opportunities that could be applied in Company Z.

In the execution stage, the new system was tried out, already using the electric transport car, using the defined quantity Kanban cards to meet one production hour. Here, we analyzed the performance reports of the routes performed, the data collected were: time of each route, number of items per route, compliance with predetermined times, material separation time.

In the fourth stage, opportunities for improvement, planned and implemented, were identified. The main opportunities identified were about the organization of items by product family, change of route itinerary, creation of new supply points. With the system in full operation, the future state was analyzed based on the same variables of the first step.

### 4. Methodology

The research is applied and was an adaptation of the methodology proposed by Harris et al. (2004), explained in Section 2.3 because it most closely resembles company culture. Information and data were collected through day-to-day work findings, where internal logistics flow was observed, and problems and improvements were identified. To better understand the functioning of both the warehouse and production, the operators were monitored during their activities. Besides, material requests and delivery reports were analyzed.

For comparison between the two states, data from three variables were studied: V1) Space occupied by the production supermarkets: the quantitative data, in square meters, of all the spaces occupied in the production with storage of raw material, empty boxes and finished product released for collection by the Warehouse were collected; V2) Coverage time: this refers to the total time that the quantity of each raw material available in supermarkets meets the need for production; V3) Headcount: number of people working in the company in the line supply and warehouse functions.

The schedule of this work was established as observed in Chart 1. For data analysis, a comparison was made between the states before and after the implementation of the supply system based on the three variables mentioned.

The difficulties encountered were addressed based on consensus with other team members and opportunities for improvement were made based on indirect satisfaction interviews with key employees who benefit from such a system.

Stage	Date completed
Methodology and Collection	01/27/2016
Analysis of the current situation	04/04/2016
Implantation	05/02/2016
Improvements	09/21/2016
Results	11/21/2016

Chart 1 - Schedule of the implementation of the supply route.

Source: Author (2016).

## 5. Discussion

Next, the results obtained through the implementation of the internal supply system will be reported. In this section, we will compare the data of the three variables: Space occupied by production supermarkets, Coverage Time and Headcount, in the states before and after implementation. Besides, the main difficulties encountered based on the opinion of the team members were raised, as well as the potential opportunities for improvement and how they can be addressed.

### 5.1 Main Results

An analysis was made by observing the supply process, from which was elaborated on the flowchart shown in Figure 4.

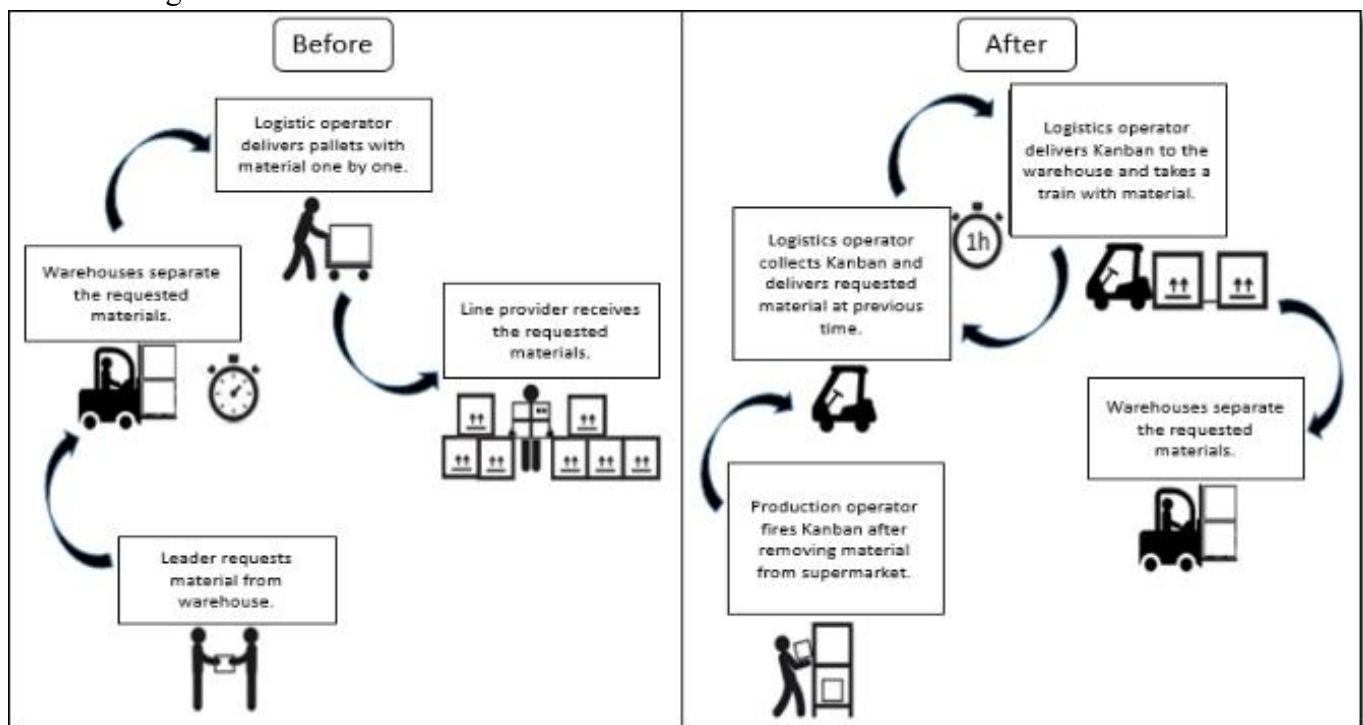


Figure 4 - Flowchart of the material supply process (before and after).

Source: Author (2016).

Materials were ordered twice a day, i.e. the materials supplied to the assembly lines supplied a minimum of 5 working hours, considering a 10-hour shift. Due to the low frequency of supply, the lines had high levels of in-process inventory, as shown in Chart 2. Also, the sorting process was slower due to the high



number of items ordered and the larger quantities of each material. to meet production needs by the next supply time.

According to the flowchart of the later state, shown in Figure 4, the supply frequency becomes hourly, divided into two itineraries (Figure 5), that is, every thirty minutes the logistics operator performs an itinerary. Some points can be highlighted:

- The autonomy of production operators: request materials at each withdrawal from the supermarket and not wait for the production leader;
- Fast delivery: faster delivery;
- Less fatigue: the logistics operator makes deliveries in an electric car and not in manual transport;
- Less movement of the logistics operator: possibility of taking more than one train on one trip.

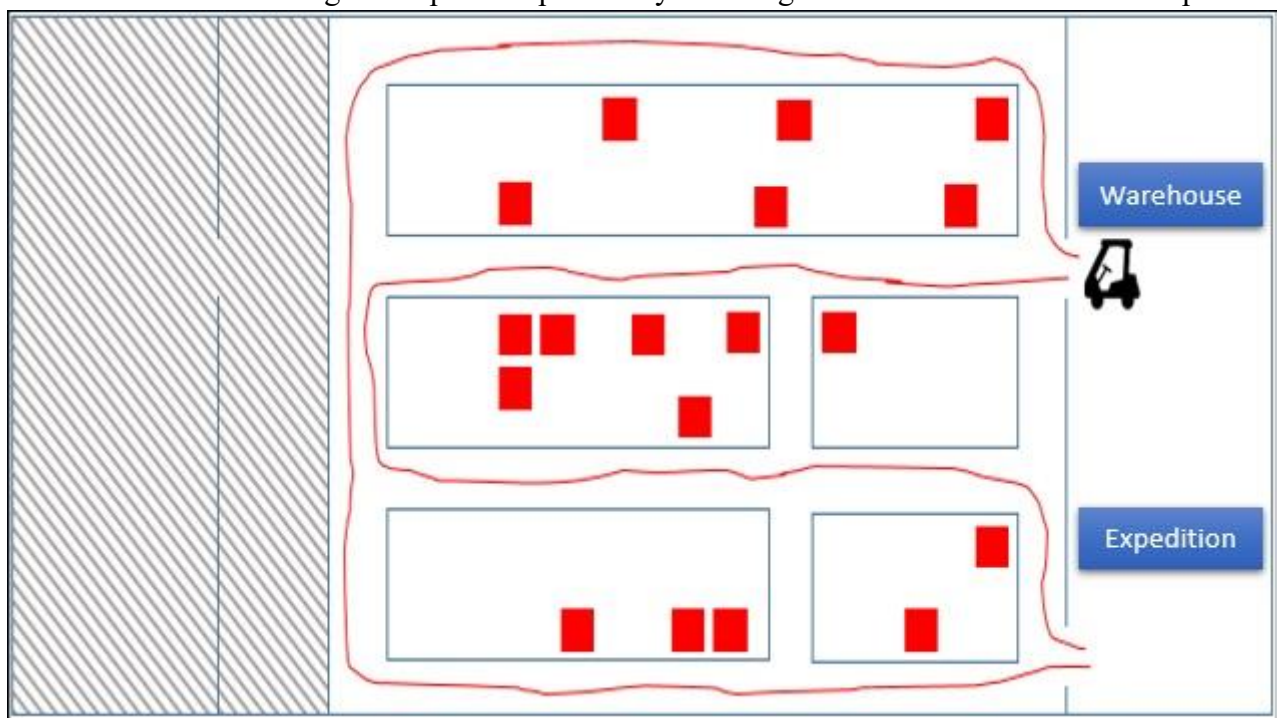


Figure 5 - Layout with a new supply system implemented.

Source: Author (2016).

OCCUPATION	REDUCTION	HEADCOUNT	BEFORE	AFTER	ACTIONS
Feedstock	46,00%	Line provider	4	0	Reallocation in another function
Empty box pallet		Storekeeper	10	9	Resignation
Finished product pallet					

Charts 2 and 3 - Occupancy Reduction and Headcount Reduction.

Source: Author (2017).

Through the implementation of the internal supply route and layout of the production lines, there was a significant improvement in the efficient use of the production area. Charts 2 show the percentage reduction in occupations with raw material, finished product, and empty boxes, which together add up to 46%. Chart 3 shows the Headcount reduction for the line supply and storeroom functions, which were relocated to another function (Test Line) and shut down from Company Z, respectively. From the



reduction of productive area occupied by each production line, it was possible to start the process of the layout of the lines, to group all the small empty spaces resulting from the reduction of inventory in the process.

Both works performed were responsible for the reduction of a significant part of the productive area (area highlighted in Figure 5), which affects the cost of shed rent, as well as expenses with refrigeration, electricity and factory maintenance. Also, the layout project included the analysis of the efficient use of inventories, and the low occupancy rate of inventories of raw material and the finished product was found. For this reason, Company Z chose to group the two stocks in the same warehouse area, increasing the area to be vacated as can be seen from Figure 5.

Analyzing the coverage time, 91% of the items had coverage over 2 hours of production. In the new state, 20% of items have coverage of up to 2 hours of production. The major difficulty in having the coverage time closest to the frequency of the route is because the supplier's packaging has more than one hour's production. However, they were treated with priority, bulkier items to achieve the objectives of the work. The company has no structure to reduce packaging to smaller quantities, and because they are small items such as screws and springs, it was decided to keep these items in the quantity set by the supplier, although it has coverage of up to 2 days of production.

Another positive aspect of the implementation of the supply route was the possibility of not only supplying the production lines with raw material but also the collection of empty boxes and later, finished product. The collection of empty boxes and finished products, also done manually, was performed when necessary. When the raw material is left, space is cleared at the logistics operator and new material is collected, either the empty box or finished product, as analogous to the bus commented in Section 2.3.

## **5.2 Main difficulties**

After brainstorming meetings, three main points were listed by the members of the work developed:

- a) Employee resistance to adapt to the new supply system. These are now responsible for ordering materials as they are consumed. Besides, supplies are hourly, unlike the previous state twice a day. To overcome this problem, a meeting was held on all production lines to explain the operation of the system and its importance;
- b) The layout of the production area that prevented the movement and maneuvering of the transport car. It was necessary to make changes in the corridors of the manufacturing areas to expand them;
- c) Safety of the operators now dividing the aisles with the material transport car. For this purpose, demarcations were made for traffic and car traffic, so that they do not circulate in the same space. To raise awareness, circulation recommendations were passed at weekly safety and health meetings organized by the Occupational Safety team.

For the elaboration of the article, the main difficulty was the lack of previous state data to compare with the most recent data. As the average displacement traveled by logistics operators to make a comparison between the movement before and after work, as a way to measure fatigue.

Also, the time required to separate the previously ordered items in larger quantities to calculate the average turnaround time of the two sourcing models at Company Z.

### 5.3 Potential improvement opportunities

Through interviews with key employees on each production line, it was found that the major dissatisfaction of the main internal customer of the supply route is the delayed delivery of the requested material.

From this, an Ishikawa Diagram (Figure 6) was prepared to analyze the possible root causes of the problem.

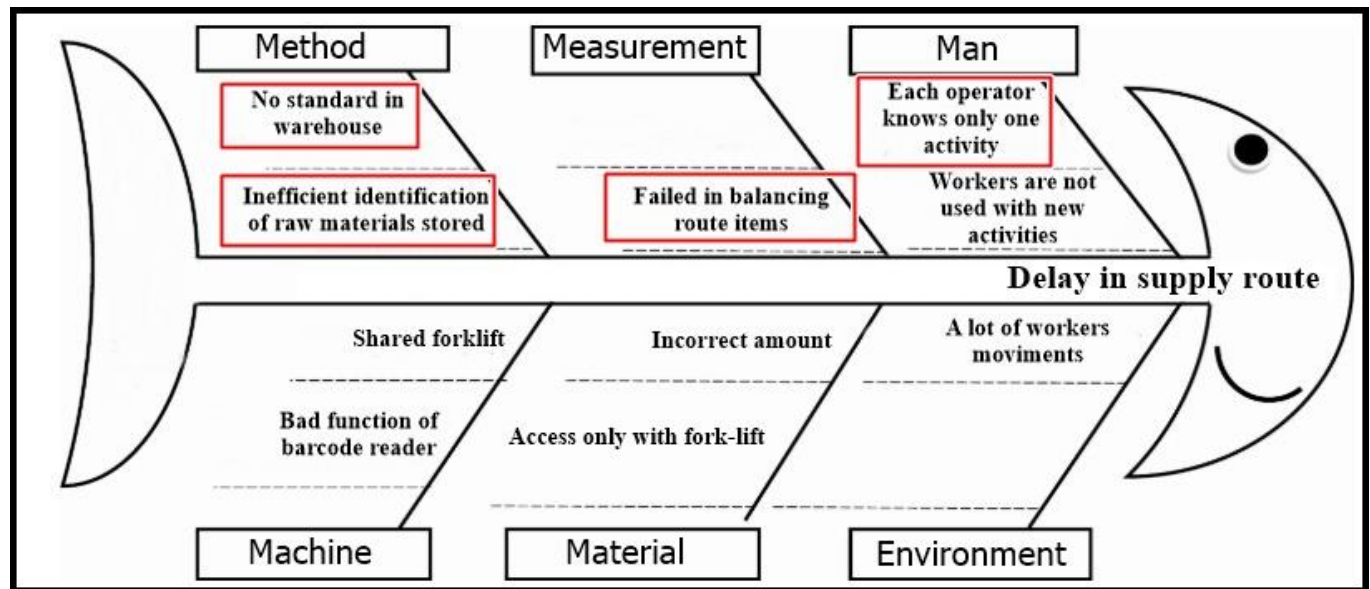


Figure 6 - Root Cause Analysis of Supply Route Delay

Source: Author (2017).

Around ten causes were found to be solved. Then for each of the root causes identified as red box in the Ishikawa Diagram (Figure 6), it was made proposal for improvements.

#### 5.3.1 Balancing supply routes

It was found from the timing of the supply route that the exits established every thirty minutes were not being met.

Analyzing the deliveries made by routes A and B, there was a disparity in the requested quantity of materials, which directly impacts the delivery time and also the delivery time. The greater the number of materials to be separated, the more time will be required in subsequent activities.

To balance routes A and B and respect the set times, the alternative found was to change the route itinerary, to reduce the load of route A and occupy more time of route B.

The result can be observed in Figure 7, which illustrates the times before and after balancing.

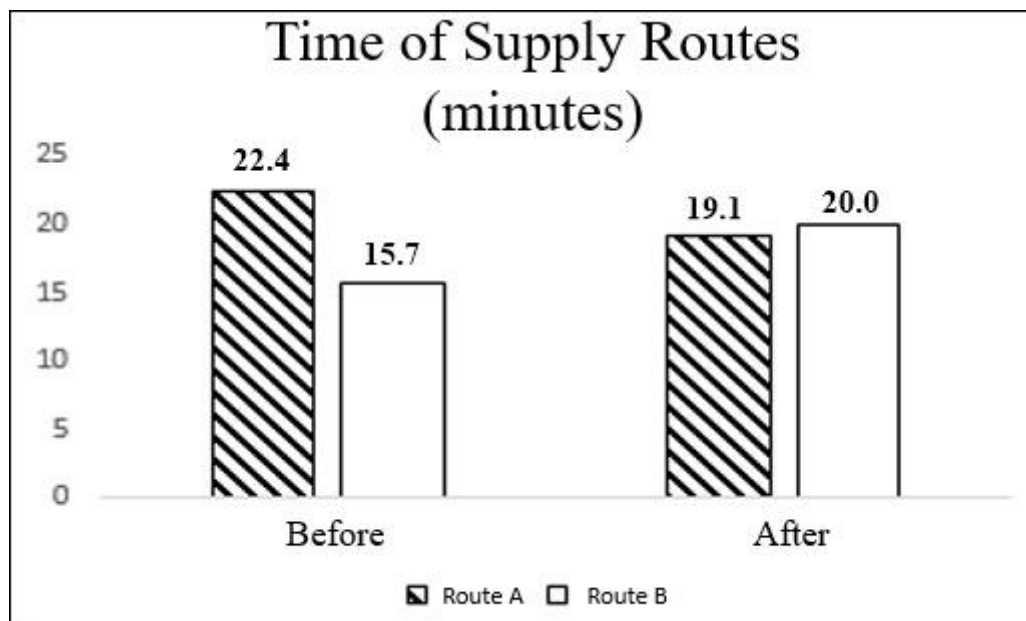


Figure 7 - Route times  
Author (2017)

### 5.3.2 Addressing the inefficiency in identifying materials

As a form of organization, each item arranged in the production supermarket had a defined location marked with item code label and description. However, the filling process takes longer due to the time taken to find the right place to store the material

For this, a new identification model has been designed to meet the demands of employees performing material supply activities and also for production line employees to return unused materials to the correct location. The model consists of identifying in each Kanban board the correct location of the material on the production shelves.

Each shelf is identified in matrix form, lines representing the levels in numeric characters and columns represented by letters. Similarly, cards are identified with alphanumeric characters, corresponding to the column and row on the shelf. For example, Kanban card labeled "A2" means the item must be placed in column A and level 2 of the supermarket.

For R\$ 9.80, it is sold in stationery, a package with 2882 label units that can be used in printers commonly used in organizations. Considering 2 packages plus the cost of printing at R\$ 0.11, this model costs less than R\$ 30.00 and ensures faster supply due to the agility to find the correct place to store such an item.

### 5.3.3 Training on all supply route activities

Employees involved in the activities must be fully aware of all other supply route activities for their development and meet unexpected demands. This way, everyone needed to be trained to take on other activities in case of the absence of a collaborator, vacation, among others.

This initiative was deployed to the shipping and receiving teams.

#### 5.3.4 Warehouse organization by product

Observing the process of separation of materials, it is possible to observe:

- a) Excessive movement;
- b) Waiting to use the forklift shared with the material allocation and shipping activity;
- c) Materials of the same family arranged in different streets causing unnecessary movement.

To optimize material separation and to ensure that materials are sorted within the defined time, good inventory management is required from receipt of materials from the supplier. However, to have better use of resources, one may choose to organize by product family, that is, to have the items of the same production line nearby to avoid unnecessary movement between the streets of the Warehouse.

Also, to reduce forklift usage, ABC analysis can be done for inventory management. This tool consists of classifying items according to the frequency of use. Higher output items are rated A and should be more accessible, usually, do not require transport tools to collect. Moderate items are often rated B and finally rated C for sporadic items that can be stored at heights.

The ABC rating is based on the Pareto chart, which says that in many situations a small part of a group represents most of a certain characteristic. Thus, items A are usually 20% representing 80% of the annual demand in value, class B items are 30% representing 15% of the demand, and finally items C are 50% representing 5% of the annual demand in value.

## 6. Final considerations

The present work aimed to analyze the implementation of an internal supply system, to identify the main results achieved based on two variables, the difficulties encountered by the work team and to propose improvements to make the system even more efficient.

The deployment process was divided into four key steps to achieve the results shown. At the same time, line layout initiatives and increased inventory occupancy rates were essential to maximize gains.

From the implementation of a pull supply system, Lean Logistics aims to eliminate waste by replacing only the items that are consumed by customers, in the right amount, at the right time, and closest to the point of use. For the proper functioning of a supply system, the routes must have higher frequencies and lots defined in minimum quantity for the full operation of the production lines. In this way, it is possible to obtain better use of the productive area and efficiency of the whole process, besides ensuring a better movement of people and materials.

As a result of the supply route implementation and line re-layout work, there was a significant reduction in the company's manufacturing area, which means lower rental costs and other fixed costs such as electricity, factory maintenance, among others. Besides, it is possible to highlight the reduction of response time for material delivery to production, less activity fatigue, reduced handling waste.

Through the implementation of this new supply system in Company Z, it was possible to note three main points regarding the philosophy of lean logistics: 1) Increased delivery frequency: hourly supply on two well-defined routes with departures every thirty minutes; 2) Batch size reduction: through the use of Kanban cards to signal the need for the material; 3) Efficient use of the productive area.

Thinking in this way, other opportunities were found in order to achieve a lean internal logistics process,

such as: a) stock organization by product family, to group the items used in the same point of use; b) organization of the inventory by frequency of use, where items with higher exit history are addressed in more accessible positions; c) reduction of suppliers' lots, in order to make the lot as close to the route coverage time (one hour); d) adjust the size of containers in production supermarkets.

The limitations of the research are defined by the unique character of Company Z, although factors that may restrict the application of the method in other companies are not identified, only needing adaptations for each one. The difficulties encountered in measuring data can also be considered as work limitations, reason by which the opinions of the employees involved in the supply route activities and the perception of those who use such a system were also taken into account.

As a suggestion for future work, it is recommended an analysis of the impacts of lean logistics on performance indicators such as flexibility, lead time, among others, commonly used in organizations. Another suggestion is the analysis of areas that support production in which the same philosophy can be applied to achieve a lean system or elaborate a generalized Lean Production method for other sectors of organizations.

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## How to evaluate the "Bolsa Universidade" Program in Manaus

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### Abstract

*The research evaluates the satisfaction level of the services provided by the Manaus Municipal Public Service School and Socio-Educational Inclusion (ESPI) to the scholarship holders of the Bolsa Universidade Program. To this end, an online questionnaire adapted from the SERVPERF model was applied, using five quality dimensions: tangible, reliability, effectiveness, assurance and empathy. It has 20 items distributed among the dimensions, where the respondent indicated their level of satisfaction through a 10-point Likert scale. It was available for eight days and had 442 respondents. After data collection, the Cronbach's alpha reliability test was performed. Then, the data were analyzed using the average and standard deviation of dimensions and items. It was observed that the best dimension was reliability, and the item with the best performance was the "reliable documentation management". On the other hand, the dimension that needs improvement is effectiveness, and the item that needs urgent improvement is "waiting in line for documentation delivery". After analyzing the data, the main conclusion was that the level of satisfaction was considered Good. In the end, suggestions for improvement were made for the critical items. For future studies, it is suggested to evaluate the level of satisfaction after applying the improvement actions.*

**Key-words:** Bolsa Universidade; Satisfaction; Servperf;

### 1. Introduction

The Municipal Secretariat of Administration, Planning, and Management (SEMAD) acts as the responsible for managing the administrative system of the Municipality of Manaus and under the terms of Delegated Law No. 11 of July 31, 2013, ratifies its integration with the Administration Manaus City Council, as an institutional management body, to achieve the following purposes:

- I – plan, coordinate and supervise the execution of activities related to administrative modernization;
- II – coordinate and supervise the execution of human resources management;
- III – implement and supervise the real estate management;
- IV – guarantee the development of municipal services and ensuring the perfect integration of the Systems;
- V – manage planning within the Municipal Executive Branch;
- VI – offer public tenders to provide effective positions of the Direct and Indirect Administration of the executive branch;

- VII – improve and train civil servants and political agents of the executive branch;
- VIII – foster, implement and manage social and educational inclusion programs;
- IX – plan, execute and control functional health plan activities;
- X – periodically update the registration of server data.

The Secretariat's vision is to be a national reference as efficient public management, recognition of the public servant and quality in citizen service, using the following actions as strategic guidelines: Securing to citizens the access to quality public services; Promote the recognition of the public servant and modernize the public management.

The Secretariat is divided into four undersecretaries: Undersecretary of Planning and People Management; Undersecretary of Process Management; Municipal Public Service School and Socio-Educational Inclusion - ESPI; and Health Care Service of Public Servants of Manaus - MANAUSMED. ESPI was created in 1990 and implemented in 1996, taking the current form with Delegated Law No. 11 of July 31, 2013, when the Municipal Public Service School Foundation (FESPM) and the Socio-Educational Inclusion School Foundation (FESPM) were merged (FMDS).

Thus, the new department, with undersecretary status, became linked to SEMAD, with the mission of training the public servants, public agents and politicians of the Municipality, as well as managing the socio-educational inclusion programs of the Manaus City Hall: Programa Bolsa Universidade (PBU), Bolsa Idiomas (PBI) e Bolsa Pós-Graduação (PBPG).

Among the city hall's socio-educational inclusion programs, the oldest (with announcement published in 2009), and which offers the largest number of vacancies is the Bolsa Universidade Program, with an average of 10,000 vacancies per year and more than 100,000 vacancies offered until 2017. The program is intended for people who are not able to afford the tuition of an undergraduate degree. The Program offers 100%, 75%, and 50% scholarships, with the highest percentage scholarships being aimed at people with lower per capita income.

Considering that ESPI is responsible for each fellowship throughout their undergraduate years, it is relevant to evaluate their level of satisfaction with the services offered by the organization to continuously improve the services provided to this public.

Given the absence of this type of evaluation, the objective of this research is to evaluate the level of satisfaction concerning the services provided by ESPI to propose suggestions for continuous improvement to the program managers.

## **2. Theoretical Referencial**

### **2.1 Public policy**

Bittencourt and Ronconi (2016) say that public policy results from decisions made by the government with the objective of both maintaining the status quo and modifying it. According to the authors, public policies involve the fundamental decision of whether or not to do something on the part of governments. According to Pase and Melo (2017), public policies are the result of power relations between state, society and market, synthesis of conflicts, and accord of social and political segments. Public policies are materialized through policies, programs, actions, and strategies that can be implemented directly or in



partnership with private organizations. This statement is following the concept of Jacometti et al. (2016) that affirm that public policies, after being designed and formulated, unfold into plans, programs, projects, databases or information, and research systems, being put under evaluation and monitoring after implementation.

For Crumpton et al. (2016), evaluating involves judging values of the policy implemented and aims to provide information that can improve the choice of decisions in the public sphere. Requires definition of criteria to be adopted and the set of attributes and characteristics of policies or programs to be evaluated. The criteria generally adopted are efficiency, effectiveness, effectiveness/impact, comprehensiveness, technical and scientific quality, user satisfaction and acceptance.

In addition to a clear definition of the evaluation criteria, the extent of the policy or program needs to be considered. The offer is municipal, regional or national? The target audience for policies or programs must be clearly defined.

Santos and Nunes (2016) say that public policies can be evaluated both through public investments and also by evaluating the population's satisfaction with these policies, as they enjoy these actions.

## **2.2 Educational Services**

According to Alves, Mainardes and Raposo (2010), the characteristics of the education service can be defined as:

### **a) Intangibility:**

It is defined by the people who perform the service, which evaluates service quality as a difficult process, because due to intangibility, there is a great subjectivity in the evaluation of the service by the client, besides the difficulty of demonstrating the attributes of this type of service;

### **b) Heterogeneity:**

It represents the inability of companies to provide the same service each time it is requested. For example, the way the teacher teaches, and the student responds varies because it depends on the interpersonal relationships between students and teachers. This problem can be caused by factors ranging from empowering the service provider to the way the customer explained what they wanted. Employee training and the pursuit of standardization can be viable solutions to minimize this aspect. It is also important to monitor customer satisfaction and identify potential points for improvement through such monitoring;

### **c) Inseparability:**

It is impossible to separate the provider from the service it offers. For example, teaching and learning are interlinked and not realized without the simultaneous presence of teacher and student. Importantly, there are 3 levels of interaction between the provider and the service taker: Physical presence of the client; customer presence only at the beginning and end of the service; and mental presence of the client (as happens in educational services). It is noteworthy that, regardless of the level of customer integration, it influences the results achieved in the service delivery, as well as the presence of other customers at the service site and the interaction between them may affect their perception of the final quality;

### **d) Perishability**

The education service cannot be stored and is never uniform. Perishability represents the conflicts

between supply and demand that service managers face. In seasonal services, for example, demand may be higher than supply at certain times, rendering the company unable to satisfy all who seek it.

### **2.3 Service User Satisfaction Assessment Methodologies**

According to Pouget, Campos and Paulo (2014), the perception of quality and expectation may vary according to the consumer and their beliefs and values.

Something can be good for a consumer but may not even be perceived by someone else. Therefore, the quality and satisfaction measurement scales must be adapted and modified according to the attributes one wants to research and know. For Lopes, Pereira, and Vieira (2009), there are several evaluation models, such as ACSI, ECSI, SERVPERF, SERVQUAL among others, some of which will be presented in the next sections.

#### **2.3.1 American Customer Satisfaction Index - ACSI**

According to Lopes, Pereira, and Vieira (2009), the American Customer Satisfaction Index (ACSI) model is divided into two parts: the first is formed by satisfaction antecedents, which are of perceived quality, such as expectations and perceived value; a second is made up of the consequents, which records the recovery and loyalty.

##### **Antecedents of Satisfaction:**

- a) Perceived quality: this is the customer's assessment of the physical good or service based on two factors, customization and reliability;
- b) Expectations: reflects the wishes of consumers and allows comparing what the customer expected to receive from service and what he received from the company;
- c) Perceived value: the perceived market quality of a physical good or service, adjusted by its relative price.

##### **Consequents of Satisfaction:**

- d) Complaint: this is the result of customer dissatisfaction with a physical good or service.
- e) Loyalty: is the consequence of various interactions between the parties, in which the consumer acquires confidence in the consumed services of the company. It can be defined as an intention to behave relative to the product or the supplier company.

Several studies were developed by using ACSI model (HACKL; SCHARITZER; ZUBA, 2000; JUHL; KRISTENSEN; OSTERGAARD, 2002; VILAES; COELHO, 2003; KNUTSON et al., 2004; VAN RIZYN et al., 2004; CHITTY; STEVEN; CHUA, 2007) and for further information, the ACSI model with other cases applied into service, trade and industries can be accessed through the site <<https://www.theacsi.org/>>.

#### **2.3.2 European Customer Satisfaction Index - ECSI**

According to Lopes, Pereira, and Vieira (2009), given the acceptance of ACSI, in 1998 the European

Customer Satisfaction Index (ECSI) pilot project was launched, the main objective of which was to develop a satisfaction measurement instrument more suited to the European market.

Santos et al. (2017) affirm that the ECSI model relates student satisfaction to antecedent variables - image, student expectation, perceived quality, perceived value and reliability - and consequent variables - loyalty and word of mouth communication.

According to the authors, in addition to the antecedent variables adopted by the ACSI model, the ECSI model considers the antecedent variable Image, which is how the market views the company, reflecting the external prestige of the organization.

Lopes et. al (2009) realized a comparative study between ACSI and ECSI by using a sample with 2145 of customers in service sector located in the Minas Gerais state (Brazil), finding that ACSI can measure the satisfaction more accurately than ECSI.

### 2.3.3 SERVQUAL Model

According to Lopes, Hernandez and Nohara (2009), the scale called Service Quality Gap Analysis (Servqual), developed by Parasuraman, Zeithaml and Berry (1988), takes into account customer expectations for a given service, regarding the perception of the quality of service received.

The scale contains 22 pairs of items that can be grouped into five quality dimensions, whereas the first item in each pair identifies the expected performance level and the second item identifies the perceived service level.

For Silva, Medeiros and Costa (2009) and Fonseca (2011), the five dimensions of scale quality are:

- Tangible Aspects: includes physical evidence of the service, such as physical facilities, equipment, employee appearance, and communication materials;
- Reliability: involves performance consistency, ie, the ability to perform the promised service reliably or the provision of accurate (first) service, timely and promising;
- Effectiveness: responsiveness, customer help, and promptness in service;
- Assurance: it involves a company's competence, courtesy, and knowledge of its operations. It is a security and knowledge transmission for clients;
- Empathy: it averages the company's ability to understand and satisfy its customers' needs on an individual basis.

According to Lopes, Hernandez, and Nohara (2009), the operationalization of the scale occurs by calculating the difference between performance perceptions and service expectations. For each pair of items, an index is obtained, which is defined as the difference between the perceived service and the desired service, called the Service Superiority Measure (MSS). It can be said that the higher the MSS index, the greater the superiority of the service.

Despite its wide use, it should be noted that most studies that use the SERVQUAL model are directed to the private and non-public market.

### 2.3.4 SERVPERF Model

According to Silva, Medeiros and Costa (2009), based on the concept of quality as an attitude. Cronin

and Taylor (1992, 1994) argue that the difference between expectation and performance, proposed by the SERVQUAL model, only measures the perception of quality, but not determines it directly. Its main determinant is the performance of the service itself. The authors argue that performance evaluation alone provides better results for measuring the quality of service, thus eliminating the need to measure expectations.

The authors developed a model for quality measurement, called SERVPERF (*Service Performance*). Although they do not agree with the theory that supports the SERVQUAL model, they believe that the dimensions used in the scale are adequate to represent the quality of service. Thus, for the construction of the SERVPERF model, they used the same dimensions of quality proposed by the SERVQUAL model. Thus, the SERVPERF model consists of 22 statements about service performance, representing the five dimensions of quality developed by Parasuraman, Zeithaml, and Berry, creators of the SERVQUAL model.

Therefore, for the SERVPERF model, quality of service is represented by equation (1):

$$Q_j = D_j \quad (1)$$

Where:

$Q_j$  = Quality of service assessment against feature  $j$ ;

$D_j$  = Performance perception values for service characteristic  $j$ .

Affirmations are evaluated on a Likert scale ranging from 1 to 7, where 1 represents strongly disagree and 7 represents strongly agree. After applying techniques that analyze the reliability and validity of the instruments, Cronin and Taylor (1992) concluded that the SERVPERF scale has a higher reliability to measure the quality of service than the SERVQUAL scale. Also, it can be said that it is more efficient because it reduces by 50% the number of items that must be evaluated by respondents.

The application of the SERVPERF model can be found in various types of companies, such as in the restaurant sector (SILVA; MEDEIROS; COSTA, 2009), laboratories (GONÇALVES; FREITAS; BELDERRAIN, 2010), in hotels (AQUINO; JERÔNIMO; MELO, 2015), among other applications.

In summary, Miguel and Salomi (2004) reviewed the main models for measuring quality in services and concluded that there is no consensus in the literature on the most appropriate model to measure it from the clients' point of view.

## 2.4 Cronbach's alpha

According to Hora, Monteiro and Arica (2010), Cronbach's alpha coefficient measures the correlation between answers in a questionnaire by analyzing the profile of the answers given by the respondents. Considering that all items of a questionnaire use the same measurement scale, the coefficient  $\alpha$  is calculated from the variance of the individual items and the variance of the sum of the items of each respondent through equation (2):

$$\alpha = \left( \frac{k}{k-1} \right) X \left( 1 - \frac{\sum_{i=1}^k s_i^2}{s_t^2} \right) \quad (2)$$

Where:

$k$  = number of questionnaire items;

$s_i^2$  = variance of each item;

$s^2_t$  = total variance of the questionnaire, determined as the sum of all variances.

Gliem and Gliem (2003) establish the following concepts for Cronbach's alpha coefficient:

	> 0.9 (Excellent)	> 0.8 (Good)	>	0.7
(Acceptable)				
	> 0.6 (Questionable)	> 0.5 (Poor)	<	0.5
(Unacceptable)				

### 3. Methodology

#### 3.1 Choice of Evaluation Model

Considering that the clients are scholarship holders in the middle of the academic period, therefore with little time to respond, the evaluation model chosen was the SERVPERF model, since the practicality of the model is a crucial point for their choice concerning the SERVQUAL model.

#### 3.2 Elaboration of the Questionnaire

The questionnaire (Table 1) was divided into two sections. In the first section, twenty items were elaborated considering the five dimensions of quality adopted in the SERVPERF model: Tangible Aspects (installations), Reliability, Effectiveness, Assurance, and Empathy.

For each of the five dimensions, four items were elaborated to be evaluated using the Likert scale from 1 to 10, as follows: 1 or 2 = Very Bad; 3 or 4 = Bad; 5 or 6 = Regular; 7 or 8 = Good; 9 or 10 = Excellent. In the second section, there are five items, four of which are multiple-choice and one item is open to scholarship suggestions. The Table 1 contains the SERVPERF questionnaire adapted and applied to the scholarship holders of the Bolsa Universidade program to assess their satisfaction.

#### 3.3 Sample Size Definition

The sample size determinant chart was used to define the sample size (Chart 1), considering: a) the total population of 76,802 scholarship holders; b) The 95% reliability level; c) the sampling error of 5%; d) Split 50/50.

Assurance level: according to Sebrae/MG (2013), the assurance level is a statistical measure that indicates the probability of repeating the results obtained if the same survey is performed again.

Sample error: according to Sebrae / MG (2013), the sampling error identifies the variation of the results of a survey. For example, a 5% sampling error indicates that the percentages of responses obtained may vary by plus or minus 5%.

Split:

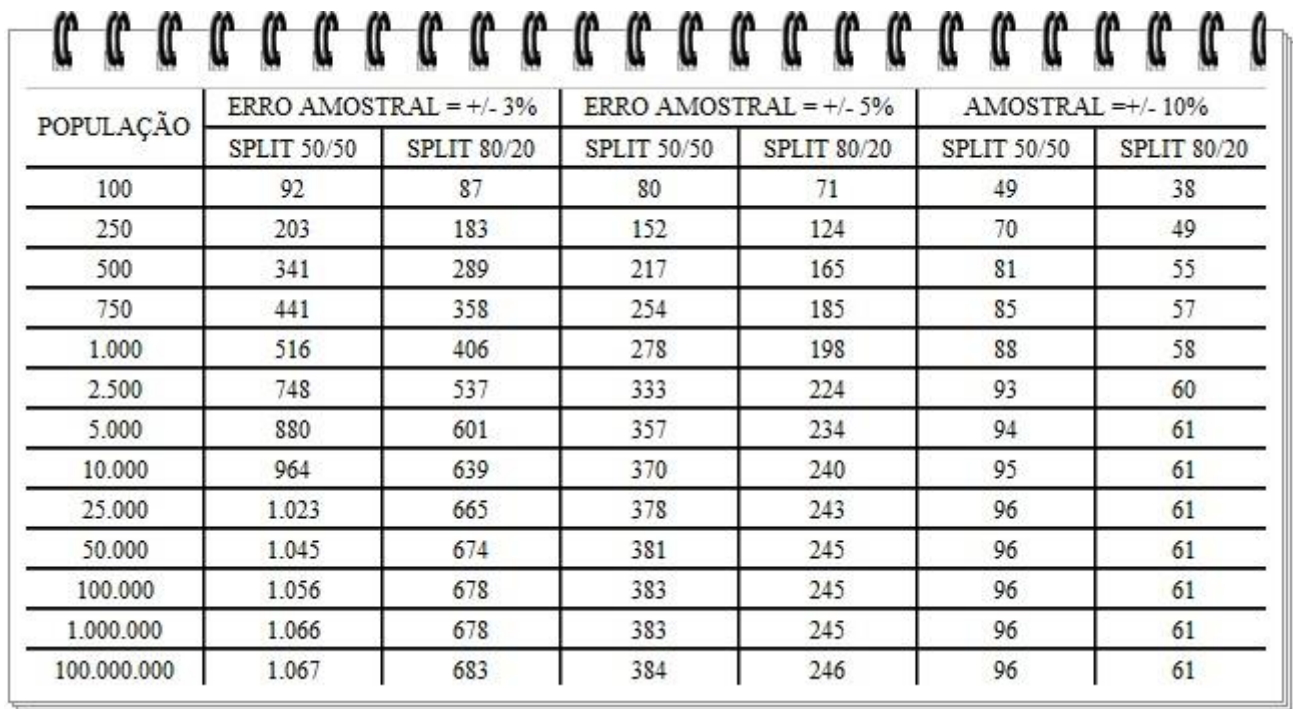
The *split* in the sampling table shows the level of variation of the responses in the survey, that is, the degree of homogeneity of the population. A more homogeneous population corresponds to a population that has similar characteristics such as income level, age, gender, etc. Thus, a 50/50 split indicates much variation among respondent responses (more heterogeneous population). Already an 80/20 split indicates a smaller variation in responses (more homogeneous population). (SEBRAE/MG, 2013, P. 32).

Table 1: Scholarship Satisfaction Measurement Questionnaire

QUESTIONÁRIO		
Objetivo: Avaliar seu nível de satisfação com os serviços prestados pela ESPI		
Todas as informações serão tratadas confidencialmente para fins de pesquisa		
<b>Seção 1: Questionário Adaptado do Modelo SERVPERF</b>		
Para tanto, avalie de 0 a 10 o seu nível atual de satisfação com cada item abaixo.		
Escala: 1 ou 2 = Muito Ruim; 3 ou 4 = Ruim; 5 ou 6=Regular; 7 ou 8=Bom; 9 ou 10=Excelente		
Dimensão	Itens	Resposta
Aspectos Tangíveis (instalações)	1) A localização da ESPI na cidade	
	2) O estacionamento da ESPI	
	3) Facilidade de encontrar o local de entrega de documentação na ESPI	
	4) As instalações da ESPI são confortáveis	
Confiança	5) A ESPI é pontual na entrega de seus serviços	
	6) A capacidade da ESPI em solucionar seus problemas com as bolsas	
	7) O processo de seleção é confiável	
	8) A gestão dos documentos por parte da ESPI é confiável	
Eficácia	9) A capacidade dos Colaboradores da ESPI em sanar as dúvidas	
	10) O Tempo de espera na fila para entregar documentação foi menor que 30 Minutos (Acima de 30min (1 a 5); Abaixo de 30 Min (6 a 10)	
	11) O tempo para resolver alguma reclamação	
	12) Os colaboradores da ESPI respondem prontamente aos pedidos	
Garantia	13) A ESPI executa as responsabilidades dela descritas em contrato com o bolsista	
	14) Os colaboradores têm conhecimento para responder as perguntas dos bolsistas	
	15) A garantia de segurança dos bolsistas dentro das instalações da ESPI	
	16) A comunicação da ESPI disponibiliza informações relevantes aos alunos (Ex: Revisão de Percentual, Suspensão, Prorrogação de Vigência, etc)	
Empatia	17) A ESPI dá atenção individual ao bolsista	
	18) A Capacidade dos colaboradores da ESPI em identificar suas necessidades	
	19) Os colaboradores da ESPI demonstram interesse em lhe atender	
	20) Os colaboradores da ESPI são educados	
<b>Seção 2: Dados Demográficos dos Respondentes</b>		
21) Sexo: Masculino/Feminino		
22) Qual sua faixa etária? Entre 18 e 30 anos; Entre 31 e 40 anos; Entre 41 e 50 anos; Mais de 50 anos		
23) Qual sua situação atual ? Cursando; Suspenso; Desligado; Formado		
24) Na sua opinião, as questões foram claras e objetivas?		
Agradecemos por sua participação. Sinta-se à vontade de sugerir propostas de melhorias		

Source: Adapted from Fonseca (2011)





POPULAÇÃO	ERRO AMOSTRAL = +/- 3%		ERRO AMOSTRAL = +/- 5%		AMOSTRAL = +/- 10%	
	SPLIT 50/50	SPLIT 80/20	SPLIT 50/50	SPLIT 80/20	SPLIT 50/50	SPLIT 80/20
100	92	87	80	71	49	38
250	203	183	152	124	70	49
500	341	289	217	165	81	55
750	441	358	254	185	85	57
1.000	516	406	278	198	88	58
2.500	748	537	333	224	93	60
5.000	880	601	357	234	94	61
10.000	964	639	370	240	95	61
25.000	1.023	665	378	243	96	61
50.000	1.045	674	381	245	96	61
100.000	1.056	678	383	245	96	61
1.000.000	1.066	678	383	245	96	61
100.000.000	1.067	683	384	246	96	61

Chart 1: Sample Size Determinant for 95% Reliability

Source: Sebrae (2013)

Due to the high number of fellows and time constraints, the institution has made available the electronic contacts of 11500 fellows, which is the population considered.

So, considering the values written in Chart 1, for 95% of reliability, +/- 5% sampling error and 50/50 split, the sample to be representative must have between 370 and 378 respondents, then it was fixed as target a sample with at least 400 respondents.

### 3.4 Pilot Test Application

The questionnaire was transformed into a Google® form format and randomly sent to 1037 fellows (approximately 10% of the 11500 samples) via e-mail. The form was available for three days between November 2 and 5, 2017, and of the total emails sent, only 80 were answered, which is 7.7% of the 1037 fellows invited to answer the questionnaire. Considering that in the item “In your opinion, the questions were clear and objective?” It was found that the majority (96%) answered “Yes”, it was decided to apply the questionnaire without changes to the rest of the population considered (10,463 scholars), thus totaling the 11,500 fellows. It is noteworthy the low rate of return of answers of the pilot questionnaire (7.7%), below the 25% of return, is expected by the authors Marconi and Lakatos (2005).

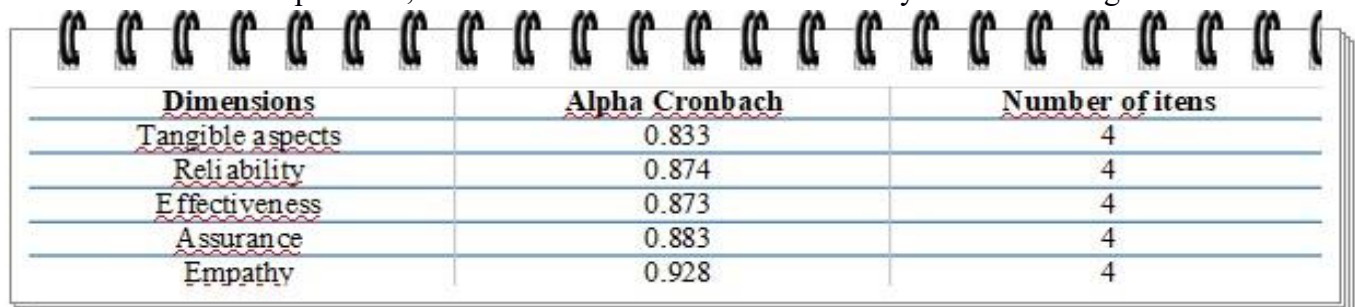
### 3.5 Application of the definitive test

After applying the pilot test and verifying that the questionnaire was understandable to respondents, it was sent to the remaining sample of 10,463 fellows. The questionnaire was available for eight days, between November 6 and 13, 2017 and had 442 respondents, which is equivalent to 3.84% of the total people invited to participate.

### 3.6 Reliability Test

Cronbach's alpha reliability test was performed on the IBM SPSS Statistics® Software.

From the tests done in each of the five dimensions, the Tangible Aspects, Reliability, Effectiveness, and Assurance dimensions have Cronbach's Alpha between 0.8 and 0.9 (Chart 2), which, according to Gliem and Gliem (2003) classifies the reliability level of the questionnaire as Good. The complete questionnaire obtained Cronbach's alpha 0.96, which indicates an excellent reliability level according to the authors.



Dimensions	Alpha Cronbach	Number of itens
Tangible aspects	0.833	4
Reliability	0.874	4
Effectiveness	0.873	4
Assurance	0.883	4
Empathy	0.928	4

Chart 2: Questionnaire Dimensions Reliability Statistics

Source: Author

## 4. Discussion

### 4.1 Respondents Profile

Regarding gender, 67% of respondents are female and 33% male. Regarding the age group, 60.41% are between 18 and 30 years old, 30.54% are between 31 and 40 years old, 7.24% are between 41 and 50 years old and 1.81% are over 50 years old. Concerning with the current (november, 2017) situation of the scholarship holder: 58% were studying, 33% already graduated, 6% had been disconnected from the program and 3% were suspended (Figure 1).

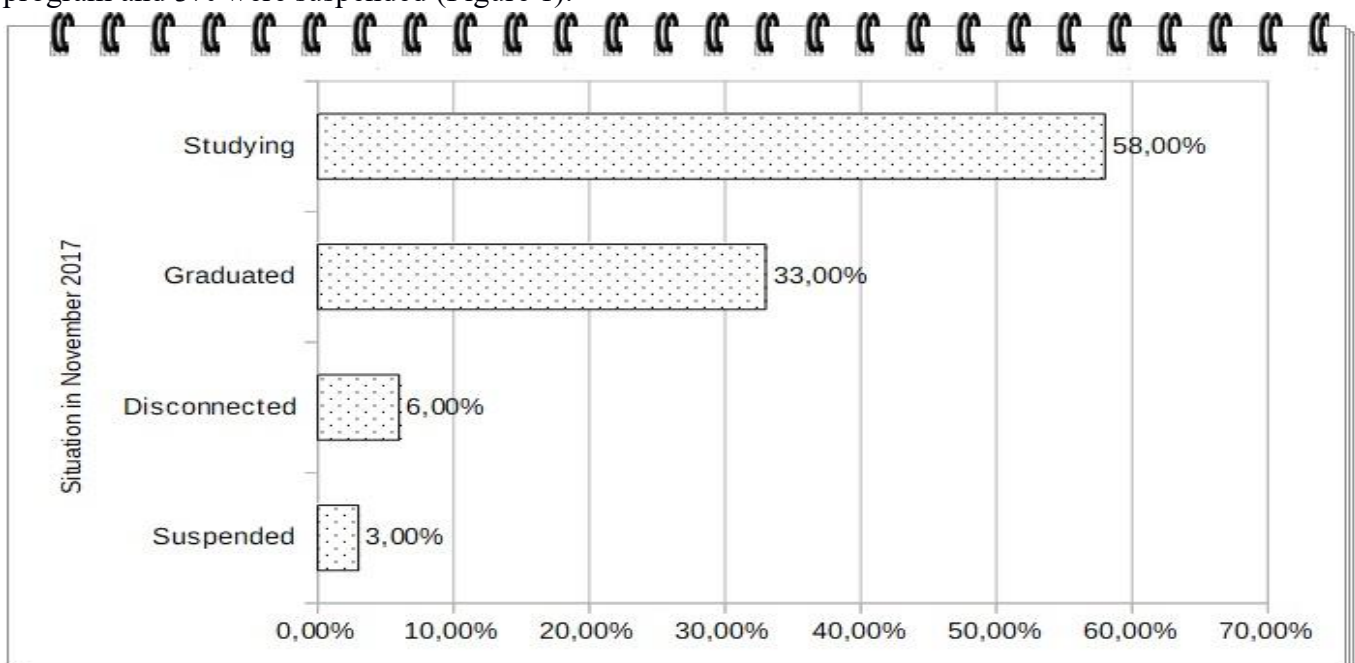


Figure 1: Respondents Profile Regarding Current Status in November 2017

Source: Author



Dimensão	Item	Média	Desvio Padrão	Média da Dimensão	Desvio padrão da Dimensão
Aspectos Tangíveis	1) A localização da ESPI na cidade	7,08	2,58	7,58	2,30
	2) O estacionamento da ESPI	7,97	2,11		
	3) Facilidade de encontrar o local de entrega de documentação na ESPI	7,61	2,33		
	4) As instalações da ESPI são confortáveis	7,65	2,03		
Confiança	5) A ESPI é pontual na entrega de seus serviços	7,99	2,05	8,19	1,98
	6) A capacidade da ESPI em solucionar seus problemas com as bolsas	7,99	2,02		
	7) O processo de seleção é confiável	8,32	2,04		
	8) A gestão dos documentos por parte da ESPI é confiável	8,47	1,75		
Eficácia	9) A capacidade dos Colaboradores da ESPI em sanar as dúvidas	7,94	2,07	7,45	2,26
	10) O Tempo de espera na fila para entregar documentação foi menor que 30 Minutos (Acima de 30min (1 a 5); Abaixo de 30 Min (6 a 10))	6,93	2,47		
	11) O tempo para resolver alguma reclamação	7,31	2,24		
	12) Os colaboradores da ESPI respondem prontamente aos pedidos.	7,60	2,15		
Garantia	13) A ESPI executa as responsabilidades dela descritas em contrato com o bolsista	8,38	1,81	8,10	1,94
	14) Os colaboradores têm conhecimento para responder as perguntas dos bolsistas	8,00	1,96		
	15) A garantia de segurança dos bolsistas dentro das instalações da ESPI	8,16	1,82		
	16) A comunicação da ESPI disponibiliza informações relevantes aos alunos (Ex Revisão de Percentual, Suspensão, Prorrogação de Vigência, etc)	7,84	2,13		
Empatia	17) A ESPI dá atenção individual ao bolsista	7,76	2,18	7,74	2,15
	18) A Capacidade dos colaboradores da ESPI em identificar suas necessidades	7,66	2,08		
	19) Os colaboradores da ESPI demonstram interesse em lhe atender	7,64	2,23		
	20) Os colaboradores da ESPI são educados	7,92	2,10		

Chart 3: Averages and standard deviation of Satisfaction by Dimension and Item

Source: Author

## 4.2 Overall Performance of Dimensions

From the results obtained, it is observed that the general satisfaction level of the fellows is good, considering that the total average attributed through the questionnaire was 7.81.

The dimension with the highest average attributed by respondents is the confidence dimension (8.19). On the other hand, the one with the lowest average attributed is the effectiveness dimension (7.45). The average and standard deviation of each dimension can be seen in Chart 3.

## 4.3 Performance by Dimension

To detail each of the five dimensions evaluated, the results were divided into the following topics.

### 4.3.1 Tangible Aspects

Chart 3 shows that the tangible aspects dimension averaged 7.58, the second-worst average among scholarship holders. The standard deviation of this dimension is 2.30, the highest standard deviation among the five evaluated, thus demonstrating greater variability among the responses collected. The Figure 2 shows each item of this dimension in detail. It shows that item 2, referring to the institution's parking lot was the one that obtained the best evaluation (7.97). Item 1 referring to the location of the institution in the city obtained the lowest average (7.08) among the items.

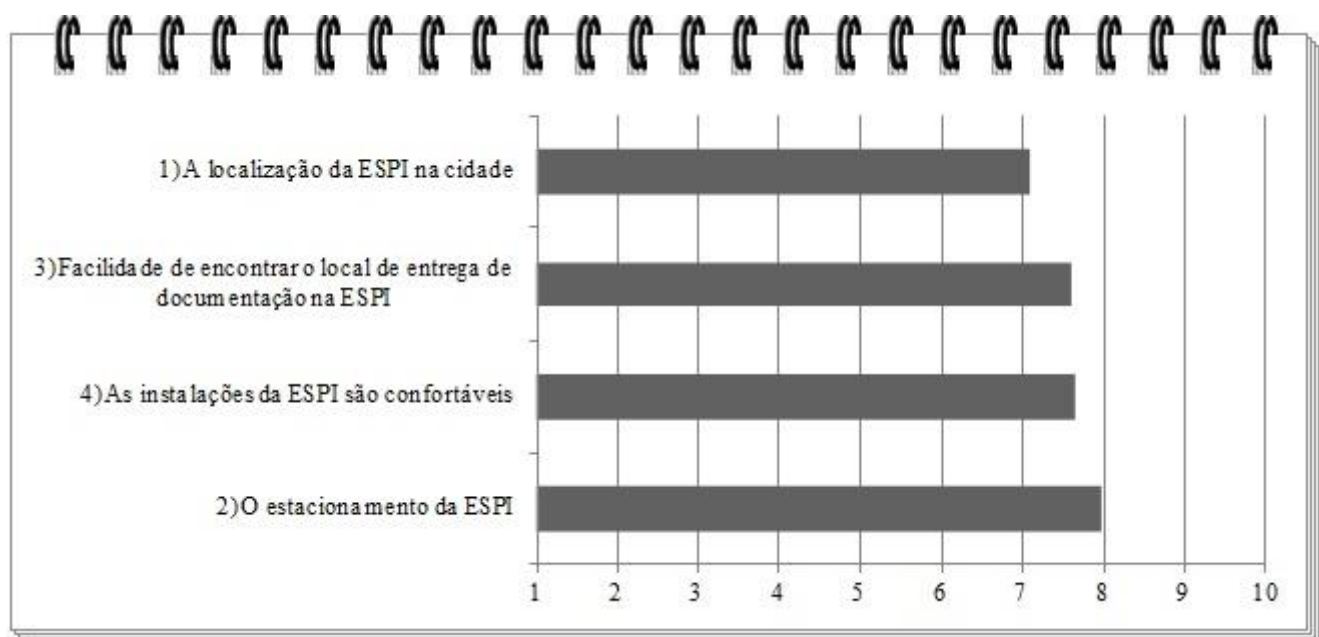


Figure 2: Averages of Tangible Aspects Dimension

Source: Author

#### 4.3.2 Reliability

Chart 3 shows that the reliability dimension obtained the highest average (8.18). The standard deviation of this dimension is 1.98, the smallest standard deviation among the five evaluated dimensions, demonstrating that the reliability dimension is the best evaluated and has the lowest variability in the answers. Figure 3 shows that item 8, referring to the institution's management of documents, was the one that obtained the best evaluation (8.47) in this dimension. Items 5 and 6, regarding the punctuality in the delivery of services and the ability to solve problems associated with the benefit, respectively, obtained the lowest average (7.99) among the items.

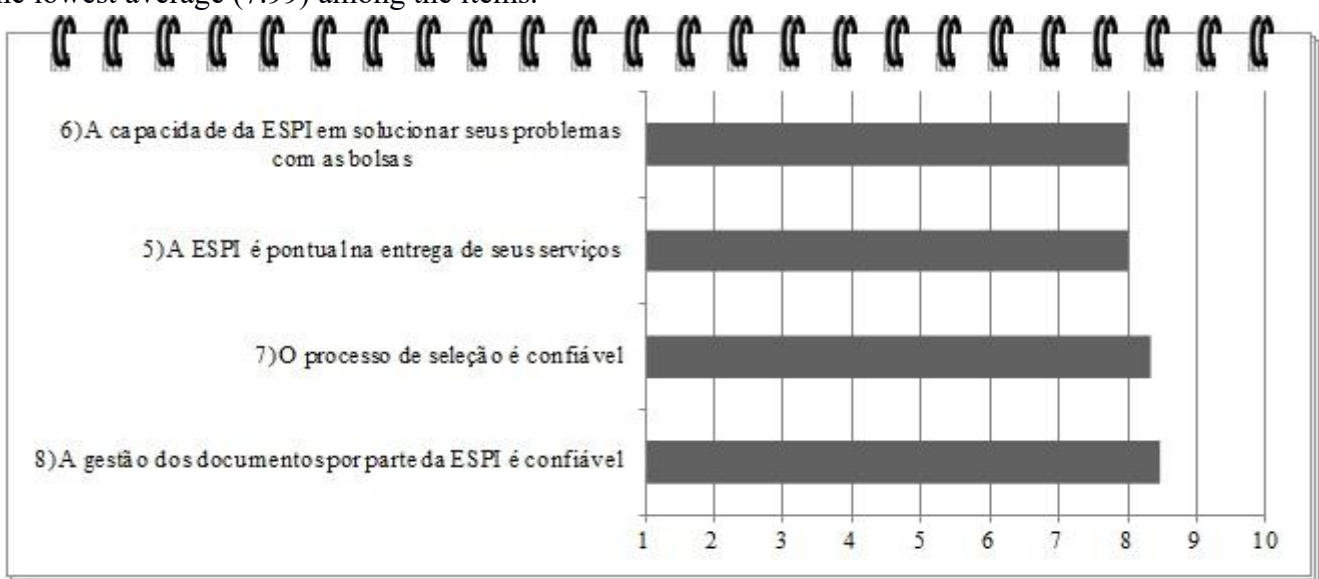


Figure 3: Average of Reliability Dimension

Source: Author

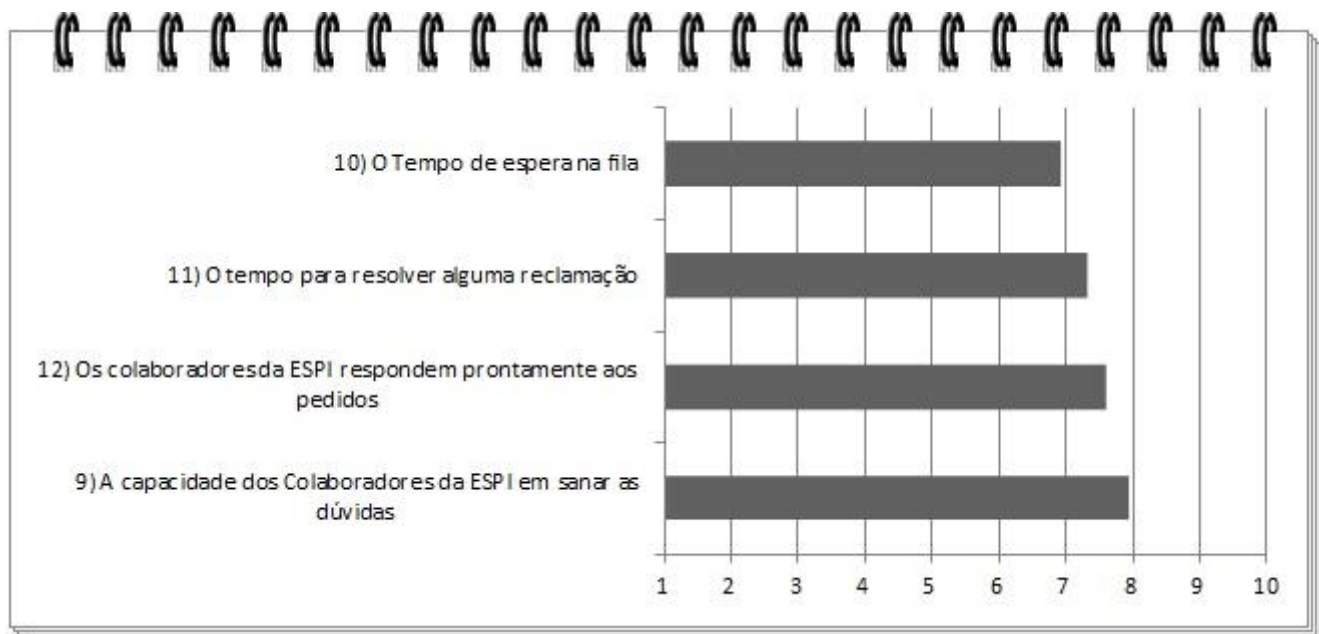


Figure 4: Average of Effectiveness Dimension

Source: Autor

#### 4.3.3 Effectiveness

Chart 3 shows that the effectiveness dimension averaged 7.45, the lowest average among the others. The standard deviation of this dimension is 2.26, the second-largest standard deviation among the five dimensions evaluated. Therefore, the effectiveness dimension obtained a worse evaluation by the scholarship holders, having the lowest average attributed. Figure 4 shows that item 9, referring to the ability of employees to answer questions, was the one that obtained the best evaluation (7.94) in this dimension. Item 10, on the waiting time in line at the time of delivery of documentation, obtained the lowest average (6.93) among the items.

#### 4.3.4 Assurance

Chart 3 shows that the assurance dimension obtained an average of 8.10, the second-largest average among the dimensions. Figure 5 shows that item 13, which refers to the execution of the responsibilities provided for in the contract, was the one that obtained the best evaluation (8.38) in this dimension. Item 16, regarding the availability of relevant information to the fellows, obtained the lowest average (7.84) among the items.

#### 4.3.5 Empathy

Chart 3 shows that the empathy dimension obtained an average of 7.74 among the fellows.

Figure 6 shows that item 20, relating to the education of the institution's employees, was the one that obtained the best evaluation (7.92) in this dimension. Item 19, referring to the interest on the part of employees to serve the fellows, obtained the lowest average (7.64) among the items.

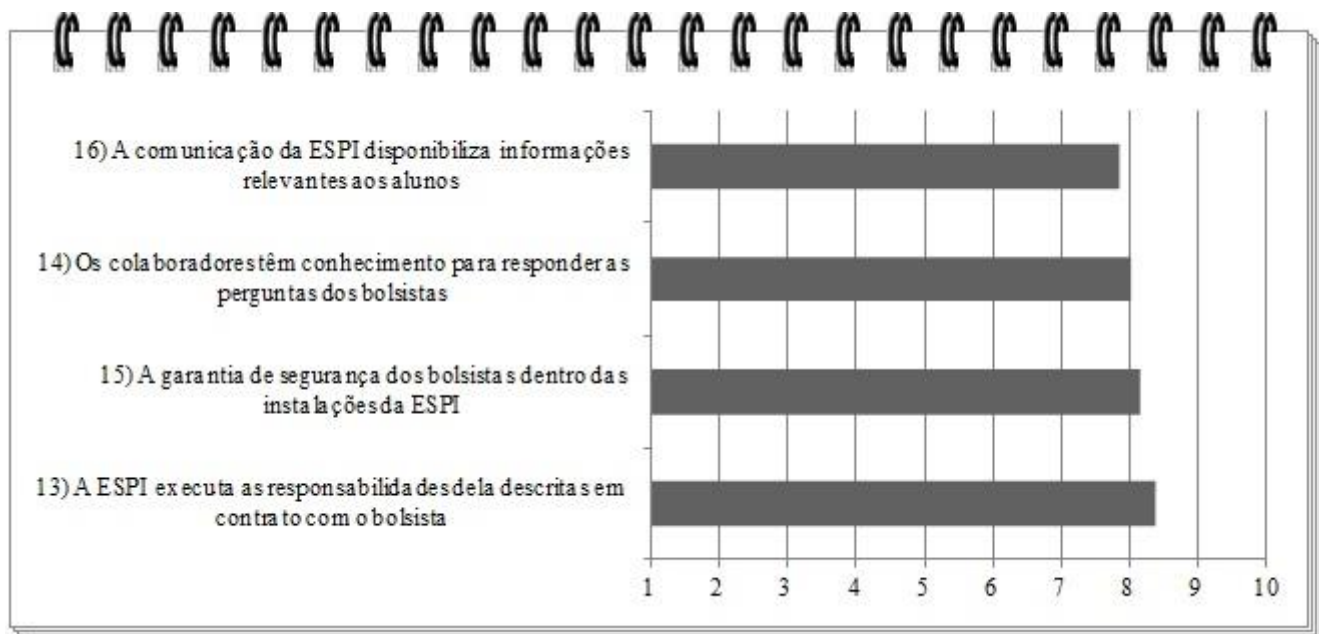


Figure 5: Average of Assurance Dimension

Source: Author

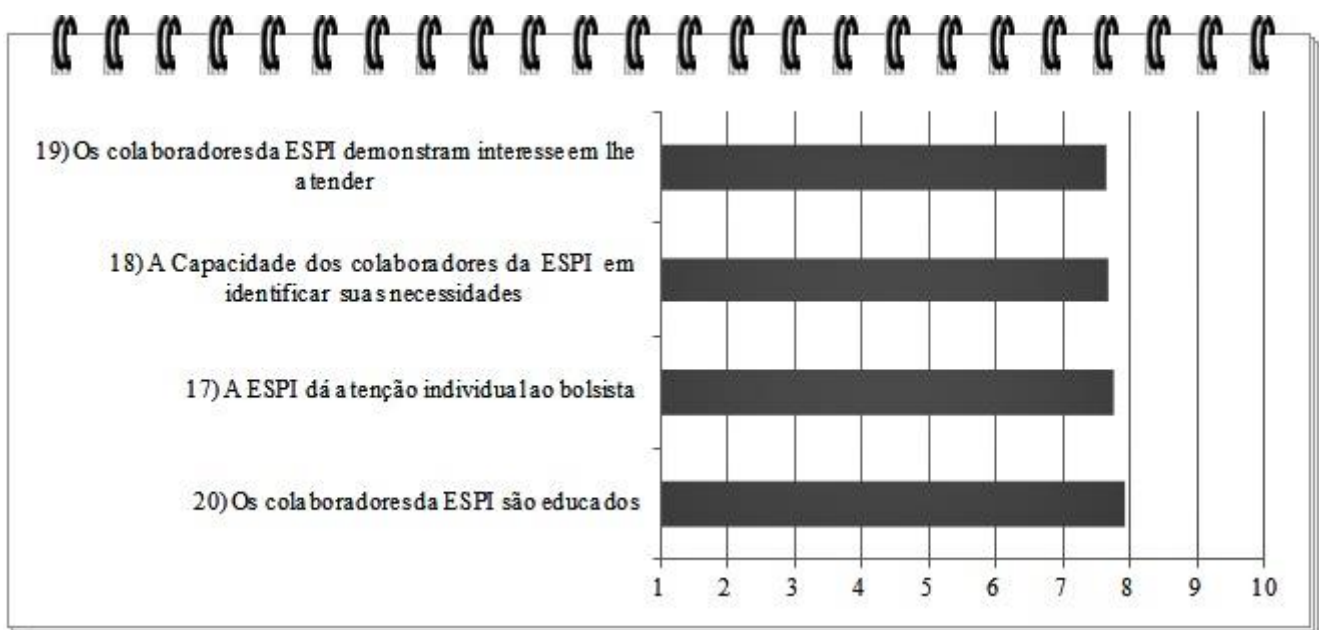


Figure 6: Average of Empathy Dimension

Source: Author

#### 4.4 Five lowest performing items

After the analysis per dimentions, it was sorted the items in ascendent order of average, in order to identify the five lowest itens, as can be viewed in Figure 7: item 10) Queue wating time (6,93); Item 1) ESPI's location in the city (7,08); Item 11) The time to resolve any complaints (7,31); Item 12) ESPI employees respond promptly to requests. (7,60); and Item 3) Ease of finding the place of documentation delivery at ESPI (7,61).

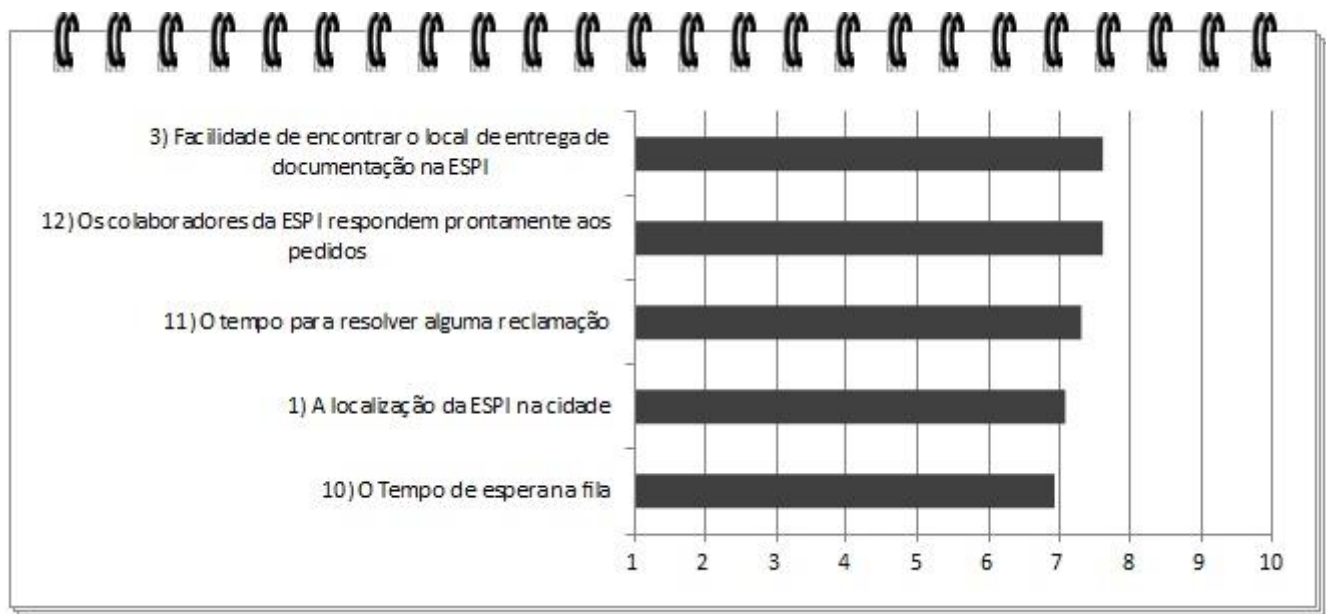


Figura 7: Average of Critical Items

Source: Author

After checking the five lowest-performing items, suggestions were made for improvements to each of the items, as noted in the following topics.

#### 4.4.1 Item 10 – Queue waiting time (6,93)

It was observed that the item with the lowest performance was the item related to waiting time in the queue for delivery of documentation. So, the main suggestions for improvements are:

- Disseminate the documentation and how to obtain the required documents;
- Encourage the delivery of documentation in the first days;
- Training of analysts responsible for receiving documentation;
- Use the waiting time for awareness about the rights and duties of future fellows;
- Increase days for documentation delivery.

#### 4.4.2 Item 01– ESPI's location in the city (7,08)

The location of ESPI in the city was the item with the second-lowest performance.

This item obtained several observations from the scholars who affirmed that ESPI's location is far from other areas. It was also reported the difficulty of access to the local due to the limited amount of public transport lines in this area of the city.

Considering the impossibility of relocating, suggestions were made to mitigate the negative impact of this item on the satisfaction level of the fellows.

- Decentralize services to respective Higher Education Institutions;
- Train the partners of the Education Institutions;
- Providing ESPI agents at partner Higher Education Institutions.

#### 4.4.3 Item 11 – The time to resolve any complaints (7,31)

Another underperforming item was the time for the institution to resolve grantees' complaints. It is



suggested to constantly train the employees involved in the direct attendance to the scholarship holder.

#### 4.4.4 Item 12 – ESPI employees respond promptly to requests. (7,60)

Another underperforming item was the item related to the promptness of responses to requests and complaints from the fellows.

- Constantly train employees involved in direct attendance to the scholarship holder;
- Avoid high employee turnover in the service sector.

#### 4.4.5 Item 03 – Ease of finding the place of documentation delivery at ESPI (7,61)

The item on ease of finding the place of delivery of documentation also underperformed the fellows. The following suggestions for improvement for this item:

- Disseminate the averages of getting to the place (bus lines) and places of reference.
- Attach signs on the day of delivery of documentation.
- Verify the possibility of delivery of documentation to partner institutions.
- Check the possibility of delivery of documentation at points distributed throughout the city.

## **5. Final considerations**

The article aimed to evaluate the level of satisfaction of scholarship holders of the "Bolsa Universidade" Program about the services provided by ESPI, the agency that manages the Program, to propose improvements to managers.

To this end, a questionnaire consisting of 20 questions adapted from the SERVPERF model, with four multiple-choice questions for characterization of the population and an open question for suggestions for improvement were prepared. The questionnaire was sent via email to the fellows.

Based on the survey results, it was observed that Reliability is the dimension that obtained the best performance (8,19) among the five dimensions evaluated, indicating that the fellows have between good and excellent levels of confidence in the services provided by ESPI. On the other hand, the Effectiveness dimension obtained the worst performance (7.45) among the evaluated dimensions, indicating that there is a need for improvements in this dimension.

In addition to the overall assessment, the five items that urgently need improvement are: 1) Queue wait time; 2) The location of ESPI in the city; 3) The time to resolve any complaints; 4) The promptness of the answers given by the collaborators to the scholarship requests; 5) The ease of finding the place of delivery of documentation.

The most relevant suggestions for improvements were: 1) Employee training; 2) Decentralize services; 3) Avoid high employee turnover; 4) Fellowship awareness about their rights and duties; 5) Achieve actions in partnership with the Higher Education Institutions;

For future studies, it is suggested to evaluate the level of satisfaction after applying the improvement actions, to evaluate the level of satisfaction of users of the ESPI website and the partner institutions of higher education.

Finally, it can be said that the overall satisfaction level of the fellows with this program was considered

good (average of 7.81) and that ESPI can continuously improve its services from effective actions made through continuous performance evaluations with its beneficiaries.

## 6. Acknowledgment

We would like to thank ESPI managers for their support and also Doctor Nilson Rodrigues Barreiros and MsC Ely Sena de Almeida for their contributions during the Industrial Engineering Course Examining Board when the article was defended in the end of 2017.

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# Causes of Non-Treatment of Nonconformities in a PIM Company X

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## Abstract

*To remain competitive, organizations have been adopting quality management systems to continually improve their performance and ensure the quality of products and services. However, many companies have shown some difficulty in the effectiveness of the corrective action process for nonconformities identified in external audits, internal assessments, and legal compliance assessments. This study aims to identify the causes that lead to the effective non-treatment of nonconformities in a company X of the Manaus Industrial Pole (PIM). The methodological approach used was the case study research, whose data collection was through brainstorming, Ishikawa diagram and meetings with managers and workforce in 2014. The compilation and analysis of the data allowed to conclude that the main faults detected were in the labor category, which showed that the teams did not have the knowledge and skills needed to handle nonconformities.*

**Key-words:** Nonconformity; Quality; Causes;

## 1. Introduction

The pursuit of excellence in an increasingly competitive market makes companies look for a differentiating factor that keeps them in the market, and increasing quality plays an extremely important role in this scenario, providing companies with mechanisms to control their processes and continuously improve them to satisfy and exceed consumer expectations and increase their competitiveness (GALDÁMEZ; CARPINETTI; GEROLAMO 2009; OLIVEIRA; MARTINS, 2008; OLIVEIRA, 2011).

The quality of the services provided, the satisfaction of customers and other stakeholders are extremely important and decisive factors for companies. Therefore, problems that affect and compromise the quality of products and services should have special treatment. Many companies lose efficiency and productivity because of failure in the treatment of their problems, negatively affecting the philosophy of continuous improvement.

Besides, some organizations fail to manage and analyze their nonconformities, regarding the planning of corrective and preventive actions that combat the origin cause of the problems and, thus, avoiding the repetition of the unwanted event.

And it was the scenario that the research was realized in the Company X (fictitious name given for confidential reasons), a case study conducted in a large company linked to the oil products transportation segment. The company has procedures and an integrated nonconformity treatment system (SIGA).

Nevertheless, there is a significant number of Anomaly Treatment Registration (RTA) forms that are treated superficially, without reviewing the root cause of the problem and with an extensive delay of the deadline. This fact deserves attention since proper management of nonconformities is a crucial point for the improvement of the Quality Management System (QMS). Therefore, the causes of failures and their effects must be investigated and adequately treated on time.

In this study, the term nonconformity (NC) will be characterized by non-compliance with a requirement defined in standards, procedures, legislation, policies, and internal documents, among others.

### ***1.2 Importance of Research***

For the academic world: the article could be used in class room for teaching and discussions purposes, specially in quality management subjects. Also, it can contribute to generate new topics for researchers interested in the theme;

For the company: reducing the recurrence of nonconformities will increase organizational productivity and efficiency and waste costs will not be borne by the product with the consumer. Effective management of nonconformities as one of the pillars of the QMS will help to block the effects of mismanagement by repeating a failure or even reaching larger proportions that match the company's image and therefore society;

For society: contribute to the reduction of costs related to NC passed on to the final product.

### ***1.3 Objectives***

To identify the causes that lead to the effective non-treatment of nonconformities in Company X of the Manaus Industrial Pole (PIM).

To propose an action plan to reduce the undesirable effects arising from the ineffective treatment.

## **2. Theoretical Referential**

### ***2.1 Quality Management***

Companies are increasingly organizing and adopting quality management as a way to help them achieve their goals (PINTO; CARVALHO; HO, 2006). Quality management makes it possible to obtain everyone's commitment to excellence in processes, products, and services, prioritizing their continuous improvement and consequent customer satisfaction (VIEIRA, 2013).

For Oliveira (2011), the quality of goods and services should be seen as a bigger issue within the company and not just as an aspect focused on the production sector.

Quality management practices include the continuous pursuit of opportunities for improvement and should be incorporated into the organizational culture to perpetuate a climate of cooperation and teamwork within the organization.

For this to be done more efficiently, organizations must place great value on quality, which will require greater creativity from managers, other employees, recognition of individual and collective efforts, resulting in many improvements in both product production, as to perform more reliable and efficient services.

The good performance of a quality system depends on the commitment of the human factor, that is, the qualification, training, and motivation of those involved in the process (SILVA, 2003).

Linguistically, quality comes from the Latin *qualis*, which means "as it actually is." Technical Standard NBR ISO 9001:2008 - Quality Management System - Fundamentals and vocabulary define quality as "The degree to which a set of inherent characteristics satisfy requirements".

However, there is no consensus on the definition of quality. For Oliveira (2011) quality has many definitions, which may vary according to the context, the business segment can be termed as compliance with customer requirements, converging to stakeholder needs and preventing and managing nonconformities, including the actions for corrections.

Classic authors as Crosby, Deming, Feigenbaum, and Juran present different concepts concerning quality, but there is a predominance of two meanings: "the absence of failures" and "satisfying customer needs". Part of quality management is responsible for identifying and addressing nonconformities, and the negative consequences of poor quality management result in errors, rework, employee dissatisfaction, waste, dissatisfied customers, and worn-out image.

Additionally, quality management practices can be certified through the implementation of Quality Management Systems (QMS), which focuses on the development, implementation, maintenance and quality improvement of organizational processes, representing the part of the organization management system that aims to achieve results concerning the quality objectives to reach the needs, expectations and requirements of stakeholders (ABNT NBR ISO 9001: 2008).

## **2.2 Quality Management System**

Quality management systems (QMS), for Oliveira (2011), are a means for introducing and systematizing the philosophy and quality procedures in organizations.

Lagrosen and Lagrosen (2003) define QMS as a collection of quality management techniques and models for both manufacturing and service industries. Valls (2005) and Ueno (2008) complement the definition of QMS as a form of management defined by top management based on the identification of customer requirements, process standardization, and continuous improvement.

For Poksinska et al. (2006), several studies indicate that QMS provides important benefits to companies. However, existing difficulties are also identified. Benefits include improved processes, products and services, increased customer satisfaction, improved company image, new market opening and greater competitive advantage over competitors. About the difficulties, the following are observed: resistance to change, difficulty in understanding and accepting certain quality precepts, lack of compromise of the middle management and low involvement of top management, including small capital contribution to activities associated with quality.

To meet market needs about QMS, a set of requirements suggested by the NBR ISO 9001: 2008 standard arised aiming to guarantee consumers products and services offered according to the requirements. The standard induces a continuous improvement system, which can be obtained through the Deming cycle (PDCA) - Plan, Do, Act and Check;

According to ABNT NBR ISO 9001:2008, the PDCA model can be summarized as follow:

Plan: establish the objectives and processes necessary to generate results following the customer requirements and organizational policy;

Do: implement the processes;

Check: monitor and measure processes and products regarding policies, objectives, and requirements for the product/service and report results;

Act: take actions to improve process performance continually.

### **2.3 Quality Tools**

Quality tools have been developed and refined to support the application and use of quality management in companies. These include Flowcharts, Ishikawa Diagrams, Histograms, Pareto Charts, Control Charts, and Scatter Diagrams.

According to Bamford and Greatbanks (2005); Alsaleh (2007), these tools are used to develop, implement, monitor quality precepts in organizations, representing important and necessary tools for QMS to achieve maximum efficiency and effectiveness.

Using quality tools is a way of identifying where problems are and how to solve them.

### **2.4 Continuous Improvement**

Continuous improvement is a fundamental element of quality practices. Its objective is to systematically evolve projects, processes, products, and services, overcoming obstacles, solving problems, learning from mistakes and successes, teaching, knowing, sharing and contributing to both individual and organizational growth (BESSANT; CAFFYN; GALLACHER, 2001; MESQUITA; ALLIPRANDINI, 2003; JAGER et al., 2004).

The goal of continually improving a QMS is to increase the probability of growing customer and other stakeholder satisfaction.

Process improvement is a necessity present in the routine of all organizations. Feedback from customers and other stakeholders, audits and review of the quality management system can also be used to identify opportunities for improvement.

Irani et al. (2004) highlight two groups of characteristics essential for the practice of continuous improvement. The first group deals with individual characteristics regarding employee skills and behavior. The second group consists of the organizational characteristics, it refers to the cultural and structural aspects that promote it.

So, people need to have the skills and knowledge indispensable for problem-solving, enabling participation through ideas, suggestions, and executions.

The term competence have two meanings, one facing the organizational level and the other towards the individual. The first refers to the core competencies of every organization that gives it a competitive advantage. The second, the individual, concerns the contextualized mobilization of employee knowledge and know-how to generate economic value for the organization and social value for itself (GONZALEZ, 2011).

In the context studied in this article, the implementation of the philosophy of continuous improvement is

only solidly perceived when there is a commitment to treat any “variation” that deviates from the concept of quality.

Actions for improvements under ABNT NBR ISO 9001:2008 include the following:

- a) Analysis and assessment of the existing situation to identify areas for improvement;
- b) Establishment of improvement objectives ;
- c) Search for possible solutions to achieve the objectives;
- d) Evaluation and selection of these solutions;
- e) Implementation of the chosen solution;
- f) Measurement, verification, analysis, and evaluation of implementation results to determine if objectives have been reached;
- f) Formalization of alterations.

### ***2.5 Organizational Learning***

According to Bhuiyan et al (2006), quality and its improvement are based not only on formal tools and organizational processes but also on the solidification of norms, values and assumptions, that is, a culture that stimulates learning and improvement of the skills of individuals.

Organizations that engage continuous learning in their culture have, according to Gonzalez (2011), six main routines: 1) Systematic problem solving through programs and tools; 2) Experimentation, aiming at the acquisition of new knowledge; 3) Learning through past experiences; 4) Learning through integration with other organizations (Benchmarking); 5) Internal knowledge transfer; and 6) Measurement of the learning process.

The organizational learning process integrates three levels: individual, group and organization.

### ***2.6 Quality Assessment***

When evaluating quality management systems, four basic questions should be asked regarding the cause of the processes being evaluated: a) Is the process identified and appropriately defined? b) Are the responsibilities assigned? c) Are the procedures implemented and maintained? d) Is the process effective in achieving the required results?

The answers to these questions may determine the result of the assessment.

### ***2.7 Audits***

Quality Management System (QMS) auditing is an important management tool used to improve business performance through objective, systematic and periodic assessments and is a key step in the certification process. It is used to monitor and evaluate system effectiveness, identify opportunities for improvement, and thereby mitigate the risks associated with the survival of organizations. Poksinska et al. (2006) show that certification auditing can be a tool to ensure the effectiveness and continuous improvement of QMS. According to Beckmerhagen (2004), the word audit was never accompanied by a broadly positive connotation, although the process, when well done, has benefits for the management of an organization. The criticism of the process, according to Kaziliunas (2008) is that the vast majority of audits are only to produce data to issue a certificate, to improve the documentation or to enforce conformity.

The fact is that quality auditing alone does not guarantee the quality of products and services, but their contribution to this is undeniable since the improvement actions are based on facts from quality auditing. However, the audit alerts the organization of the need to review, update and improve its production processes. But when the problem is treated ineffectively, it can be repeated indefinitely until it contaminates the productive capacity or at least its customer concept about the organization.

It is important to highlight that the organization must take responsibility for the critical analysis of nonconformities, identifying their causes to finally correct these actions that may compromise their ability to provide a good service.

### **2.8 Correction Plans**

ISO 9001: 2008 determined that an organization should take corrective actions to eliminate the causes of nonconformities, detected by employees and/or auditors and also by parties' manifestations to avoid their repetition. Corrective actions shall be appropriate to the effects of nonconformities detected and a documented procedure should be established to define the requirements for:

- Critical analysis of nonconformities
- Determination of causes of nonconformities
- Evaluating the need for action to ensure its non-repetition
- Determination and implementation of necessary actions.
- Record of results of actions taken
- Critical analysis of corrective actions taken

### **2.9 Standardization**

Process standardization is one of the elements that compose QMS. According to Silva, Duarte and Oliveira (2004), standardization allows the company to offer products and/or services with constant characteristics, that is, with the same quality standard, satisfying customer requirements.

Thus, standardization aims to ensure the execution of processes always in the same way to obtain greater predictability of results. It is used to control, predict and minimize nonconformities (TEIXEIRA, 2013).

Process standardization, for Münstermann, Eckhardt and Weitzel (2010) is conceptualized as the degree to which procedures are formalized and followed. Quality of service or product requires consistency in business processes. This consistency is made possible through the standardization of processes (UNGAN, 2006).

With the standardization of processes, the production and services become more effective, thus contributing to increased efficiency of processes and activities (MÜNSTERMANN; ECKHARDT; WEITZEL, 2010).

Some authors (UNGAN, 2006; MÜNSTERMANN; ECKHARDT; WEITZEL, 2010) reinforce that process standardization has a positive effect on service quality, as it contributes to reducing uncertainty and process variability. Besides, developing standards contributes to increased operational performance by eliminating errors, reducing costs and facilitating communication (BEIMBORN et al., 2009).

Ungan (2006) analyzed that the standardization of products, components, and processes, contributes to the creation of new products; development of problem-solving approaches; reduction in the number of

components and activities; in addition to reducing storage and transportation costs.

Jayaram, Vickery and Droge (2000) reinforce that process standardization is an important variable for supply chain performance, mentioning gains in Lead Time manufacturing performance, speed of delivery and customer responsiveness.

However, it is important to note that simply imposing a standard for the workers will not create a sense of responsibility for the activity. The workers need to be involved in setting the standard, explaining to them the goals and potential results. Thus, avoiding treating the laborers as a mere substitute for a machine and prioritizing participatory management, there will be much less resistance to change and, therefore, the chances of success of the standardization process will increase considerably (TEIXEIRA, 2013).

Process standardization occurs mainly through formal documentation. It is information in the form of text or graphics, aiming to clarify the relationships between activities, employees, information, and objectives in a given workflow (UNGAN, 2006).

### ***2.10 Leadership***

Leaders establish unity of purpose and direction of the organization. They should create and maintain an internal environment in which people can be fully involved in achieving the organization's objectives (ISO 9001: 2008).

Hersey and Blanchard (2007) define leadership as the process of influencing the activities of individuals or groups to achieve a goal in a situation. One definition of leadership that captures the essence of its characteristics is that of Weathersby (1999), for whom leadership focuses on creating a common vision. It means motivating people to contribute to the vision and encouraging them to align their interests with those of the organization.

When addressing the leadership theme, many aspects can be considered, related to the skills that the leaders must demonstrate, or the style that the leader can adapt in function of the focus given to their activities, more in the processes or more in the people involved. Emphasis can also be placed on the role of the leader, what is expected of him, and how he positions himself in this regard. All these possibilities will act within an environment, or situation, influencing the way leadership is exercised (GONÇALVES, 2011).

Gonçalves (2011) adds that the leadership style that a manager must use to influence an individual or team will depend on their level of maturity. Maturity can be defined as the ability and willingness of people to take responsibility for directing their behavior.

However, if the leaders do not disseminate important values to the team, such as those contained in their quality policy, the leaders will inevitably assume the role of disengagement from the quality aspects.

Leadership should provide evidence of its commitment to the development and implementation of the quality system and continuous improvement (NBR ISO 9001: 2008).

### ***2.11 Elements that prevent the correction of nonconformities***

In the context of the most different standards that value quality, complying with its contents is not an easy task, especially when a nonconformity arises, because knowing how to treat it correctly is delicate work.

Although there is much discussion about the elimination of these factors, what is still constantly seen are



companies that do not focus on reducing, eliminating and preventing their nonconformities.

ISO 9001:2008 conceptualizes non-compliance as non-compliance with a requirement (implicit or mandatory need or expectation). Hence arises one difficulty to define clearly what is nonconformity. Because of this, some nonconformities are treated incorrectly.

Another related difficulty is linked to the financial aspect and some companies prefer to delay the solution of the problem and when a solution comes lately, often is necessary to change processes, which becomes expensive for the company, so they prefer not to change the situation.

It is also noted the problem of limiting the issue of nonconformity to quality professionals, which cannot occur, since the understanding of the subject has to be on the part of all employees of the company, and not only of the quality sector.

Therefore, it is necessary not only to train, but also to follow and carry out constant recycling, and it cannot restrict the only sector the responsibility for the quality problems generated by the occurrence of nonconformities.

Although many companies are already improving their treatment of nonconformities, eliminating failures, redesigning processes, and training employees, there are still organizations that have major flaws in their procedures, especially having difficulties in recording and handling nonconformities.

So, one of the major causes for not solving the problem is the use of corrective actions instead of preventive actions. Corrective action is used to eliminate the cause of an identified nonconformity or undesirable situation (ABNT NBR ISO 9001:2008), and it must be performed to solve an immediate problem, learning with the experience.

Many companies are very advanced when it comes to containing nonconformities, due to market and statutory requirements, which make their processes robust to the point of not providing nonconformities.

On the other hand, some companies still neglect their nonconformities, pretending that they do not exist, resulting in record complaints, disrespecting their customers, competitors, regulatory bodies, often generating situations irreversible to humans, the environment and to public coffers.

### **3. Case Study**

The Company X belongs to the petroleum derivatives logistics sector and is located in the industrial district of Manaus, located in Amazon state, Brazil.

In 2014, its facilities have been operating for 15 years and it had a staff of approximately 160 employees, distributed among Technicians, Engineers, Coordinators, and Managers.

The company's main customers are the petrochemical industry and the distribution companies that serve diesel consumption in the northern region.

The company's operating facilities are located in the private port area of the city of Manaus and operate with ships, ferries, and barges. It performs vessel berthing and unberthing services, measurement and sampling on oil and propane ships, in the receipt and storage of oil and oil products. The administrative facilities are at the company's base.

The activities developed, in summary, are administrative, operational, maintenance, safety, environment, health (SMS) and port security following the guidelines contained in the ISPS-Code (International Code

for the Protection of Ships and Port Facilities).

Company facilities are periodically evaluated on internal and external audits, self-assessments, stakeholder satisfaction surveys, reviews, etc.

Quality and SGI audits indicate that the company faces many obstacles in treating its NCs. The area most affected by the problem studied is the Administrative Services (AS) area, which is responsible for administrative and logistic support contracts (automobiles, speedboats, Industrial kitchens, and Container leasing). The sector consists of 15 people, including administration technicians, Coordinator, and Regional Manager.

In other sectors, equivalent problems were seen, however, to a lesser extent. Audit reports show that SA has the largest number of repeat NCs and other RTAs terminated with palliative measures only.

### 3.1 The software SIGA – Integrated Anomaly Management System

In the organization under study, the SIGA system is used to assist in the management of anomalies.

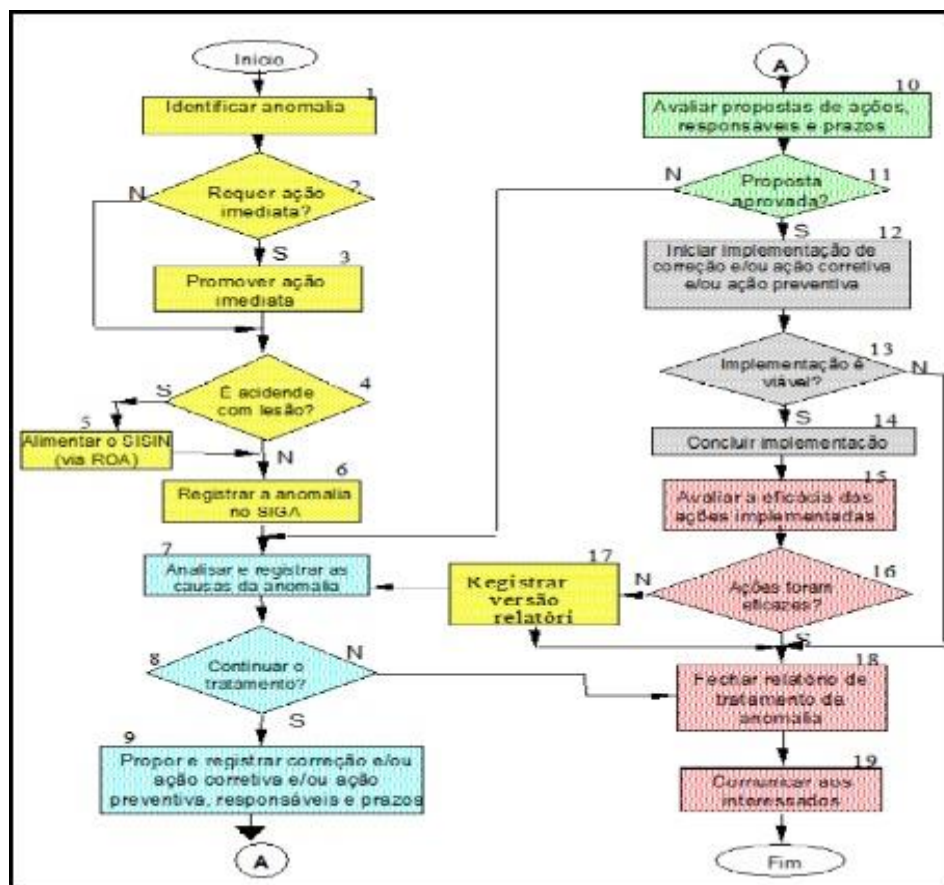


Figure 1 – Anomaly treatment process adopted by the organization under study.

Source: Company X

This software was developed by the organization, being customized to the needs of the company. The main items registered in this system are:

- Register anomaly, including the mandatory completion of the correction field;
- Analyze anomaly and the facts associated with its occurrence to identify the underlying cause;

- Establish corrective actions, define responsible for their implementation and reasonable deadlines for the actions to be implemented;
- Approve or disapprove analysis performed and proposed actions, responsible and deadlines presented;
- Establish a deadline for verification of effectiveness and complete implementation phase;
- Evaluate the effectiveness of the treatment performed and terminate the RTA.

Figure 1 shows a flowchart of the anomaly treatment process provided for in the organization's internal procedure.

#### 4. Methodology

The research is applied and a case study, using some quality tools to identify the root causes of problems and meetings with the leadership and workforce.

Basically, after the choice of the theme “Causes of non-treatment of nonconformities in a company of the Manaus Industrial Pole,” an applied and descriptive research was carried out to seek information regarding the theme and its components, as well as the identification of contributing factors for the non-effective treatment of NCs.

The study was developed based on current concepts on quality management and analyzed on the perspective and proactive vision of NC treatment as a way to stay in the current competitive market.

It was necessary to perform a literature review, using articles from the area of Industrial Engineering, which allowed an understanding of the causes for non-treatment of nonconformities.

Data collection was performed during March 2014 and the chosen place was the base of the company in question. Two meetings were held, one at the company's operational safety department and the other at the base auditorium. The first meeting was attended by the Operational Safety Coordinator, a Safety and Environment Engineer, an Integrated Management System professional, an Administration Technician, and a Safety Technician. All present act directly in the process and use the tools provided by the company for problem management. The second meeting had a larger number of employees. It was held in the auditorium of the company. There were on average 25 employees from the 13 sectors that compose the company.

The premises of the company's administrative bases are small and therefore gathering this number of employees was relatively easy. Present were Administration Technicians, Maintenance Technicians, Environmental Technicians, Operation Technicians, Occupational Safety Technicians, Labor Nurse, Accounting Technician, ICT Technician, Administrative Services Coordinator, Support and Works Coordinator, Maintenance Coordinator, SGI Professional, Operations Supervisor, Mechanical Engineer, and Electrical Engineer. All areas have been heard, as the appropriation, investigation, and treatment of NC are in the area where the failure was detected and it is the area's responsibility to follow the anomaly treatment standard of the RTA (Anomaly Treatment Report) registration on SIGA at closure, with verification of effectiveness.

The data collection and analysis instruments used were in loco observation, the use of Ishikawa diagram and brainstorming, analysis of documents, procedures, and standards related to the anomaly treatment process.

## 5. Results

### 5.1 Identification of Causes

To identify the causes of noncompliance treatment was held in March 2014, two meetings, the first common small group of four people and another meeting with a larger group of 25 people. All employees present work directly in the anomaly treatment process and have or already have RTAs under their concerns.



Figure 2 – Causes of recurrence of a NC concerning Labor Category

Source: Author

This data collection to obtain as causes of problems studied were made with the representatives of the Administrative Services, Monitoring, and Results Control, Maintenance, Inspection, Engineering Support, Operational Safety, Health, Environment, Human Resources, Operation, Information and Communication Technology (ICT), Institutional Communication areas and Management.

To help identify possible causes that cause unwanted return (conformity effect), brainstorming and the Ishikawa diagram were used at both meetings, with a survey of the possible causes that cause or ineffective the treatment of NCs identified in the company.

The causes of the recurrence of a NC (Figure 2), mostly belong to the category labor, such as: failure to register, failure to analyze the root cause, failure to define corrective and preventive actions, failure to define deadlines, weak communication and scope, failure to implement actions, failure to approve

actions, failure to verify the effectiveness of actions implemented.

The other causes identified were in the machine category, such as integration failure between the SIGA and ABRA (Coverage System) systems. The slowness of the systems, caused by the low ICT infrastructure that serves the company, was also cited as a critical point in using the SIGA system to treat RTAs.

In the Measurement category, was mentioned the failure of external audits that often present unrealistic results and aimed only at maintaining certification. Failures were also noted in the periodicity of self-assessments that only precede external audits as a form of preparation.

In the Method category, there was no fault identification. In the Environment and Raw Material category, there was no applicability.

This assessment already presents the need for better management of the human resources that collaborate for the treatment of NCs, and effective management, in terms of capacity building and awareness, would avoid that most of the problems related to the ineffectiveness of the same treatment failure or others were caused.

In the organization, after data collection, it was noted that the most critical area of the steps that focus on the treatment of nonconformity (provided in the internal management standard), is the analysis of failures.

For Martins and Laugeni (2005) failure analysis is a technique used to prevent or to analyze nonconformities in projects, processes, and products. According to these authors, in a more preventive view, a methodology should take into account seven phases: Phase 1) Specification of the problem; Phase 2) Determination of hypotheses of causes; Phase 3) Verification of the hypotheses with the specification of the problem; Phase 4) Analysis of existing controls that prevent the occurrence of failures; Phase 5) Evaluation of occurrence rates, severity detection and risk of failures; Phase 6) Development of corrective and preventive actions; Phase 7) Monitoring the implementation of measures to prevent failures.

Alvarez (2002) also considers the existence of different methodologies for fault identification and treatment. However, for this author in organizations, it is not common to apply such methodologies since most of them live with a culture of "put out a fire". In his analysis, the author points out that there is no better method of failure analysis, and consensus among the methods is the identification of the root causes. What the author highlights are the fundamental difference in approach where one method is best suited for simpler problems or failures and others whose approach is more focused on problems that are more complex.

Campos (2011) argues that in structuring a failure analysis system each organization should develop its approach model so that it becomes a culture and organizational value. The author points out that a good failure approach system presupposes the existence of a sequential process that allows good conduction of analyzes, as well as the application of analytical tools for the simplest cases whose root cause, is easily identifiable. It also considers the need to combine a specific analysis process and tools for the most complex cases, in which teams, due to the complexity of the fact, elaborate the development of the critical analysis process.

This fact reinforces the understanding that it is necessary to enable teams to fully develop their functions.

The company has a system of treatment of nonconformities well defined in internal procedures of management and execution. Besides, it has an integrated non-compliance management system that works by alerting those responsible for meeting deadlines and if the deadline is due, the pending alert extends to the immediate sector of the employee. However, the training sessions were insufficient and did not attend all the teams. Which left a gap in the process as a whole.

### 5.2 Action Plan Proposed

Taking as reference the amount of insufficient training as one of the main causes of non-treatment of NC, the following action plan based on the 5W2H technique was proposed (Chart 1). This action plan provides the training necessary to qualify employees to identify and analyze nonconformities and establish action plans using the appropriate tools to solve problems and continually improve their Quality Management system. The same was built from research and the author's perception, with the contribution of the company's SGI professional.

What?	Why?	Where?	When?	Who?	How?	How much?
Planning the class for training	All area managers will appoint representatives to receive NC treatment training	Training room	April, 2014	Sector Coordinators	Indication of names through internal document.	-
Conducting training with teams on anomaly treatment standard	Know and attend the anomaly treatment system.	Training room	April, 2014	SGI Professional	Use of datashow with slide show about standard. Opening of the standard in SINPEP.	-
Integrated Anomaly Treatment System Training (SIGA)	Regional Manager of SIGA.	Training room	April, 2014	SGI Professional	Use of datashow with slide show about the system. Computer use by student for system simulation.	-
Training about abrangências system	Regional Manager of ABRA	Training room	April, 2014	SGI Professional	Use of datashow with slide show about the system. Computer use by student for system simulation.	-
Concepts and definitions related to Nonconformities and Corrective Actions	Empower employees to identify and analyze Nonconformities and establish Action Plans using appropriate tools to solve problems and continually improve their Quality Management system.	Training room	May, 2014	Hired company.	Use of handouts, teaching materials, data and show sharpener.	Contracting costs of the company to training.
Related Regulatory Requirements Overview (ISO 9001)		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Identification of						Contracting

Nonconformities		Training room	May, 2014	Hired company.		costs of the company to training.
Types and Classification of Nonconformities		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Awareness and Responsibilities		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Describing Nonconformities		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Nonconformity Treatment		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Troubleshooting Techniques		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
The basic troubleshooting tools: Cause and Effect Diagram (Ishikawa); Pareto Diagram, Brainstorming, etc.		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Corrective Actions Evaluation		Training room	May, 2014	Hired company.		Contracting costs of the company to training.
Examples, Exercises and Applications		Training room	May, 2014	Hired company.		Contracting costs of the company to training.

Chart 1 – Presentation of the Action Plan to combat Insufficient Training

Source: Author

## 6. Final Considerations

This paper aims to identify the causes that lead to the effective non-treatment of nonconformities in a company of the Manaus Industrial Pole (PIM), in order to propose an action plan to reduce the undesirable effects arising from the ineffective treatment.

The procedures and the computerized system adopted by the company for the management and treatment of its failures were evaluated and no significant failures that could be part of this study were found.

However, the main faults detected were in the labor category, which showed that the teams did not have the knowledge and skills needed to handle nonconformities. It was asked during the meetings whether the failures in the other categories were corrected, whether the problem would persist or be blocked. The answer to that question was that the big problem is that the company has invested heavily in employee training in the past, but with the optimization and reduction of operating costs program that was

established more than three years ago, training has been reduced and prioritized only those of Safety, Environment and Health (SMS). Many new employees were admitted to the company, and most attending the meeting did not recall the last time they received training related to anomaly management.

It is important to point out that the company faces problems mainly in the analysis of the root cause since several times it was seen the absence of a tool that would help in investigating it. This flaw was found in most filtered anomaly treatment reports in the system. This evidences the superficial treatment, since the other steps, such as the implemented actions are strongly linked to the study of the root cause.

Even with specific implementation and management procedures within the organization, computerized systems, adequate infrastructure if there is no motivation among employees, awareness, and training, effective controls, periodically established measurements or committed to demonstrating the reality of the organization. In addition to leadership that is little committed to quality management in processes and services, the organization will inevitably fail to score on efficiency and productivity. Therefore, the human factor is reinforced as the essence of any management system.

As suggestion, an action plan was proposed to assist in the training of its employees. Follow-up on the implementation of this plan will support the organization to seek continuous improvement of its processes, following the awareness of its employees, as well as the use of a system to control failures.

Further research could be done to identify the impact of this action plan implementation on the reduction of causes related with non-treatment of nonconformities.

## 7. Acknowledgements

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# How to evaluate the quality of suppliers in a PIM's Company X

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## Abstract

*The research was carried out in Company X that operates in the electronics industry at Manaus Industrial Pole (PIM). The objective is to propose a system of indicators to evaluate the quality of suppliers, in order to enable their relationship's continuous improvement. Based in the collection and analyzed data, it was possible to identify six successful cases of suppliers' quality assessment indicators system, which permitted to propose, in partnership with managers, a model that does not need a high cost investment to implement it. Finally, it was suggested to company: a) computerize this process; b) to train employees that work in quality material sector; c) to strengthen relationships with current and future suppliers by showing the company's new vision and model. Doing so, it is believed that the company studied will have a great advance in the field of raw material acquisition, thus obtaining more quality and may be more competitive in the market.*

**Keywords:** Suppliers; Evaluation; Quality.

## 1. Introduction

The company where this article was developed is located in the Polo Industrial de Manaus (PIM), located in Manaus city, capital of Amazon, Brazil. For private reasons, the company real name will not be revealed, so from now on this company will be cited here as Company X. It is characterized as an outsourced company for providing manufacturing services in electronics, which cover various segments, such as: cameras, digital decoders and printed circuit boards for computers and ATMs. In 2013 it had around 16,135 suppliers registered in its system.

With its structure and market, the company sees the need to evaluate its suppliers in order to achieve its market vision: “To be the world leader in the provision of manufacturing services, enabling its employees to proactively offer their customers. innovative and strategically beneficial solutions.”

Given this, there is a concern on the part of the company to offer quality products to its customers, so it is essential to evaluate suppliers, because if the raw materials, goods and materials do not meet the interesting expectations for the company will certainly not meet. customer needs, compromising

customer satisfaction.

In this sense, the main objective of this study is to propose a system of indicators to evaluate the quality of suppliers, in order to enable their relationship continuous improvement. To this end, the specific objectives are: 1) to investigate success stories of suppliers' quality assessment indicators system; 2) analyze the company's current supply chain in order to identify active suppliers to be evaluated; 3) propose suggestions for improvements to the company, based on the results obtained in this article.

The research is relevant because: 1) it will provide strategic information that will support the decision making process of managers; 2) provide valuable information for the company to develop and improve the quality of suppliers; 3) in the medium and long term it will help to control the performance of suppliers; 4) it will contribute to the continuous improvement of the relationship between the company and its suppliers; 5) can be benchmarked and implemented in other companies that aim to improve product quality; 6) it can serve as a case study to be used in class room, specially in quality management subject, as well as for new research to be realized by professionals interested in the theme.

## **2.1 Theoretical Referential**

### ***2.1 Reasons for evaluating suppliers***

The challenge for companies is to develop an adequate system capable of measuring the potencial performance of their suppliers (SILVA, 2017).

The purpose of the supplier assessment is to prove the ability to meet the specified requirements to be purchased, i.e. to have an adequate quality assurance system, this assessment can be done in different ways:

Qualitative assessment by track record: this type of assessment is only acceptable at the implementation stage of supplier procedures. The evaluation is made by analyzing the supply records of certain suppliers and it can be verified that during a period of time there was (FRANCISCHINI, 2004):

- No or small percentage of lots or services delivered with quality problem;
- No or small percentage of lots or services delivered with delays.

Quantitative Valuation by history: this type of valuation involves a scoring method applied to the supply history. It is essential that records are available to apply this type of method.

Evaluating and selecting suppliers according to Francischini (2004), it is not enough just to select the supplier for the good price of his product, but besides this factor, the supplier must meet the qualifying criteria and the classification criteria of supply.

In practice, it is not appropriate to use only one type of valuation for all suppliers of the purchasing company. Firstly, more detailed evaluations place a high burden on quality system management, and secondly not all components have the same relative importance as the final product. (FRANCISCHINI, 2004).

According to Juran (1992), the main objective is to create a relationship that ensures that the product and/or services meet the needs of suitability for use with a minimum of receipt inspection and corrective action. The main activities are: a) define the product and specify the quality requirements; b) evaluate alternative suppliers; c) select suppliers; d) perform joint quality planning; e) cooperate with the supplier

during the execution of the contract; f) obtain proof of compliance with requirements; g) approve qualified suppliers; h) conduct quality improvement programs as needed; i) create and use vendor quality ratings.

According to Carvalho and Garvin (2005) to meet market demands, increasingly lacking in quality goods and services, one of the elements that companies need to pay attention to is the relationship with suppliers, establishing a long-term relationship. aiming at mutual collaboration and the pursuit of continually improving product quality.

For Viana (2012) the ability of organizations to meet the needs of their customers increasingly depends on the quality of products and services of contractors.

According to Baily et al. (2000) companies spent 80% of the budget with 20% of suppliers, which increasingly requires closer relationships with these suppliers. According to Martins & Alt (2006), gains in terms of productivity in the purchasing area end up having a major impact on the company's profits. Therefore, it is essential to have a system of indicators for quality assessment of suppliers that is efficient and capable of generating strategic information so that managers can make the best decision regarding supplier management.

## **2.2 Performance Indicators**

It is understood that in order to measure performance, either from an isolated part or from a complex arrangement, the measurements should be concentrated on a manageable set of indicators that eventually produce a combined final index. For Tiago (2017), indicators are measured by cycles and presented at the supplier quality meeting, where they are discussed by a multidisciplinary team that involves several departments such as Quality, Purchasing, Logistics, After Sales and the company's Board.

The methodology for monitoring results through indicators is of great value for measuring any improvement system. This is because it allows the visualization of process oscillations over time. Therefore, the use of indicators in the business world is crucial for several reasons, as they signal what is important, indicating where to ``position`` people so that they know their priorities. They focus everyone's efforts on what matters most, indicating where to make improvements and allocating their time and efforts to maximize return. So, one of the objective of using indicators is to seek the best quality management process to provide adequate analysis and evaluation for decision making. Therefore, the indicators are efficient tools for monitoring changes in the organization and essential for the daily life of managers and administrators, especially when the goal is the search for better levels of competitiveness.

According to Fleury (2000), there is uncertainty in the notion of performance, because sometimes it is not known exactly what should be measured. Pires (2004) defines performance as the quantified information of process outcomes that can be compared with goals, past outcomes, and other processes.

Bititci et al. (1997) stated that the vast majority of researchers believe that there is a need for the formulation of performance measurement systems that include not only financial indicators. Schmidt (2001) states that part of this research arises from the clear need for each company to use measures that are relevant to its own situation.

There are several studies focused on system or organizational performance indicators, such as Van Bellen (2002), Fernandes (2005), Merchant (2006), Machado, Machado, and Holanda (2007), Callado, Callado,

and Almeida (2008), Menezes, Guimarães and Sellitto (2008), etc. A broad study of the characteristics of performance indicators used in research conducted in the fields of Administration, Accounting and Tourism from 2000 to 2008 revealed 24 terminologies (page 381) used involving performance indicators as well as 21 concepts (page 382) extracted from the authors researched by Nascimento et al. (2011).

In this research, the indicators are considered like flags that seek to express and demonstrate the reality in a way that is possible to observe and obtain more concrete data to improve the evaluation, they are considered supportive tools to evaluate processes (FREIRE; CHRISÓSTOME; CASTRO, 2007) and performance indicators are qualitative or quantitative elements used to detail the scope to which objectives or goals have been achieved, observing the timeframe and resources used.

### **2.3 Nonconformities**

To Macedo (2007) nonconformity is a deficiency in a feature, product specification, process parameter, record or procedure that makes the quality of a product unacceptable, undetermined or beyond established requirements. The process of non-compliance is nothing more than non-compliance with specific requirements, below are mentioned ways of finding a non-compliance: a) Internal Quality Audits / Self Inspection (1st part); b) Second party external audits (customers and suppliers); c) 3rd Party Audits (Headquarters, government agency and certification body); d) Follow-up audits; e) Deviations related to suppliers / service providers, inspections and routine testing of products / processes (controls in process); f) Product analysis results; g) Product batch reconciliation; h) Claims; i) Returns; j) Performance Indicator Results; l) Results of the top management review of Quality Management System.

Managing nonconformities, in addition to being a requirement of current legislation, is a critical success factor of the Quality Assurance System. The objective of any good management system is to prevent recurrence of nonconformities and to proactively prevent them from occurring. Each effective action implemented (corrective, preventive or improvement) represents a step forward in the pursuit of continuous improvement of the Quality System.

Excellence in total quality management dictates that any opposition to established procedures, instructions or standards be properly investigated and recorded, together with any necessary corrective, preventive or dispositive actions. However, each company has its quality policy, which establishes its own guidelines regarding the registration of nonconformities. In any case, it is essential to record, investigate and properly treat nonconformities that significantly impact product quality.

### **2.4 Supplier Evaluation Cases**

#### **2.4.1 Indicators for performance evaluation of suppliers in a cosmetics industry**

Komura (2008) proposes a supplier evaluation model where he defines, through interviews with key sectors of the company (purchasing, engineering, quality, planning and manufacturing), the evaluation criteria, which he called external indicators. The data was extracted from the company system. At the end, a combined percentage score was obtained and analyzed according to the goal estimated by the organization. The purpose of the evaluation is to reward suppliers, as well as to seek for quality development practices of the materials supplied, increasingly consolidating the company's supply chain.

#### 2.4.2 Supplier Evaluation Model at the Regional Triticola Santiaguense Ltda Cooperative

Glaserapp et al. (2003) proposed an evaluation model based on the partnership with the purchasing sector of the company from which the data were collected. After collection, the data resulted in the supplier evaluation spreadsheet, where it was organized in a way that allowed the satisfaction measurement provided by the suppliers of the Triticola Cooperative sectors. Taking into account previously established criteria, the analysis performed on the collected data allowed to obtain a knowledge base for the effective management of suppliers. In addition, it provided continuous improvements to the organization's evaluation process, as the results obtained were more focused on a given focus, thus providing subsidies for decisions of specific interest to the company.

#### 2.4.3 Supplier evaluation model through performance indicators

Cavalcanti et al. (2009) proposed a supplier evaluation model based on performance indicators capable of providing the decision maker with fast and quality information. From the criteria defined by the decision maker, an order of alternatives sorted by preferences is established, where scores are given for each criterion and at the end a general performance index for each supplier, called the IDF (Supplier Performance Index), is determined. which is the result of the arithmetic mean of the evaluated criteria, which are: distribution, quality certificates and warranty. Therefore, the adopted model becomes suitable for the company as it contributes positively to the performance of the organization's results and increase of the company's profits, besides enabling partnerships that will assist in the implementation of quality and productivity improvement programs.

#### 2.4.4 Northrop Gromman Supplier Performance Appraisal Model.

The international company Northrop Gromman adopted 4 indicators to evaluate its suppliers, as follows: 1- Quality assessment profile; 2 - Deliveries, 3 - Customer Satisfaction; 4 - Structured process / Lean six Sigma, where a score was assigned, which at the end, is summed, and it is possible to see in a table the general classification of suppliers.

#### 2.4.5 Supplier evaluation model through performance indicators.

The company ALCOA adopted a predefined criterion based assessment system which establishes a score for the supplier depending on the assessed criterion, for example, quality is measured by the PPM criterion, where there are PPM ranges with their respective scores. The main criteria used to evaluate suppliers are: quality (PPM criteria - Parts per million); deliveries (delivery time criteria - <6 days) and service (criteria to evaluate the service provided by suppliers). The benefits of applying Performance Indicators in organizations have drawn the attention of many managers as it helps companies achieve better results through their most effective method (RODRIGUES, 2015).

#### 2.4.6 Supplier Evaluation Model by Performance Indicators

In order to evaluate its suppliers, KODAK adopted certain criteria to ensure that they meet company requirements or even above established levels where a number of criteria are measured including, the minimum performance for a quality management system, product or service, performance measures such



as DPPM, delivery performance, time, and productivity performance. The data that makes up these performance measures is managed across multiple systems. By evaluating these criteria, the company aims to establish a partnership relationship with suppliers, aiming to consistently measure their performance over time, and provide significant results in reducing failures that compromise the quality of the final product.

The Table 1 present a summary of the indicators explored in the previously reported cases.

Table 1 - Cases used to measure supply indicators performance

CASE	Indicators	Definition	Data source	Points
<b>Komura (2008)</b>	1. Wape (Tissue Trend) 2. Compliance with MPS 3. Lack of Material 4. Compliance with MRP 5. Critical Requests 6. Receiving Time	Interviews with key company sectors.	Internal system.	Combined (%) - Goals
<b>Glaserapp at al. (2003)</b>	1. Communication 2. Compliance 3. Purchase and Receipt Documentation 4. Quality 5. Profitability	Defined together with the company team -Proposed goals.	Data collection - purchasing, checking and inventory control.	Satisfaction score (points: 0 to 3)
<b>Cavalcanti at al. (2009)</b>	1. Distribution 2. Quality Certificates 3. Warranty	Defined based on evaluation models and performance indicators.	Internal system	Weights according to importance
<b>Nortrop Gromman Company</b>	1. Quality assessment profile; 2. Deliveries; 3. Customer Satisfaction; 4. Structured Process / Lean six Sigma.	Defined by the company.	Internal registration	Supplier Scorecard Rating Blue: 91-100 Green: 75-90 Yellow: 51-74 Red: 0-50
<b>ALCOA Company</b>	1. Quality (PPM criterion - Parts per million); 2. Deliveries (delivery time criteria - < 6 days); 3. Service (criteria for evaluating the service provided by suppliers).	Defined by the company.	Internal registration	Scoring according to importance and punctuation at intervals.
<b>KODAK Company</b>	1. DPPM; 2. Number of corrective actions requested.	Defined by the company.	Internal registration	Score according to degree of importance.

Source: Author

In addition, the company expects to reduce defects and improve its overall performance, the number of corrective action orders will decrease, productivity will increase and quality costs will decrease and the number of certified suppliers will increase. Utilizing this vendor evaluation system provides year after year satisfaction and improvement in the organization's performance by establishing a vendor base.

### 3. Methodology

The research is applied with a qualitative approach through case study and bibliographic survey. Also, the research was realized a seven years ago as part of a graduate student final project defended in Industrial Engineering Department of Federal Amazon University. Basically, to development a Supply indicator performance evaluation system to Company X, it was necessary seven phases as shown in Table 2.

Table 2 - Research Schedule

PHASES	Dec/12	Jan/13	Feb/13	Mar/13	Ap / 13
Bibliographic Survey	14-20	-	-	-	-
Definition of indicators	-	15	-	-	-
Data Collection	-	-	15	-	-
Data consolidation in spreadsheet	-	-	20	-	-
Data analysis	-	-	-	01	-
Drafting of the Article	-	-	-	10	-
<b>Review and Article Delivery</b>	-	-	-	-	<b>05</b>

Source: Author

#### 3.1 Bibliographic Survey

At this stage, we sought to make the literature review aiming to identify articles and company cases that addressed quality assessment of suppliers.

#### 3.2 Definition of Indicators

After bibliographic survey, it was shown to Company X manager some criterias to develop the indicator system. Since Company X had a computerized internal system, it was proposed as criteria the combination of qualitative and quantitative assessment by historic approach by monitoring the results through performance indicators directly related to the suppliers' performance.

The indicators were established according to the objectives proposed in this article and the feasibility of their application in the company. Then, in a meeting made in January 15<sup>th</sup> 2013 with strategic team from Engineering, Quality, Plan and Purchase sectors, the bellow indicators were defined:

Indicator 1) DPM indicator: defects per million;

Indicator 2) SRR indicator: number of lots returned in relation to the number of lots received;

Indicator 3) SCAR indicator: number of corrective action plans requested to suppliers.

These indicators were established to reduce quality costs related to: a) batch rejection processing costs: can be estimated based on the processing and handling document costs of each rejected batch; b) claims investigation costs: costs associated with human resources and others involved in solving the quality problems detected on suppliers' items; c) receipt inspection costs: these represent an estimate of the receipt inspection costs for a particular item from a certain vendor. The amount of these costs may vary widely, depending on the reputation of the supplier and his previous supplies; d) costs of nonconforming products identified upon receipt inspection: costs incurred in rework, servicing, replacement, machinery adjustment and others if a presented product is nonconforming and is not identified prior to processing or

prior to processing. be delivered to the customer.

It is important to note that the quality cost evaluation system varies from organization to organization, and in organizations that are more updated in terms of management, the group of “few and vital” suppliers is taking into account (addapted from MARINHO & NETO, 1997).

As a guideline of the study, the suppliers present in the company's database were analyzed, according to deliveries made during the period of December/12 to February/13, where the main focus is on incidents related to nonconformities in the materials supplied.

Table 3 - DPM Indicator

Goal	Score Range	
	Range - DPM	Performance (%)
Demonstrate the supplier incident level based on the number of nonconforming parts divided by the quantity of material delivered by the supplier during a given period.	0.00 - 0.00	100%
	1.00 - 50.00	96%
	51.00 - 100.00	92%
	101.00 - 150.00	88%
	151.00 - 200.00	84%
	201.00 - 233.00	80%
	234.00 - 500.00	76%
	501.00 - 750.00	72%
	751.00 - 1,000.00	68%
	1,001.00 - 1,250.00	64%
	1,251.00-1,500.00	60%
	1,501.00 - 1,750.00	56%
	1,751.00 - 2,000.00	52%
	2,001.00 - 2,250.00	48%
	2,251.00 - 2,500.00	44%
	2,501.00 - 2,750.00	40%
	2,751.00 - 3,500.00	36%
	3,501.00 - 4,250.00	32%
	4,251.00 - 5,000.00	28%
	5,001.00 - 5,750.00	24%
	5,751.00 - 6,500.00	20%
	6,501.00 - 7,250.00	16%
	7,251.00 - 8,000.00	12%
	8,001.00 - 8,750.00	8%
	<b>8,751.00 - 10,000.00</b>	<b>4%</b>

Source: Author

### 3.2.1 DPM Indicator: defects per million

This indicator analyzes the results of a process in terms of the number of nonconforming components. Its main function is to demonstrate suppliers' results regarding the number of non-conforming components delivered to the factory. This indicator provides the information to assess whether the supplier is improving its results relative to the number of incidents, as can be seen in Table 3.

DPM shows the number of defective parts or materials delivered by a particular vendor, as a function of the total quantity of parts delivered over a given period. This indicator allows an analysis of the defective

parts against one million components supplied and takes into account all defective parts or materials that have entered the company and have been inspected or used after the production process where the calculation of this indicator can be performed. through the calculation below:

$$\text{DPM} = (\text{Number of Non-Compliant Parts} / \text{Number of Parts Supplied}) \times 1,000,000 \text{ (Equation 1)}$$

### 3.2.2 SRR indicator

This indicator analyzes the results of a process in terms of the number of nonconforming batches. Its main function is to demonstrate suppliers' results regarding the number of non-compliant batches returned. This indicator provides the information to assess whether the supplier is improving its results in relation to the number of incidents, reflecting directly on the assessment of deliveries as can be seen in Table 4.

Table 4 – SRR indicator

Goal	Score Range	
	0.00 - 0.09	100%
	0.10 - 0.34	85%
	0.35 - 0.59	60%
	0.60 - 0.74	45%
	0.75 - 1.00	30%
	<b>&gt; 1.00</b>	<b>0%</b>

Source: Author

### 3.2.3 SCAR indicator

This indicator is considered one of the most important parts of the supplier evaluation and management process, as it is through this step that corrective actions are requested from suppliers for the definitive solution of nonconformities.

Suppliers are formally notified through the Supplier Corrective Action Request (SCAR), where they become aware of the failures arising from the material supplied as well as the impacts generated on the company. In addition, they need to return with action plans answered and implemented for effective noncompliance resolution.

Table 5 - SCAR Indicator

Goal	Score Range	
	0 SCAR issued	100%
	1 SCAR issued	50%
	Entre 2 e 3 SCARs issued	25%
	<b>&gt; 3 SCARs issued</b>	<b>0%</b>

Source: Author

### 3.2.4 General Indicator of Supplier Quality

This indicator aims to classify suppliers from the arithmetic mean of the score achieved in the proposed indicators (DPM; SRR and SCAR), where the result will be classified as Table 6:

Table 6. General Indicator of Suppliers

Ranking	Description	Score
<b>A</b>	Good	91% to 100%
<b>B</b>	Satisfactory	81% to 90%
<b>C</b>	Acceptable	60% to 80%
<b>D</b>	Unacceptable	0% to 59%

Source: Author

### 3.2.5 Data Collection

This phase took place after the definition of the indicators, which sought to understand the operation of the company's system to extract the data needed to propose the indicator system to assess the quality of the company's suppliers.

Although the company had 16,135 registered suppliers, the data collected only applied to active suppliers, who made deliveries or made returns during the period.

### 3.2.6 Data Sheet Consolidation

During this phase the data obtained were organized and structured in a spreadsheet, where indicator formulas were added to optimize the evaluation system.

Data were collected monthly, where in the end data were consolidated in the general indicator for supplier quality rating.

## 4. Results

The results obtained during the collection period allowed to evaluate the quality of the suppliers according to the established criteria, where it was verified that of the 1,310 suppliers evaluated during the period from November/12 to March/13, around 1,236 suppliers were classified with good performance, 29 were classified with satisfactory performance, 9 with acceptable performance and 36 with unacceptable performance, as shown in Table 7.

Table 7. General Indicator

Rank	Description	Score	November/12		December/12		January/13		February/13	
			Total suppliers	Average	Total suppliers	Average	Total suppliers	Average	Total suppliers	Average
<b>A</b>	Good	91% to 100%	246	100%	329	100%	327	100%	334	100%
<b>B</b>	Satisfactory	81% to 90%	5	83%	9	83%	12	83%	3	83%
<b>C</b>	Acceptable	60% to 80%	2	71%	5	66.67%	0	0%	2	70%

<b>D</b>	Unacceptable	0% to 59%	10	21.3%	6	29%	10	23.93%	10	22.9%
<b>Total suppliers evaluated</b>			263	-	349		349		349	

Source: Author

In this sense, it was found that during the study period, in December there was a reduction in the number of suppliers classified in D, with only 6 suppliers, on the other hand, in the following periods the number remained in 10 suppliers in this category.

To better understand and analyze the indicators, the Table 8 shows the stratified data of the general indicator (DPM; SRR and SCAR), where it is possible to check which indicators need the company's attention and action with the supplier.

Table 8 - Indicator stratified data

Rank	Description	Score	November/12			December/12			January/13			February/13		
			DPM	SRR	SCAR	DPM	SRR	SCAR	DPM	SRR	SCAR	DPM	SRR	SCAR
<b>A</b>	Good	91% to 100%	0	0	0	0	0	0	0	0	0	0	0	0
<b>B</b>	Satisfactory	81% to 90%	0	0	5	0	0	9	0	0	12	0	0	3
<b>C</b>	Acceptable	60% to 80%	0	0	12	982,000,000	1	0	0	0	0	0	0	6
<b>D</b>	Unacceptable	0% to 59%	392,500	34.3	45	1,240,212,698	107	13	165,974	54.4	31	238,996	142	50
<b>Total suppliers evaluated</b>			263			349			349			349		

Source: Author

From Table 8, it is noted that the DPM and SCAR indicators need more attention from the organization, as they directly affect the quality indicator of suppliers, since, with the high index, the supplier does not get any score in the respective indicator.

Given the data obtained, the company has the basis for decision making, as well as can act strategically on suppliers who failed to achieve an appropriate score, in other words, help through partnerships suppliers who do not meet expectations. from the company.

From the supplier performance view, the company has a range of options to implement its supplier development and quality improvement programs, where the starting point is the D rated suppliers, which directly affected the costs. quality of the organization as a function of the batches and parts that failed due to nonconformities detected, in addition to issuing SCARs with corrective action request.

The proposed model of indicators makes possible the analysis of the performance of each supplier, allows the organization to monitor the performance of suppliers over time, besides keeping a history to visualize the behavior of the indicators, it will be possible to observe the variations, increase or decrease of the suppliers in their respective classifications. From this analysis, it is recommended that the company look for practices aimed at continuous improvement and align with the evaluated indicators, so that both can move towards the common goal, which is the quality of materials.

## **5. Final Considerations**

The objective of this article is to propose a system of indicators to evaluate the quality of suppliers, in order to enable the relationship continuous improvement among company and its suppliers.

Based in the collection and analyzed data, it was possible to identify six successful cases of suppliers' quality assessment indicators system, which permitted to develop Company X model.

As the company did not authorize the disclosure of supplier names, the evaluation indicator system was generally proposed, where the details of each supplier were provided to the company through the spreadsheet, where the data were consolidated.

Based on the company's need to become a leader in manufacturing services, an indicator-based evaluation system was proposed, in which the criteria were adopted in relation to material quality. In this system, three indicators were defined, where a score was assigned according to the interval criterion. At the end, a general indicator was obtained to assess the quality of suppliers as A (Good), B (Satisfactory), C (Acceptable) or D (Unacceptable) categories.

During academic partnership with company, it was possible to develop a proposal model that does not need a high cost investment to implement it. In the evaluation, it is suggested to company: a) computerize this process; b) to train employees that work in quality material sector; c) to strengthen relationships with current and future suppliers by showing the company's new vision and model. Doing so, undoubtedly the company studied will have a great advance in the field of raw material acquisition, thus obtaining more quality and may be more competitive in the market.

During the construction of this article it was found that the changes suggested with the model generated discomfort in people, because the suggestion of evaluating suppliers led to new activities to be developed, besides the dedication of time for data collection. However this resistance was bypassed by the benefits that the evaluation provided, as well as managers' awareness among employees about the importance of this evaluation system, mainly by assisting in the analysis of suppliers who need help to improve quality levels.

It is suggested for future research, a study on effective strategies to develop strong partnerships between companies and suppliers. The more dialogue and knowledge are shared with whom you negotiate, the more likely the partnership will work.

It is also suggested to company perform a monthly audit on suppliers that have been rated in D category, and request an action plan to improve their indicator for the following month.

In addition, for the company to ensure that the supplier is involved and committed to the quality of the materials provided, it is suggested to realize monthly meetings to present the supplier's score, aiming to establish strategies to improve the indicator over the following month.

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## How to evaluate the services of a small beauty salon in Manaus?

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### Abstract

*The research evaluates the performance of the services provided by the Nivea Mangabeira Space Salon, located in the Redenção district of Manaus City, capital of Amazonas. To this end, for 20 days in November 2019, a questionnaire was applied to 50 clients, containing twenty items referring to the five quality dimensions: Tangible Aspects, Reliability, Responsibility, Assurance, and Empathy. The collected data were analyzed using descriptive statistics and after analyzing the results, it was concluded that empathy is the best performing dimension, indicating that professionals have a great relationship with clients and that they feel very well treated. On the other hand, the Tangible Aspects dimension had the lowest performance, even though the hall structure being considered good, it can be improved. Suggested improvements by respondents include parking, a wider place, offering snacks, courtesies or promotions for birthday people, always having coffee, doing micro-pigmentation wire-to-wire and hiring more professionals for the most demanding days. As for management, it is recommended that managers pursue improvement courses in small and medium business administration at SEBRAE-AM, CETAM or in another establishment, to professionalize its management, leaving a small family-based company to maybe become a national franchise.*

**Key-words:** Perceived Quality, SERVPERF, Satisfaction.

### 1. Introduction

The field of hairdressers and cosmetics has been growing continuously in Brazil. According to data from the Brazilian Association of Personal Hygiene and Cosmetics Industry (ABIHPEC, 2019), the beauty market has advanced about 2% in the last year. In this sense, being recognized the professions of hairdresser, barber, beautician, manicure, pedicure, epilator and makeup artist by law 12.592 / 2012 (SEBRAE, 2017), the beauty salons have drawn attention, as it is estimated that in Brazil there are already five hundred thousand formalized establishments, corresponding to half of the salons in the whole country, since about 48% of the existing ones are informal. By 2021, the number of such establishments is forecast to increase by 4.5% (BEAUTY FAIR, 2018).

Given the increased competition in this segment, the quality of services becomes indispensable in performing the activities of a beauty salon, thus gaining a lasting relationship with the customer (NORONHA et al, 2006 apud RIBEIRO; THIESEN; TINOCO, 2013). In addition to bringing confidence and credibility, maintaining this quality can increase market share, as it is common for customers to refer

and talk about the establishment to their friends, family, as well as on their social media.

This research is a case study focused on Nivea Mangabeira Space, a small beauty salon located in the Midwest of Manaus city that operates in this branch since 2015. The salon has in its staff four professionals, being two hairdressers, who also provide hair removal and eyebrow design services. Two manicurists perform services on the feet and hands of clients. During its existence, the company has always been concerned with providing the best service and meeting the expectations of its customers, offering discounts and performing promotions.

However, in almost 4 years of existence, no methodology has been formalized to assess customer satisfaction of the salon, which hinders the process of continuous improvement of services provided to the public, mostly women.

In this context, the article evaluates the performance of the services provided by the Nivea Mangabeira Space Salon, in order to propose suggestions for improvements.

The specific objectives are a) to develop and test a data collection instrument; b) identify the strengths and points to improve concerning the services provided to the salon customers; c) propose suggestions for improvements.

The key questions in the study are "What is the average level of salon customer satisfaction?" And "what are the strengths of the salon" and "which points need improvement?".

The research is relevant to the salon because from this study it will be possible to visualize the perception of quality that customers have about the services provided and then to improve services.

A similar and update study has not yet been conducted in Manaus, which makes the research relevant also to academia, which can later use the research for classroom discussions or to develop new research or assessment methods.

Finally, there are hundreds of these establishments in Manaus, it can be found on sites "Telelista" such as <https://www.telelistas.net/am/manaus/cabeleireiros+e+institutos+de+beleza>, "Guias" <https://www.guiamais.com.br/manaus-am/institutos-de-beleza/saloes-de-beleza-e-cabeleireiros> or other internet search services. Thus, the research can serve as a benchmark for several beauty salons to apply with adaptation to their reality, becoming another useful tool for the managers of these enterprises.

## 2. Theoretical Referencial

### 2.1 Services

According to Kotler (1998, p. 412) "Service is any act or performance that someone can offer to the other and that is essentially intangible and does not result in ownership of anything."

Grönroos (2009) defines service as a process that contains a series of activities that lead to being intangible and that is most often done directly between a customer and the service provider.

For Bateson (1978), services are characterized by inseparability, in which creation and consumption occur at the same time and with the direct participation of the client; Intangibility, the nonphysical, is not a good or product to be transported or stored; heterogeneity, where there is no possibility of standardization, and a service may have a different result for each customer; and perishability and the service cannot be stored or waited for later, as downtime can have many impacts on the costs of

providing services, not meeting the desired demand.

## **2.2 Services in Beauty Salon**

Service companies like salons have a great interaction between employees and customers, this contact can benefit the establishments since with a more trusting relationship, customers can feel free to expose their perceptions about the service that is being offered. being performed.

Bota (2007), in a survey conducted in Rio de Janeiro, identified five factors most relevant to the quality of attendance. These include freedom to be called by name, level of customer attention, comfort and professionalism. Here it is also worth mentioning the importance of meeting deadlines and shorter time in the execution of the service as competitive factors (JURAN; GRUNA, 1993).

A beauty salon is expected to provide personal, respectful and discreet treatment, always in a friendly, committed manner and with the possibility of making new social interactions. It is also expected to find a variety of services to meet all needs in one place. In addition to providing new products and always being aware of industry innovations, such as health care, products for all skin and hair and sustainability (SEBRAE, 2019).

In the services provided in beauty salons the characteristics of inseparability are evidenced, with the creation and consumption at the same time; the heterogeneity where each service can have a different outcome for each customer, as each skin, hair or nail can react uniquely in contact with the same types of products and the perishability where a customer's loss and downtime directly affects the professional profit.

## **2.3 Customers' satisfaction**

In the business world, the customer is the key to the development of any company. Within the service sector, this perception is even stronger, as quality service is essential to attract the consumer, so the quality of service and service being provided should always be improved, as these concepts are directly linked to satisfaction of the customer.

Costa, Nakata and Calsani (2013), affirm that all care must be done with good treatment to obtain a greater possibility of a sale. Excellence in service is classified as a competitive strategy in the market. Galdino and Silva (2018) affirm that in the case of non-customer satisfaction, the company must be willing to correct its mistakes, always seeking improvement, as this commitment generates credibility with customers. Moreover, customer loyalty can be a decisive factor in the survival of the enterprise within the scenario that is included.

## **2.4 Quality in Services**

For Ferreira (1975 apud MARTINS et al., 2014) service is the product of human activity, which does not assume the form of material goods, but satisfies a need.

According to Campos (2004, p.02), "a quality product or service is one that perfectly, reliably, affordably, safely and timely meets customer needs". Bassan (2018, p. 12) believes that there are several perceptions regarding the concepts of quality, which depend on the situation and the context in which this concept is being inserted since quality can be seen as something subjective.

Quality can be defined as the satisfaction and adequacy of services to customer needs, being directly linked to the concepts of efficiency and effectiveness: do the best possible activity, perform services without errors, meet standards and norms, ensuring compliance or even exceeding customer expectations, thereby seeking positioning concerning competitors.

Parasuraman, Zeithaml and Berry (1985) argue that quality is analyzed by consumers by comparing their expectations with their perception of service performance. It warns that there are differences or gaps between users' expectations and what is offered. In this sense, they proposed that service quality is a function of the differences between expectation and performance/perception throughout the analysis of quality dimensions. To this end, the authors developed a quality of service model based on specific gap analysis, as briefly described in section 2.4.3.

## **2.4 Service Quality Assessments**

Perceived quality and expectation may differ for each person, as each individual has their concepts and values. Therefore, the different quality assessment methods must be raised and adapted for the study to be objective. Some of these methods will be exposed here for comparison purposes.

### **2.4.1 American Customer Satisfaction Index (ACSI)**

The American Customer Satisfaction Index (ACSI) was developed in 1994 by researchers from the National Quality Research Center (NQRC) in cooperation with the American Society of Quality (ASQ).

According to Lopes, Pereira, and Vieira (2009) ACSI is divided into two parts:

- a) the first formed by the antecedents of satisfaction, which is perceived quality, which is the customer's assessment of the service, expectations based on customer wishes, what they expect to receive from the service provider, and perceived value, which is the quality perceived by the market, refers to the price of the service;
- b) The second is formed by the consequences of satisfaction, which are the complaint, which is the result of the customer's dissatisfaction with the service provided, and the loyalty, which is the consequence of the customer satisfaction with a given service, and there is the repetition of the relationship between the client and the professional.

Several studies were developed by using ACSI model (HACKL; SCHARITZER; ZUBA, 2000; JUHL; KRISTENSEN; VILARES; COELHO, 2003; VAN RIZYN et al., 2004; CHITTY; STEVEN; CHUA, 2007) and for further information, the ACSI model with other cases applied into service, trade, and industries can be accessed through the site <<https://www.theacsi.org/>>.

### **2.4.2 European Customer Satisfaction Index (ECSI)**

In 1998, the ACSI-based European Customer Satisfaction Index (ECSI) was developed to measure the satisfaction of the European market.

In this model, satisfaction is also related to antecedent variables, such as business image, which is the external business image in the market, expectation, perceived quality, perceived value, and trust, which is related to image; and to the consequent variables, which are customer loyalty and communication, where after performing the service, where there is word of mouth, often informal (LOPES, PEREIRA, VIEIRA,

2009).

Santos et al. (2017) affirm that the ECSI model relates student satisfaction to antecedent variables - image, student expectation, perceived quality, perceived value and reliability - and consequent variables - loyalty and word of mouth communication.

According to the authors, in addition to the antecedent variables adopted by the ACSI model, the ECSI model considered the antecedent variable Image, which is how the market views the company, reflecting the external prestige of the organization.

Lopes et al. (2009) realized a comparative study between ACSI and ECSI by using a sample with 2145 of customers in the service sector located in the Minas Gerais state (Brazil), finding that ACSI can measure satisfaction more accurately than ECSI.

#### 2.4.3 SERVQUAL Method

Parasuraman, Zeithaml, and Berry (1985) to measure the quality of service, developed the Service Quality Gap Analysis (SERVQUAL). This method states that perceived quality, or customer satisfaction, is the result of the difference between the customer's expectation of the service they seek and the performance achieved after performing this service.

In this model, several characteristics or dimensions are evaluated, being divided into many items that will be scored by customers, showing that the quality of service is influenced by some factors.

It consists of 5 dimensions: tangibility, which relates to the physical aspects of the company; reliability, which is linked to the trust that the client has in the professional and the fulfillment of deadlines; responsiveness, which is related to the responsibility that the company has with the customer, to answer their questions and solve their problems; assurance, which refers to the company's ability to correct errors that may occur in the performance of the service; and empathy, which concerns the care and attention received by the client in performing the service, and this attention is appropriate to each user.

The method is applied in two steps: the first to collect customer expectations regarding the defined dimensions, the second to collect customer perception after the service is performed. After these two steps, there is a difference between performances and expectations.

A negative result in the difference between expectation and performance indicates that customer perceptions are below expectations. A positive score indicates that the professional is offering a service that is higher than expected by the client (COELHO, 2004).

These results can be used as indicators to evaluate the quality of service provided about the evaluated dimension and to propose improvements based on customer dissatisfaction, or higher expectations than performance.

#### 2.4.4 SERVPERF Method

According to Schreider (2018), a new concept of quality was developed by Cronin and Taylor (1994), where quality is conceptualized as a customer attitude.

Cronin and Taylor (1994), based on the Parasuraman, Zeithaml, and Berry (1985) model, affirmed that quality should not be indicated by the difference between expectation and performance, this quality should be measured only by service performance. They concluded that customer satisfaction is directly

linked to the quality of service and this relationship is directly linked to the intention of a new purchase, in the case of customer loyalty or loyalty.

The developed model was named Service Performance (SERVPERF) and uses the same quality definition evaluated in SERVQUAL dimensions. In this way, SERVPERF represents the 5 dimensions of quality subdivided into statements about service performance, where service quality is directly named by the performance perceived by the customer. Being this model more efficient because it reduces the number of statements to be answered by respondents.

The SERVPERF model consists of 22 statements about service performance, representing the five dimensions of quality developed by Parasuraman, Zeithaml, and Berry, creators of the SERVQUAL model. So, for the SERVPERF model, quality of service is represented by equation (1):

$$Q_j = D_j \quad (1)$$

Where:

$Q_j$  = Quality of service assessment against feature  $j$ ;

$D_j$  = Performance perception values for service characteristic  $j$ .

Affirmations are evaluated on a Likert scale ranging from 1 to 7, where 1 represents strongly disagree and 7 represents strongly agree. After applying techniques that analyze the reliability and validity of the instruments, Cronin and Taylor (1994) concluded that the SERVPERF scale has a higher reliability to measure the quality of service than the SERVQUAL scale. Also, it can be said that it is more efficient because it reduces by 50% the number of items that must be evaluated by respondents.

The application of the SERVPERF model can be found in various types of companies, such as in the restaurant sector (SILVA; MEDEIROS; COSTA, 2009), laboratories (GONÇALVES; FREITAS; BELDERRAIN, 2010), in hotels (AQUINO; JERÔNIMO; MELO, 2015), among other applications.

In summary, Miguel and Salomi (2004) reviewed the main models for measuring quality in services and concluded that there is no consensus in the literature on the most appropriate model to measure it from the clients' point of view.

### 3. Methodology

The research has applied nature since the knowledge generated will contribute to the improvement of the services provided by the salon.

Regarding the objectives, the research is descriptive because the knowledge related to quality assessment models is already known, there is only a shortage of its applicability in beauty salons in the city of Manaus.

Thus, the research will contribute to describing the profile of customers and their perception regarding the quality of services generated. Importantly, the statistics to be applied will be descriptive without changing the value of the variables during the process of data collection and analysis.

Regarding the approach, the study is combined (qualitative and quantitative) with the use of procedures involving bibliographic research, case study and survey application along with a questionnaire and



interviews.

The development of the questionnaire and the field research were based on the SERVPERF model, which was chosen due to its simplicity of application, since inside a hall, many clients are in a hurry or maybe after a moment of relaxation, so as not to take them too long, this could affect their participation.

Adaptations were made to the model to provide better understanding and agility in responding to the statements.

The research steps were:

- a) Bibliographic survey: from September 1<sup>st</sup> to October 25th, 2019;
- b) Development of the data collection instrument: October 25-30, 2019;
- c) Target audience definition and sample size: November 1, 2019;
- d) Conduct of the pilot test: October 26, 2019;
- e) Performance of the definitive test: from October 31 to November 21, 2019;
- f) Calculation and analysis of data: from November 17 to 22, 2019.
- g) Preparation and review of the article: August 15 to November 22, 2019.
- h) Translation and submission of the article to the journal: November 23-25, 2019.

### **3.1 Data Collection Instrument Development (Questionnaire)**

A questionnaire (Appendix) was divided into 3 sections:

Section 1) Demanded service: where the respondent marks the service performed in the salon;

Section 2) Customer Satisfaction Assessment: Containing 5 dimensions: Tangible Aspects (Facilities), Reliability, Responsibility, Assurance, and Empathy, each with 4 evaluative items, totaling 20 items.

The items listed in the questionnaire were chosen from bibliographic searches in similar articles and research and discussed with the project management team.

For each item, the respondent was asked to rate from 1 to 10 using the Likert Scale:

1 or 2 = Very Bad; 3 or 4 = Bad; 5 or 6 = Regular; 7 or 8 = Good; 9 or 10 = Excellent.

When the item did not apply to the customer, he could answer NA (Not Applicable)

Section 3) Employee Profile: The respondent recorded information on gender, age, monthly personal income, educational level, and suggestions for improvement.

### **3.2 Sample Size Definition**

The administrative staff did not know the exact number of clients, but the average number was 111 clients per month, ie, an average of 4 clients per day during the 26 days worked.

Although no inferential statistics will be made, the sample size was determined using the *SurveyMonkey* calculator, using the 90% confidence level and a 9% error margin. Thus the minimum sample required is 48 responses.

### **3.3 Pilot Test Application**

To check the comprehensibility level of the questionnaire, it was applied during one day (October 26,

2019) in the salon, with 4 answers delivered correctly. Throughout the interview, it was noticed the need to make some improvements in the questionnaire, to then perform the definitive test.

### **3.4 Definitive Test Application**

The questionnaire was applied in a printed manner and was delivered to clients after performing some service between October 31 and November 21, 2019.

The questionnaire was explained and each client was given a space to respond to not influence the responses, as the respondent might feel inhibited and consequently not express their opinion honestly about the service evaluated.

An interview was also conducted through *WhatsApp* on November 15, 17 and 21, 2019, to collect more answers.

## **4. Discussion**

Fifty valid responses were collected, representing almost half (45%) of the approximate total of loyal customers who attend the salon monthly.

The data were entered in a spreadsheet to be analyzed, aiming at the organization of the following topics:

4.1 profile of respondents and demanded services; 4.2 analysis of overall dimension performance; 4.3 performance analysis by dimensions; 4.3.1 tangible aspects; 4.3.2 reliability; 4.3.3 responsibility; 4.3.4 assurance; 4.3.5 empathy; 4.4 five highest-performing items; 4.5 five poorly performing items and finally 4.6 suggestions for improvements.

### **4.1 Respondent profile**

Regarding the profile of the respondents, it was observed that: regarding gender, most (98%) are female and only 2%, male.

Concerning the age group of respondents, 30% are between 18 and 30 years old, 24% are between 31 and 40 years old, 28% are between 41 and 50 years old and 18% are over 50 years old.

About monthly personal income, 19.57% have an income of up to 1 minimum salary, 23.91% have income between 1 and 2 minimum salaries, 41.30% have income between 3 and 4 minimum salaries and 15, 22% of respondents have income above 4 monthly minimum salaries.

Regarding the last level of education, most (46%) of respondents have completed higher education, 14% incomplete higher education, 28% complete high school, 10% incomplete high school and 2% completed elementary school.

Concerning the service demanded (Figure 1), it can be seen that a good portion of respondents (43.75%) go to the salon to receive more than one service, sometimes doing Manicure & Pedicure, sometimes doing a combination of other services. About do only one service, it was found that Eyebrow Design (27.08%) and Hairdressing service (20.83%) were the most demanded. On the other hand, the lowest demand for only one service was Manicure (2.08%) and Wax (2.08%).

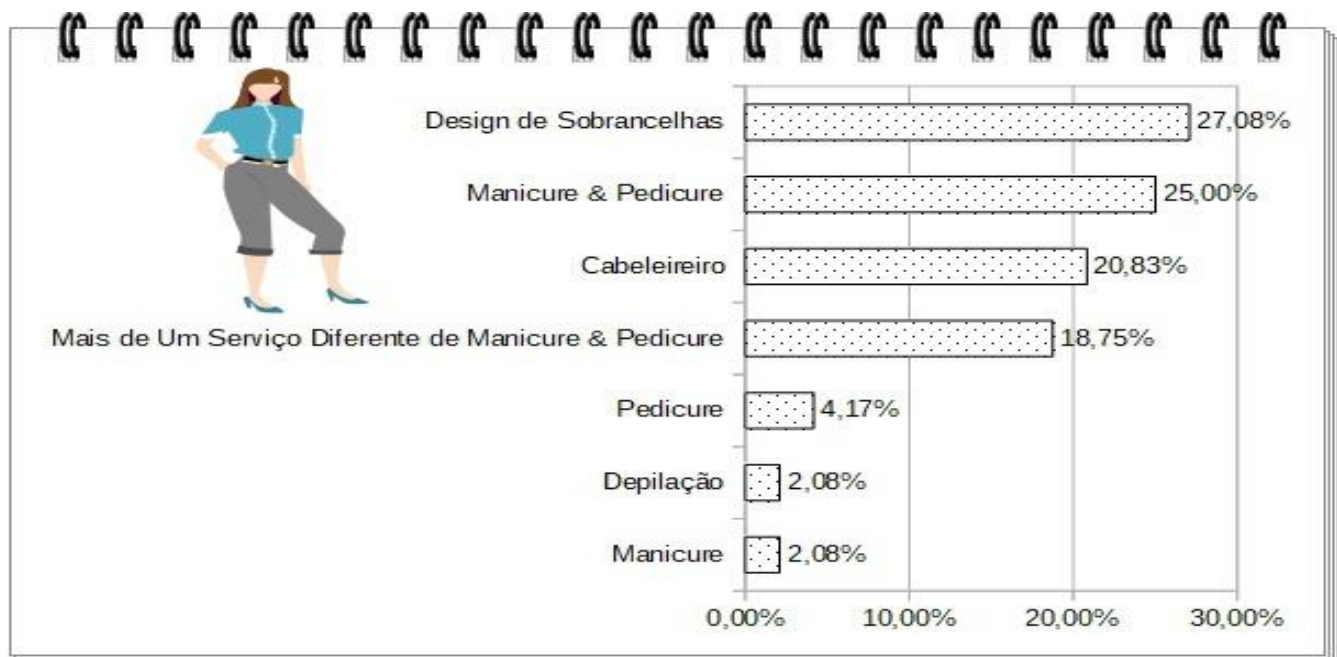


Figure 1: Services required by 50 respondents in November 2019

Source: Author

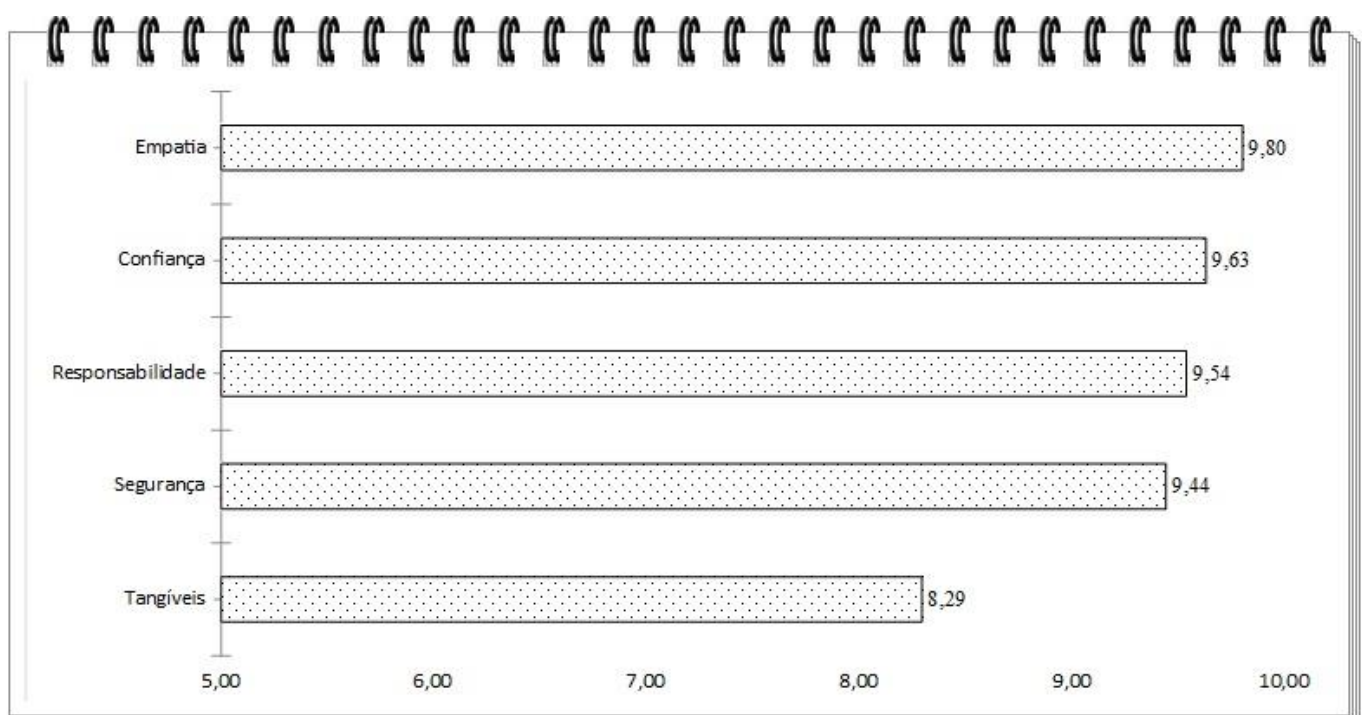


Figure 2: Overall Performance (Average) of the Five Dimensions

Source: Author

#### 4.2 Overall Dimension Performance Analysis

From the answers obtained (Figure 2), it is considered that the average level of customer satisfaction of the salon is considered high since it obtained 9.29 points with a standard deviation of 1.37.

From Figure 2 it can be seen that the dimension of lowest performance was Tangible Aspects ( $X = 8.29$ ;  $S = 2.30$ ), followed by Assurance ( $X = 9.44$ ;  $S = 0.96$ ), Responsibility ( $X = 9.54$ ;  $S = 0.83$ ), Reliability ( $X = 9.63$ ,  $S = 0.69$ ) and Empathy, with higher performance ( $X = 9.80$ ,  $S = 0.51$ ). This last dimension

presented the least dispersion of the results.

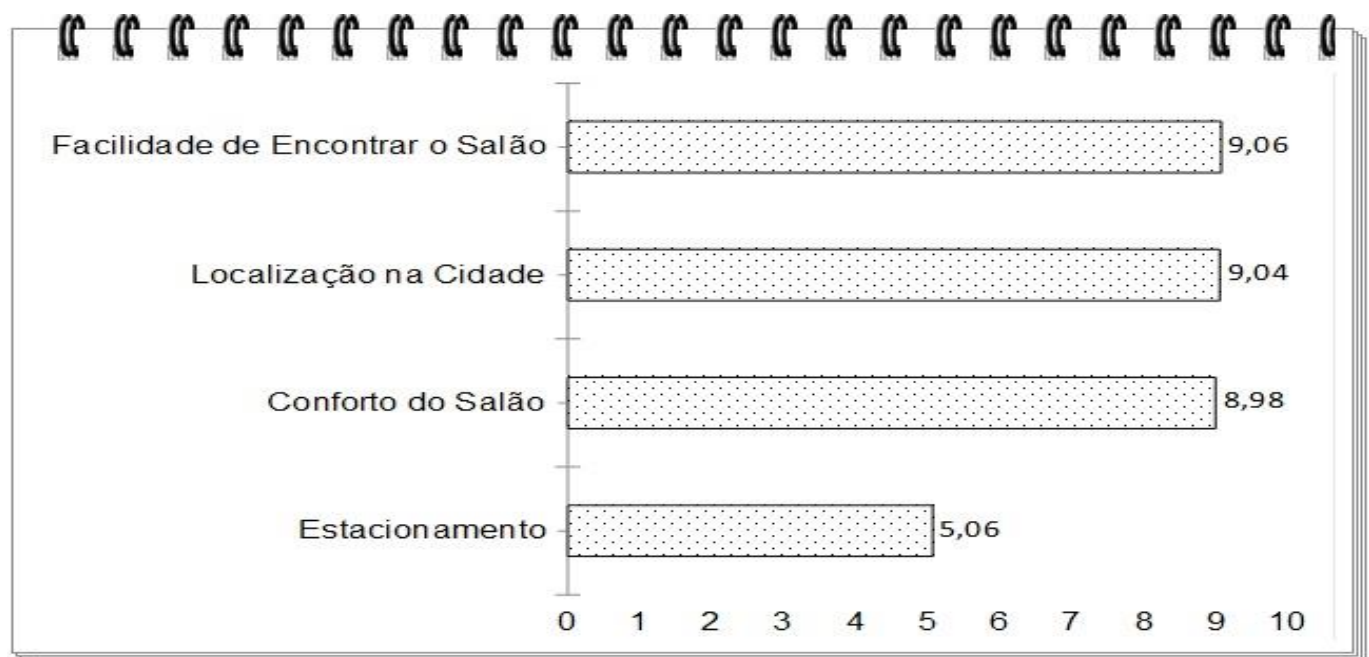


Figure 3: Items Average of Tangible Aspects Dimension

Source: Author

### 4.3 Performance Analysis by Dimension

#### 4.3.1 Tangible Aspects

In this dimension are evaluated the equipment, facilities, and location of the hall.

The results of Figure 3 indicate that the item with the lowest performance was parking, ( $X = 5.06$ ,  $S = 3.22$ ), a value considered regular, being the only item with an evaluation below 8 points, which needs to be improved.

The comfort of the salon was considered between good and excellent ( $X = 8.98$ ;  $S = 1.24$ ), while the location and ease of finding the salon were considered excellent for respondents, perhaps because they are already loyal customers and know the establishment, perhaps because they also live nearby.

#### 4.3.2 Reliability

This dimension is evaluated the level of confidence that the client has with the professional who works in the salon. It can be seen (Figure 4) that the evaluation was generally considered excellent.

The underperforming item was "Service Execution Time" ( $X = 9.26$ ;  $S = 0.99$ ), followed by the items "The product used was adequate" ( $X = 9.69$ ,  $S = 0.55$ ), "The professional is able to perform the service" ( $X = 9.78$ ,  $S = 0.46$ ) and "Satisfaction with service outcome" ( $X = 9.78$ ,  $S = 0.51$ ).

This dimension obtained the second-highest average among the others ( $X = 9.63$ ,  $S = 0.63$ ).



Figure 4: Items Average of Reliability Dimension

Source: Author

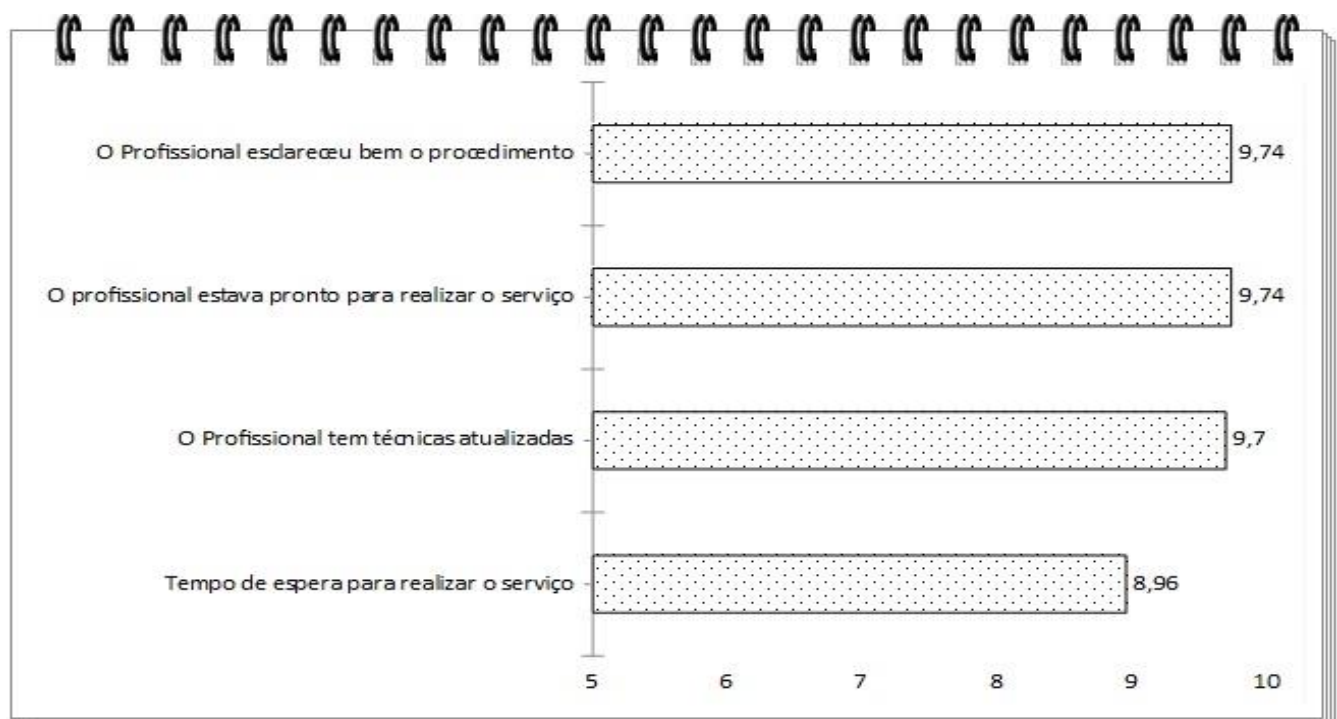


Figure 5: Items Average of Responsibility Dimension

Source: Author

#### 4.3.3 Responsibility

Overall, the dimension performance was excellent ( $X = 9.54$ ;  $S = 0.70$ ), with only one item with an average below 9. This dimension evaluates the professionals' commitment to offering the best services, in a shorter time and evaluates if the professional has updated techniques.

The results of Figure 5 indicate that the item “Waiting time to perform the service” obtained the lowest

evaluation ( $X = 8.96$ ;  $S = 1.23$ ), followed by the items “The professional has updated techniques” ( $X = 9.70$ ;  $S = 0.51$ ), “The professional clarified the procedure well” ( $X = 9.74$ ;  $S = 0.49$ ) and “The professional was ready to perform the service” ( $X = 9.74$ ;  $S = 0.56$ ).

#### 4.3.4 Assurance

The Assurance dimension is characterized by the client's confidence that the salon is complying with hygiene and health procedures and performing the service that it has set itself to perform as well as it is related to the client's sense of security regarding Hall location.

This obtained an excellent evaluation ( $X = 9.44$ ;  $S = 0.86$ ), considered the fourth highest evaluated dimension.

From Figure 6 it can be seen that in this dimension, the item that obtained the lowest performance was the “Sensation of safety regarding the location” ( $X = 8.94$ ;  $S = 1.27$ ), an evaluation that can be improved. The following items were “Availability to perform the service”, ( $X = 9.46$ ;  $S = 0.99$ ), “The professional took care of health procedures” ( $X = 9.58$ ;  $S = 0.76$ ) and “The material used was adequate” ( $X = 9.78$ ;  $S = 0.42$ ) indicating that clients feel safe in the procedures performed by salon professionals.

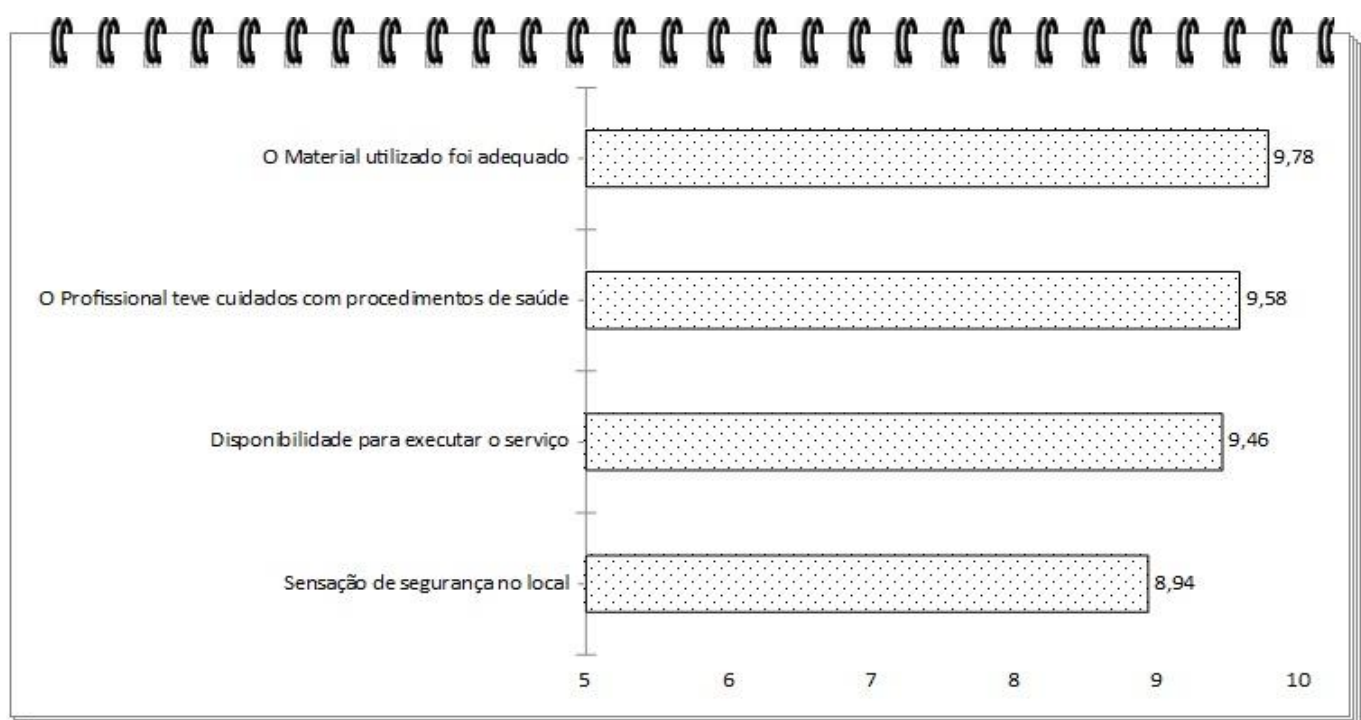


Figure 6: Items Average of Assurance Dimension

Source: Author (2019)

#### 4.3.5 Empathy

This was the highest performing dimension (Figure 7). It can be characterized by the courtesy of the professional when performing a service. The item with the lowest performance in this dimension was “Professional showed interest in attendance” ( $X = 9.78$ ;  $S = 0.58$ ), followed by “Professional was polite” ( $X = 9.80$ ;  $S = 0.57$ ), “The service was adequate” ( $X = 9.80$ ;  $S = 0.45$ ) and “The professional paid attention during the service” ( $X = 9.82$ ;  $S = 0.44$ ).



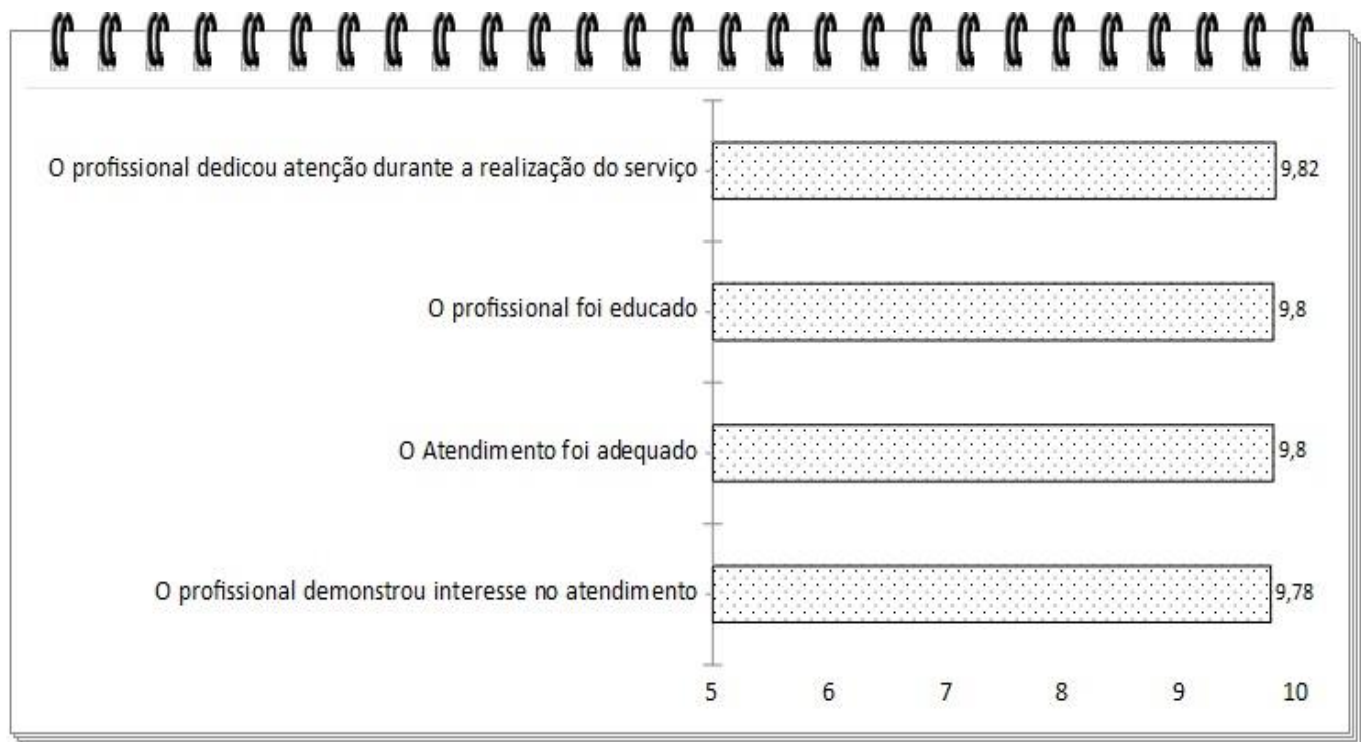


Figure 7: Items Average of Empathy Dimension

Source: Author

#### 4.4 Top Five Performance Items

After calculating the averages and standard deviations of each item, a ranking was prepared with the highest performing items, and then the five items that obtained the best scores were chosen, regardless of size.

Table 1 points out that the best items are strongly linked to the human relationship, highlighting the items: The professional paid attention during the performance of the service ( $X = 9.82$ ;  $S = 0.44$ ), the service was adequate ( $X = 9.8$ ;  $S = 0.45$ ), the professional was polite ( $X = 9.80$ ;  $S = 0.57$ ), satisfaction with service outcome ( $X = 9.78$ ;  $S = 0.51$ ) and the professional showed interest in attendance ( $X = 9.78$ ;  $S = 0.58$ ).

Table 1: Top Five Performance Items

Item	(X)	(S)
The professional paid attention during the performance of the service	9.82	0.44
The attendance was adequate	9.80	0.45
The professional was polite	9.80	0.57
Satisfaction with service outcome	9.78	0.51
The professional showed interest in attendance	9.78	0.58

Source: Author

#### 4.5 Five Lower Performing Items

Another classification was also elaborated to identify the five lowest-performing items. Table 2 points out that Parking is the item that needs to receive more attention from salon managers ( $X = 5.06$ ;  $S = 3.22$ ), the only item in the entire questionnaire with an average below 8.

The other items with the lowest scores were rated above 8.94 points, involving from this sense of security

about the local to the location in the city.

Table 2: Five Lower Performing Items

Item	(X)	(S)
Parking	5.06	3.22
Sense of security about the local	8.94	1.27
Waiting time to perform the service	8.96	0.99
Comfort	8.98	1.24
Location in the city	9.04	1.05

Fonte: Autor

#### 4.6 Suggestions for improvements

From this information, the following suggestions for improvement were proposed:

- About “parking”, it is suggested to search for a commercial point that has parking and that is of better access since the hall is located in the main street of the Redenção neighborhood, with high traffic of cars and buses, which makes it difficult for customers to park their vehicles nearby;
- Concerning the “sense of security about the place”, a partnership with Sebrae-AM, the local Civil Police, is recommended to identify strategies to improve not only this item but others as well. Besides, the need for the use of Personal Protective Equipment (PPE), the search to properly dispose of solid waste, separating them into different bags, as well as to have sanitary licenses and other certifications to improve the image establishment to customers and community;
- Regarding the “waiting time to perform the service”, it is suggested to program a time to clients, with sharing of schedules between them, so that everyone has access to information regarding the hours since the non-compliance with the schedule by the client could affect the financial result expected by the professional performing the service. It is also suggested to hire more professionals for the most demanding days of the salon. Another recommendation is an investment in technology and training for the company to create a customer database, the services they receive, etc. This information is important to cultivate and improve the relationship with users, and at the beginning of the survey, it was difficult to access customer information because of not having this local organization;
- As for the “comfort of the salon”, this can be resolved by changing the commercial point and renovating the salon furniture. With increasing space could also be offered larger and more comfortable furniture to customers;
- Regarding “location in the city”, once again, the change of commercial point would be the best solution. Despite being located on the main street of the neighborhood, the high traffic in the area affects customer comfort in terms of location, making it easy to find but difficult to drive around and park their vehicles.

## 5. Conclusion

This article aimed to evaluate the performance of the services provided by the Nivea Mangabeira Space Salon, in order to propose suggestions for improvements.

For this, a questionnaire was elaborated consisting of 20 items adapted from the SERVPERF model, as



well as 5 multiple choice questions to identify the customer profile, the most sought after services and suggestions for improvement.

From the collected data, it was observed that empathy is the dimension with the best performance among the five dimensions evaluated. This indicates that professionals have a great relationship with clients and that they feel very well treated. On the other hand, the Tangible Aspects dimension had the lowest performance, which indicates that the hall structure is good but can be improved.

The five items with the highest performance were: satisfaction with service outcome, the professional showed interest in the service, the professional was polite, the service was adequate and the professional devoted full attention during the performance of the service.

It can then be expected that the customer's trust in the professional and excellent service with dedication and respect are the requirements for customer loyalty in the establishment.

Also, the five items that had the lowest performances were: parking, sense of security regarding the location, waiting time to perform the service, comfort of the salon and location in the city, most related to tangible and safety aspects.

The most relevant suggestions for improvements were: relocating to a better-located, easier-to-reach area with less vehicle traffic and parking, scheduling services and hiring more professionals on busy days to reduce time waiting for the customer.

Suggested improvements suggested by respondents include parking, a wider place, offering snacks, courtesies or promotions for birthday people, always having coffee, doing micro-pigmentation wire-to-wire and hiring more professionals for the most demanding days.

As for management, it is recommended that managers pursue improvement courses in small and medium business administration at SEBRAE-AM, CETAM or in another establishment, to professionalize its management, leaving a small family-based company for a national franchise.

After applying the improvements, further evaluation is recommended to resize the level of customer satisfaction with the salon. In this sense, it is necessary to have a broader survey, with a long time of data collection, also trying to listen to customers who appear in the salon eventually, since most of the 50 respondents are former clients of the establishment that attended the collection period of data. As a suggestion for improvement, we recommend conducting another survey with a larger sample, trying to identify the main reasons why older customers continue to use salon services to try to identify which criteria they use to keep coming the services.

Finally, it is concluded that for the 50 respondents interviewed, the average level of customer satisfaction of the salon is considered excellent, but there are still opportunities for improvement, in this sense the suggested recommendations can help the salon to increase the client portfolio and improve its image to the community in which it operates.

## **6. Acknowledgments**

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## APPENDIX - QUESTIONNAIRE

All information will be treated confidentially for research purposes.

### Section 1: SERVICE DEMANDED

- a) Hairdresser b) Manicure c) Pedicure d) Manicure & Pedicure e) Wax f) Eyebrow Design  
g) More than one service than Manicure & Pedicure

### Section 2: SATISFACTION LEVEL ASSESSMENT

Please rate your satisfaction level with each item from 1 to 10 below:

Scale: 1 or 2 = Very Bad; 3 or 4 = Bad; 5 or 6 = Regular; 7 or 8 = Good; 9 or 10 = Excellent; NA

Dimension	Items	Answer
Tangible Aspects (Installations)	1) Location in the city	
	2) Parking	
	3) Ease of finding the Salon	
	4) Comfort	
Reliability	5) The professional can perform the service	
	6) The product used was adequate	
	7) Service lead time	
	8) Satisfaction with service outcome	
Responsibility	9) The professional clarifies the procedure well	
	10) The professional was ready to perform the service	
	11) The waiting time to perform the service	
	12) The professional has updated techniques	
Assurance	13) The material used was adequate	
	14) Availability to perform the service	
	15) The professional took care of health procedures	
	16) Sense of security about the local	
Empathy	17) The professional was polite	
	18) The professional showed interest in attending	
	19) The attendance was adequate	
	20) The professional paid attention during performing the service	

### Section 3: EMPLOYEES PROFILE

Gender: Female ( ) Male ( )

Age range: a) Between 18 and 30 b) Between 31 and 40 c) Between 41 and 50 d) Over 50

Monthly Personal Income:  
(in min. salary) a) 1 b) Between 1 and 2 c) Between 3 and 4 d) Above 4

Last level of education a) Incomplete Elementary School b) Complete Elementary School  
c) Incomplete High School d) Complete High School  
e) Incomplete Higher Education f) Complete Higher Education

Thank you for your participation. Feel free to suggest improvement proposals:

Source: Adapted from Ferreira (2017)