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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-8, ISSUE-12 of IJIER*** which is scheduled to be published on **1st December 2020.**

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 screensed 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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Biomethane Generation Produced in Municipal Landfill

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Abstract

Biogas emerged as a renewable technology that converts waste organic matter into energy. Among its components, in terms of energy, methane is the most important chemical composition, particularly for the combustion process in vehicle engines. The use of methane derived from organic matter residues in landfills to replace fossil fuel minimizes the environmental impact, providing a significant reduction in the emission of greenhouse effect gases,as does the use of the amount of urban waste generated by the population in a planned way, with a specific technological focus at the forefront of generating solutions for ecological, social, economic and management challenges, which are themes that characterize smart cities. Thus, this study is based on the investigation and analysis of the potential of biogas generated by the theMunicipal Landfill West of Caucaia (MLWC - AterroSanitário Municipal Oeste de Caucaia/CE (ASMOC))with the objective of estimating the amount of methane gas produced in the referred landfill, based on data already published related to the amount of solid waste disposed at the landfill and applying it in the Biogas - Energy Generation and Use Aterro(version 1.0) software, developed by the Environmental Company of the State of São Paulo (ECSSP - Companhia Ambiental do Estado de São Paulo (CETESB)).As main outcomes, it was found that the landfill can generate, between the years 2018 to 2034, more than 3 million m³of CH4, capable of supplying more than 201,362 vehicles fuel.

Keywords: Biogas, biomethan, renewable energy, smart cities.

1. INTRODUCTION

Since the industrial revolution, the demand for energy has grown every year around the world. According to Tolmasquin (2012), in Brazil, for the next decade, there will be an increase of 5.3% in energy per year, reaching a 372 million tons of oil equivalent.

The National Energy Balance (NEB – BalançoEnergético Nacional (BEN)) issued by the Ministry of Mines and Energy – MME (Ministério de Minas e Energia (MME)) 2019, reported that in 2018 the amount of carbon dioxide (CO2) emitted in Brazil reached 416.1 million tons of CO2 equivalent (Mt CO2 -eq), with the transportation sector accounting for 46.3% of this total, followed by the industrial sector, with 24.9%. Therefore, fossil fuels need to be replaced by clean, renewable energy sources in order to reduce emissions of greenhouse effect gases and carbon dioxide (NAHAWI et. Al, 2010). Faced with this scenario, biofuels gain prominence as a way to solve the world demand for energy and reduce the annual

depletion rate of the world quantity of oil reserves, currently the main supplier of about 88% of the global energy (DADA and MBOHWA, 2017).

Another important point to emphasize is the growing presence of society in the urban area: according to a study by the United Nations (UN), more than half of the population on the planet (54.6% or 3.6 billion people) live in cities. This study indicates that, in 2050, 70% of the global population will live in cities (UN-Habitat, 2015). According to Rodríguez-Bolívar (2015), with the growth of cities, there is a concern by government officials to elaborate complex systems on key themes such as, for example, sustainable development, education, energy and environment, security and public services, among others. In view of this, an important theme to gain prominence from the government is related to the planning, management, and sustainability of urban waste. Thereby, as maintained by Vilaca et. al. (2014), projects aimed at creating infrastructure for the development of so-called *Smart Cities* are becoming a reality in several parts of the world, where a need for change in the energy sector is identified with a view to integrating renewable sources into the energy matrix.

With that, biofuel emerges as a clean and smart alternative to this aggravating factor in cities, as it is a product generated from common and available biomass sources, and its application circulates carbon between air and fuel, in addition to simultaneously solving problems related to the greenhouse effect and power shortages.

As stated by Qian et. al., (2017), most biofuels, such as biodiesel and ethanol, have physicochemical properties suitable for effective combustion in internal combustion engines, with or without minor modifications. In particular, most biofuels contain a certain proportion of molecular oxygen that can help fuel combustion.

In fact, the application of biofuels in internal combustion (IC) engines is already successful. For example, bioethanol has been widely used as a renewable substitute for gasoline in spark ignition (SI) engines (GALBE AND ZACCHI, 2002; HANSEN et al. 2005). Recently, a biogas preparation and application has been extensively studied (BOHUTSKYI and BOUWER, 2013; ESEN and YUKSEL 2013, ONWUDILI et al. 2013).

Jury et al. (2010) studied the life cycle of biogas production and compared it with that of natural gas, finding that, on human health and the ecosystem, biogas is not competitive enough with natural gas. However, biogas is competitive in relation to the effects of climate change, damage to resources and fossil energy demands. Divya et. al., (2015) summarized the preparation of anaerobic digesting biogas, noting that the inventions of specialized multistage digesters allow the monitoring, sampling and control of the main parameters, such as pH, temperature and speed of loading, which is a benefit for the conversion of biogas.

Nowadays, biogas is produced worldwide on a large scale. This production occurs from the anaerobic digestion of organic matter present in solid waste, sewage sludge, manure, among others. Its potential use as a source of clean energy has been emphasized in recent years (APPELS et al. 2008 and PETERSSON et al. 2009).The large volume of residues from agriculture and livestock exploration, sewage station and domestic treatment shows a high pollutant load that imposes the application of solutions that allow the reduction of damages caused to the environment, using as little energy as possible throughout the process (PECORA, 2006).

Based on this scenario, the present study proposed a survey on the amount of biogas generated in the Municipal Landfill West of Caucaia (MLWC - AterroSanitário Municipal Oeste de Caucaia/CE (ASMOC)) per year and on its potential use in the vehicle fleet as a substitute for fossil fuels, where, in reality of the current scenario, there is a need to change the energy sector in order to integrate renewable sources into the energy matrix. Thus, the use of solid waste to generate biogas refers to the development of so-called smart cities.

2. METHODS AND MATERIALS

The first phase of the work was to carry out a bibliographic and documentary review, specially in the libraries of the Federal University of Ceará (FUC – Universidade Federal do Ceará (UFC)), the State University of Ceará (SUC – UniversidadeEstadual do Ceará (UECE)) and the Federal Institute of Education, Science and Technology of Ceará (FIEC – Instituto Federal do Ceará (IFCE)), as well as collecting data and information from the State Environmental Superintendence (SES - SuperintendênciaEstadual do MeioAmbiente (SEMACE)), the Municipal Cleaning and Urbanization Company (MCUC -Empresa Municipal de Limpeza e Urbanização (EMLURB)) and the Secretariat of Infrastructure (SEINFRA - Secretaria da Infra-estrutura (SEINFRA)). In this sense, it is worth noting that:

- **SES (SEMACE) -** It is the main body responsible for the environmental licensing of potentially polluting enterprises in the State of Ceará and, therefore, it was responsible for licensing the Metropolitan Landfill West of Caucaia (MLWC), object of this study.
- **MCUC (EMLURB) –**It is responsible for part of the solid waste management system in Fortaleza;
- **SEINFRA (SEINFRA) -**It is responsible for the policy for monitoring the disposal of solid waste in the Metropolitan Region of Fortaleza.

As for the nature of the data, the main technical reports of these bodies were used and the period from 2018 to 2034 was used as reference, data compiled from the tables presented by SES (2017) on the basis of the Metropolitan Region of Fortaleza data - A (MRF – RegiãoMetropolitana de Fortaleza (RMF-A)).

The estimation of the biomethane potential of the Municipal Landfill of the West of Caucaia, from 2018 to 2034, was performed using the method developed by the Environmental Company of the State of São Paulo (ECSSP -Companhia Ambiental do Estado de São Paulo (CETESB)), within the scope of the agreement with the State Environment Secretariat São Paulo (SES/SP - Secretaria do MeioAmbiente do Estado de São Paulo (SMA/SP)) and the Ministry of Science and Technology (MST - Ministério da Ciência e Tecnologia (MCT)), the Biogas - Energy Generation and Use (Aterro - version 1.0) software.

2.1.Biogas - Energy Generation and Use (Aterro - version 1.0) software.

The Biogas - Energy Generation and Use (Aterro - version 1.0) software uses a mathematical model used by the United States Environmental Protection Agency (USEPA) to estimate methane generation at landfills in the United States. In the model, the methane generation estimate is made for each year of waste

deposition at the landfill, according to equation 4, available in the Manual for the Biogas - Aterro 1.0 software (CETESB; SMA-SP; MCT, 2006).

$$Q_{CH_4} = K \times R_x \times L_0 \times e^{-k(x-t)} \quad (4)$$

Where:

Q_{CH4}– is the flow of methane generated in year x by urban solid waste (USW) deposited in year T [m3CH4 / year];

K - decay constant [1 / year];

R_x- waste flow in year x [kg_{USW}];

L_0- methane generation potential [m^3biogas/kg_{SWD}];

t -year of waste disposal at the landfill [year];

x - current year [year];

According to this model, the generation of Garbage Gas (GG) is the result of the anaerobic degradation of USW deposited at the landfill, reaching a maximum value in the year of its closure (period in which the reception of garbage ceases) and declining over the years subsequent. The efficiencyofbiogascollectionwasadoptedand 75%.

2.1.1. Constantes

As seen, in order to estimate methane generation, it is necessary to know some constants such as: decay constant and generation potential, which are described below according to the place of study.

- **Decay constant (K):**

The K value defines the time interval for the generation of methane from the deposition of waste. According to Mendes and Sobrinho (2007) the decay constant is a function of factors such as nutrient availability, pH, temperature and, mainly, humidity. The suggested values for K can vary from 0,01 $year^{-1}$ to 0,09 $year^{-1}$. Therefore, it is possible to choose a K value as a function of precipitation, according to Table 6.

Table 6- Suggested values for K.

Annual rainfall (mm)	***Values of k (1 / year)***		
	Relativelyinert	Moderatedecomposition	High decomposition
250	0,01	0,02	0,03
250-500	0,01	0,03	0,05
500-1000	0,02	0,05	0,06
1000	0,02	0,06	0,09

Source: World Bank(2004).

The Municipal Landfill of the West of Caucaia, which, according to data from the Climate-date, has an average annual rainfall that corresponds to about 1326 mm. Therefore, to perform the estimation calculations, the value of 0,09 $year^{-1}$.

- **Methane generation potential (L0):**

The variable L0 presents values that orbit between0,001 $m^3_{CH4biogas}/kg_{USW}$ for low organic waste, and 0,312 $m^3_{CH4biogas}/kg_{USW}$, for very organic waste (CETESB; SMA-SP; MCT, 2006).

The Biogas, generation and energy use - Aterro 1.0 software - suggests values for L_0 taking into account the representativeness of organic matter in relation to the history of waste disposal at the landfill. Thus, according to the gravimetric composition, the portion of organic matter corresponds to approximately 35% of the landfilled waste. Therefore, thechosenL_0valuewas0,12 $m^3_{CH4biogas}/kg_{USW}$.

2.2. Estimated fleet of fueled vehicles

The methodology used to calculate the number of cars fueled by the biomethane production of the chosen landfill was based on the ABNT NBR NM ISO 11439/2019 regulation - Gas cylinders - High pressure cylinders for the storage of natural gas as fuel on board of automotive vehicles.

This Regulation establishes the minimum requirements for light, refillable cylinders, for exclusive use in storage on board high-pressure natural gas, as fuel for motor vehicles, to which the cylinders must be attached. The service conditions of these cylinders do not cover the external loads that can occur in the event of collisions between vehicles, etc.

The 15 m³ cylinder (option most installed in automobiles) was chosen, which is equivalent to about 21 liters of gasoline or 28 liters of ethanol, thus dividing the biomethane generated in the landfill and the volume of the installed gas cylinder, according to Equation 5

$$.Fueledvehicles = \frac{Flowestimate}{standard\ 15\ m^3\ cylinder} \quad (5)$$

3. RESULTS AND DISCUSSIONS

In this chapter, initially the landfill design and characteristics and the history and future estimate of urban solid waste (USW) found in the literature at MLWC will be presented, in addition to the results obtained in the technical analysis of the use of biogas from the landfill using the Biogas - Energy Generation and Use (Aterro - version 1.0) software.

3.1. Study area characterization

The study area of the present work is the Municipal Sanitary Landfill west of Caucaia (MLWC), Figure 20, which is located on highway BR-020, city of Caucaia, state of Ceará - CE. Currently, the landfill serves the cities of Fortaleza and Caucaia and was designed for the final disposal of Class II solid waste. The landfill has an area of 123 hectares, of which 78 hectares are destined to receive USW. The way in which USW is disposed occurs by the trench or ditch method and by the area method (LINARD, 2010).

Figure 20 - Aerial photography of MLWC.

Source: Google Earth (2020).

According to Linard (2010), the MLWC was built by the Government of the State of Ceará in 1990, initially conceived to receive the USW in the city of Caucaia / CE. However, in 1998, through a legal instrument called the Term of Assignment of Use of the Government of the State of Ceará, the MLWC also became the place of deposition of the USW of Fortaleza on condition that it bears all the administrative and operational costs from that, exempting Caucaia from any burden.

In accordance with the Environmental Impact Report presented to the State Superintendence of the Environment (SES), MLWC underwent the expansion process and the area was dimensioned to meet the demand for the next 16 years and 8 months, thus functioning until 2034 (VIANA, 2018).

3.2. Characterization of the USW arranged in the MLWC

As stated on the report of the analysis of the gravimetric composition of the waste from the Municipal Landfill of the West of Caucaia, released by SES in the regional plan for the integrated management of solid waste (SEMACE, 2017), it was found that the predominant components in the composition are paper or cardboard, plastic, organic matter and waste. However, organic matter is the one with the highest percentage for the two municipalities that MLWC benefits (Caucaia and Fortaleza), of approximately 32% and 35%, respectively, seen in Table 7.

Table 7 - Estimated Typology of MLWC Urban Solid Waste (%).

County / Material	Caucaia	Fortaleza
Ferrous Metal	0	1,5
Non-ferrous metal	3,42	0,5
Hard plastic	9,39	3,1
Soft plastic	1,04	10,9
Paper / cardboard	14,77	8,0

Glass	9,82	1,5
Organicmatter	32,0	35,0
Sanitaryorigin	6,91	6,2
Tetrapack	1,05	1,2
Cloths / rags	7,38	4
Rejects	7,75	18,5

Source:SEMACE (SES), Panorama tabelas RMF-A, 2017.

The gravimetric composition reflects the percentage of each component in relation to the total weight of the sample analyzed. The knowledge of this characteristic allows the use of recyclable fractions for commercialization and of organic matter to producegarbage compounds. In addition, this variable is basic information for various activities, such as monitoring landfills, implementing selective collection and analyzing the viability of composting and recycling plants (SANTOS, 2016).

Santos (2016) also states that the detailed knowledge about the USW is advantageous not only for the personnel responsible for the landfill, but for the planning of the management system as a whole. Based on Monteiro et. al (2001), this knowledge can assist in estimating the quantities to be collected in each region of the city, in the design of collection vehicles and transfer stations, in the implementation of selective collection, recycling and composting programs, in the manufacture of odor inhibitors etc.

3.3. History and future estimate of waste grounding at MLWC

The Municipal Landfill of Oeste de Caucaia has been in operation since 1990. Table 8 describes the total values of waste received by the landfill until 2009.

Table 8 - History of waste grounding at MLWC.

Year	Total solid waste (ton / year)
1992	40.000
1993	40.000
1994	40.000
1995	40.000
1996	40.000
1997	40.000
1998	1.065.169
1999	1.012.934
2000	1.113.743
2001	1.055.160
2002	1.004.630
2003	864.737

2004	730.067
2005	944.083
2006	1.062.288
2007	1.188.843
2008	1.186.655
2009	1.436.782

Source: ACFOR, EMLURB (MCUC), ECOFOR (2010).

The notable increase in the quantity of USW disposed in the landfill observed since 1998 is due to the fact that, until 1997, MLWC received only the garbage from the municipality of Caucaia and, in subsequent years, also received the city's waste from Fortaleza.

According to Panorama Tables RMF-A released by SEMACE (SES), (2017) in the regional plan for integrated solid waste management, an average USW estimate from 2018 to 2034 was released for the municipalities of Caucaia and Fortaleza (Table 9). This estimate was made based on per capita generation information from the National Sanitation Information System (NSIS - Sistema Nacional de InformaçõessobreSaneamento (SNIS), 2016), presenting an average flow of USW in the period from 2018 to 2034 in the total of 1,608,225 ton / year, an important value for the calculation of methane production.

Table 9 - Estimated Average USW (2018 to 2037).

Year	Total solid waste (ton / year)
2018	1.423.494,00
2019	1.444.777,20
2020	1.466.398,80
2021	1.488.366,00
2022	1.510.689,60
2023	1.533.369,60
2024	1.556.409,60
2025	1.579.820,40
2026	1.603.612,80
2027	1.627.786,80
2028	1.652.353,20
2029	1.677.315,60
2030	1.702.681,20
2031	1.728.460,80
2032	1.754.658,00
2033	1.781.287,20
2034	1.808.344,80

Source: SEMACE (SES), Panorama tabelas RMF-A(2017).

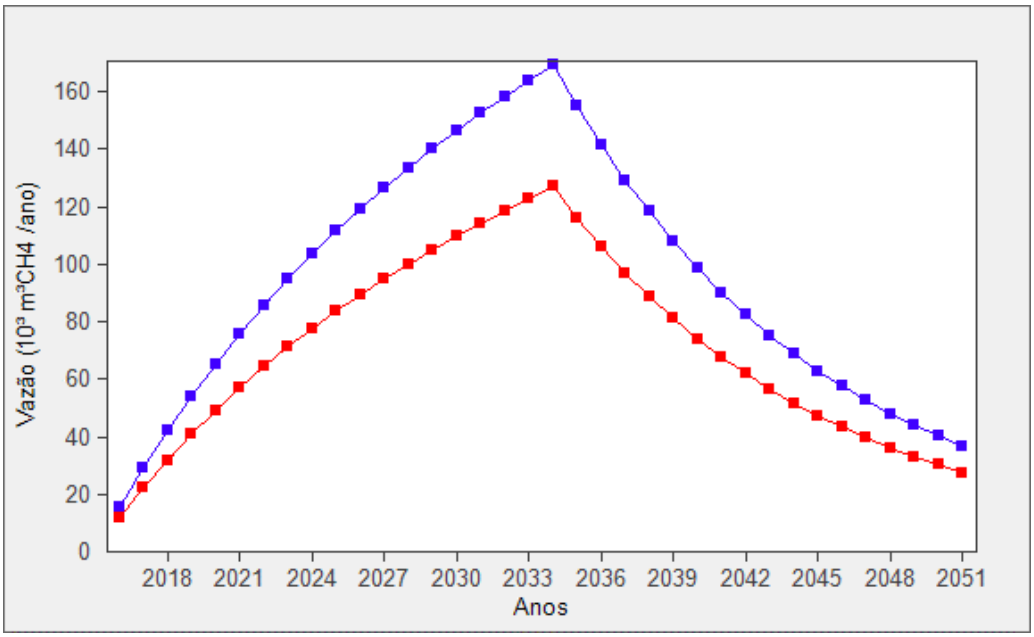
3.4. Present and future potential of MWLC

To calculate the methane production, the model of the Environmental Company of the State of São Paulo (ECSSP) was used, as reported in the previous chapter, and the volumes of landfilled waste were used, since the year in which the Renewable Natural Gas -Fortaleza project (RNG Fortaleza - Gás Natural Renovável Fortaleza (GNR Fortaleza)) was implemented until the end of the landfill operating license, which covers the period between the years 2018 and 2034; the methane generation potential (L_0) equal to 0,12 $m^3_{CH4biogás}/kg_{RSU}$suggested by the software due to the percentage of organic matter present in the landfilled waste; and the decay constant (K) equal to 0,09 ano^{-1}, taking into account the annual precipitation of the municipality of Caucaia / CE, in which the landfill is installed.

Other important values for the elaboration of the methane flow estimate is the identification of the Baseline that corresponds to the scenario that collect data related to the Greenhouse Effect Gas (GEG) emissions that occurred prior to the implementation of the project. According to Linard (2010), in the MLWC, as there is no GG controlled combustion procedure (this is partially burned), it would be characterized as partial emission of gas into the atmosphere, being a fraction burned with certain periodicity in drains, in the calculations used 20% of the flaring baseline, as well as a 95% biogas flaring efficiency (values suggested by the software).

Figure 21 shows the estimate of methane production from 2018 to 2050. This time interval was used, since, after 2050, methane production is already inexpressive and is not feasible for making energy use.

Figure 21 - Graph of the CH4 flow estimate in the MLWC.



Source: the Author.

The blue curve in the graph represents the amount of methane resulting from the decomposition of the MSW disposed there and the corresponding one in red, the amount that is actually collected (the 75% lock).

It can be seen in Figure 21 that in the first years of the installation of RNG - Fortaleza, there is an increase in the level of methane generation, because the unit has received, every year, a greater amount of USW, thus making the process more efficient and faster. of anaerobic digestion and, consequently, it appears that there is a greater production of methane gas.

Bearing in mind that methane production is directly proportional to the quantities of landfilled waste, 2034 has the maximum peak production of CH4. In that year, it is expected that the landfill will receive the largest amount of solid waste, totaling around 1,808,344.80 tons / year, as estimated by SEMACE (SES), (2017) in Panorama RMF-A tables.

From the year of 2035, the flow values will decrease because there is no grounding of new quantities of waste at the unit, as the landfill is only licensed to operate until 2034. However, it is worth noting that the landfill's operating license may be extended depending on legal procedural steps.

According to Azevedo (2000), the calorific value of biogas ranges from 17 - 34 MJ / kg (higher) to 15-34 MJ / kg (lower). The calorific value of some gases, including methane, is shown in Table 10. When compared to other fuels, the feasibility of using methane as a fuel in automobiles is possible, allowing the minimization of environmental impacts and ensuring a significant reduction in the emission of greenhouse effect gases.

However, for the application of biogas in internal combustion engines, it is necessary that it be purified, in order to reach the specifications of natural gas, and, finally, be used in vehicles adapted for this fuel (NADALETTI et. al, 2015).

Table 10 - Values of lower calorific value (LCV) and superior (SCV) of different gases.

Gas	LCV andSCV (MJ/kg)
Methane	**55,5 – 50,0**
Natural gas	50,0 – 45,0
Gasoline	47,3 – 44,0
Light diesel	44,8 – 42,5
Heavy Diesel	43,8 – 41,4
Refinedgas	42,3 – 38,6
Ethanol	29,7 – 26,9
Charcoal	29,7 – n/d
Methanol	22,7 – 20,0

Source: Azevedo, 2000.

Table 11 shows the estimated values of methane production, in m³ / year, which can be generated between the years 2018 and 2050 by the MLWC and the number of vehicles that can be refueled in that

period. Given this, it can be argued that the Municipal Landfill of the West of Caucaía will produce, in 2034, approximately 163,050 m³ of methane.

Thus, considering the 15 m³ cylinder (option most installed in automobiles), which is equivalent to about 21 liters of gasoline or 28 liters of ethanol, it is estimated that, in that year, the amount of biogas generated is enough to supply more than 10,000 cars. Furthermore, when using biogas instead of fossil fuels, there will be a reduction in the emission of gases harmful to my environment, the risk of contamination of soil, air and water resources, in addition to social impacts, such as improving people's quality of life. around the system and decreased breathing problems, among others.

Table 11 - Estimated CH_4 production in the MLWC and number of vehicles fueled between 2018 and 2050..

Year	*Flowestimate (10^3 m^3 / year)*	*Fueled vehicles (10^3 / year)*
2018	15,37	1,02
2019	29,65	1,98
2020	42,94	2,86
2021	55,32	3,69
2022	66,87	4,46
2023	77,68	5,18
2024	87,8	5,85
2025	97,31	6,49
2026	106,25	7,08
2027	114,68	7,65
2028	122,66	8,18
2029	130,22	8,68
2030	137,4	9,16
2031	144,24	9,62
2032	150,78	10,05
2033	157,04	10,47
2034	163,05	10,84
2035	149,02	9,93
2036	136,19	9,08
2037	124,47	8,30
2038	113,76	7,58
2039	103,97	6,93
2040	95,02	6,33
2041	86,84	5,79
2042	79,37	5,29
2043	72,53	4,84
2044	66,29	4,42

2045	60,59	4,04
2046	55,37	3,69
2047	50,61	3,37
2048	46,25	3,08
2049	42,27	2,82
2050	38,63	2,58
Total	**3020,440**	**201,662**

Source: theAuthor.

According to this study, the MWLC in the period from 2018 to 2050 could generate about 3,020,440 m³ of biogas, which can supply fuel to the fleet estimated at 201,362 vehicles. Thus, it can be concluded that the large volume of waste generated in the cities of Fortaleza and Caucaia / CE, which would normally be a problem, became the solution for supplying the vehicle fleet.

As a result, the biogas plant is a sustainable output for waste generated in cities. When implementing a biogas plant, an environmental liability is removed, and it can be transformed into something useful. Thus, the MWLC biogas generation plant can serve as a showcase for smart city technologies for government officials to be inspired and understand solutions for improving the management of urban solid waste. The smart city is an efficient, technologically advanced, green, and socially inclusive city (Vanolo, 2014). That is, smart city applications put a specific technological focus at the forefront of generating solutions for ecological, social, economic and management challenges (YIGITCANLAR, 2016).

In turn, this can be seen as a process of change in which the exploitation of resources, investment targeting, technological development and institutional change are consistent with present and future needs (IMPERATIVES 1987). Denoting the relationship between economics, aspects of social and environmental sustainability based on a combination of indicators for each of these components (AHVENNIEMI et al. 2017).

Yigitcanlar and Lee (2014) propose that the city be ecologically healthy, using advanced technologies and having economically productive and environmentally efficient industries, in addition to a responsible and harmonious systematic culture and a physically aesthetic and functional landscape.

4. CONCLUSIONS

From the results presented, it can be concluded that:

The gravimetric composition of the waste from the Municipal Landfill of the West of Caucaia (MLWC) found that the predominant components are paper or cardboard, plastic, organic matter and waste. However, organic matter is present in greater quantity.

According to the estimate, in the period from 2018 to 2034 the average flow of USW will be more than 1 million tons per year dumped in the MWLC, a value that corresponds to the garbage collected in the

cities of Fortaleza and Caiucaia - CE, and even more than the cities were within the concept of smart cities, they would still generate solid waste.

The feasibility in using landfill gases to replace fuels derived from oil allows the minimization of environmental impacts and ensures a significant reduction in the emission of greenhouse effect gases.

It expects the maximum production of CH4 in 2034. In that year, the landfill will receive the largest amount of solid waste, reaching a maximum value in the year of its closure (period in which the receipt of waste ceases) and declining over the following years.

In 2034, biomethane production at the landfill is approximately 163,050 m³ of methane. It is estimated that, in that year, enough to supply more than 10,000 cars.

The Municipal Landfill West of Caucaia generates about 3,020,440 m³ of biogas, which could supply fuel to the fleet estimated at 201,362 vehicles. In a socioeconomic perspective, the landfill allows the use of biogas for the automobile sector, reducing fuel costs, and decreasing the spread of diseases in the human respiratory system.

The MLWC biogas generation plant can serve as a showcase for smart city technologies for government officials to be inspired and understand solutions for improving the management of urban solid waste.

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Global productive chains and decent work management technologies: sociological evidences from Brazil

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Abstract

The article presents a reflection on decent work management technologies in the global productive chains. Based on economic sociology and anthropology authors, it discusses the general characteristics of the global productive chains, especially the concept of decent work as a management technology for the labor´s international regulation. The empirical focus of this research was a clothing manufacturing productive chain in the south of Santa Catarina. Interviews were carried out with social and economic actors that are part of this sector, in particular, unions and entrepreneurs. As a conclusion, it is important to highlight that decent work management technologies have the formal merit of inserting the decent work guidelines into the contracts between the suppliers and subcontractors. However, the research points out that the asymmetries in the financial negotiations which are typical of the productive chains continue to promote precarious and informal work in the sector.

Keywords: Global Productive Chains; Decent Work; Management Technologies; Precarious Work.

Introduction

Within the scope of economic sociology, there has been an increase of studies on precarious work in the global production chains and on business strategies to deal with the social criticism carried out by consumers and social movements (Raworth; Kidder, 2009; Hughes; Wrigley et al., 2010; Barrientos, 2013). Although the expansion of labor-intensive industries has been an important source of job creation, there is evidence that the participation of developing countries in global production chains is strongly associated with lower production costs and the expansion of precarious work. Studies carried out by non-governmental organizations and unions highlight that international buyers, such as large branded retailers, subject their suppliers to commercial pressure to keep prices low and flexible ordering contracts resulting in low wages, exhausting working hours and unstable economic relationships. (Oxfam, 2004; Miller, 2004; Actionaid, 2007).

The issue that remains open is understanding under what circumstances the insertion of firms in global supply networks can inhibit the precariousness of labor relations and generate decent work. In this

regard, a very controversial problem identified in the literature concerns new management technologies that aim to demonstrate the position of corporations regarding decent work. Is it possible for private regulations such as certifications, codes of conduct and bilateral agreements between companies and unions promote decent work across global production chains, in particular, at suppliers located in developing countries?

These questions, which emerged when the North American sociologist Gary Gereffi coined the concept of global production chains (hereinafter identified by the acronym GPC´s), are part of a wide range of research developed since the 1980. The merit lies in the fact that the concept incorporates dimensions that go beyond the economic aspect of industrial expansion worldwide. From a sociological point of view, the analyses around GPC's investigate the international geographical expansion of contemporary production networks, focusing mainly on issues of industrial reorganization, coordination, governance as well as power relations between social actors in the chain. It is, therefore, a line of research capable of understanding and explaining the causes and consequences of the organizational reconfiguration that global industries took on in the last decades after the Washington Consensus (Gereffi, 2013).

However, the first academic analyses using the GPC's approach rarely investigated labor relations, working conditions as well as management technologies oriented towards decent work guidelines. In fact, at the beginning, the literature focused on the dynamics of business organizations, with work being treated mainly as an endogenous factor of the production (Barrientos; Gereffi et al., 2011). With the progressive increase in the centrality of global production chains in developing countries, new research oriented towards labor relations and working conditions has emerged (Santos; Etcheverry et al., 2016).

With the launching of the campaign for “decent work” by the International Labor Organization (ILO, 1999), the configurations of labor markets, working conditions, union participation, remuneration and the issues of equity and social protection have come to appear as important topics of debate for the understanding of GPC's. Therefore, this article presents a reflection on the technologies for decent work management in global production chains based on the Brazilian context.

Methodology

The analysis took as a starting point the general characteristics of global production chains. Afterwards, the study addressed the characteristics of the clothing manufacturing sector that, historically, is an economic field marked by precarious work, where women, migrants and ethnic minorities occupy job vacancies which are often marked by informality. The methodologies applied to the study included a literature review on the literature on global production chains and on decent work management technologies. The field research was carried out at the clothing manufacturing pole in southern Santa Catarina and included interviews with the social and economic actors that integrate the sector's production chain at different levels. Representatives of the workers' union, entrepreneurs of different business sizes were interviewed, namely, medium and large companies and textile factions. Data on decent work management technologies in global production chains were gathered through contacts with *IndustriALL Global Union*, the international union federation that brings together unions for workers in the metalworking, chemical, energy and mines and also the textile, clothing and leather sector. Data on the

certification in decent work of the Brazilian Textile Retail Association (ABVTEX) were collected with the institution itself.

Global production chains: history and definition

The genesis of the term "production chains" goes back to the efforts of the authors of world-system theory in the 1970s. Inspired by the theory of dependency, the world-system theory emerged from the concept of economy - Fernand Braudel's world, later used by authors such as Imannuel Wallerstein, Giovani Arrighi and Samir Amin (Raikes; Jensen et al., 2000).

The world-system theory (Wallerstein, 1974) proposes an interregional and transnational division of labor between central, semi-peripheral and peripheral countries. On the other hand, the central countries concentrate highly specialized and capital-intensive production while the rest concentrate on the production with intensive and unskilled labor and the extraction of raw materials. This dynamic tends to reinforce the domination role of the central countries. Similarly, in the global production chains, some economic actors have greater power, by dominating specialized activities and exercise coordination and control over the other participants (Gereffi, 2001).

For Gereffi (2014), with the advent of globalization since the last two decades of the 20th century, the concept of GPC's inaugurates a new analytical framework for economic and development sociology. In the sociologist's view, development depends on the strategic integration of countries and companies in international networks and, above all, on the relationship between supplier companies and leading companies (*lead firms*).[1]

In fact, globalization has altered the competitive dynamics of nations and companies and has profoundly impacted the configuration of jobs in both developed and developing countries. This phenomenon is clearly observable when evaluating the patterns of international transactions, where an explosive growth in imports in developed economies indicates that the center of production and export of manufactures is present in an increasing set of developing countries (Gereffi, 2001).

However, the externalization of productive processes is not a new phenomenon in capitalism. Since 1980, outsourcing, whether in the form of simple externalization or geographic displacement of activities, has been part of an intense capitalist restructuring. It is, as Dupas (1998) observed, a reformulation in the production and distribution strategies of corporations, previously vertically integrated for the establishment of *networks*, which integrate different companies in the same global project.

Gereffi (1994; 1999; 2001) points out that there are two distinct types of international networks promoted by industrial and commercial capital: chains aimed at the producer and chains aimed at the buyer. The first refers to the strategy in which the big manufacturers, in general, the transnationals, transfer the central coordination roles to the production networks. Chains directed at the producer are typical of capital and technology-intensive industries such as the automotive and aviation sectors, computers, semiconductors and heavy machinery. On the other hand, buyer-driven chains are those in which large retailers, merchants and brand manufacturers transfer production to decentralized production networks in

[1] *lead firms* are the organizations that concentrate the greatest productive and economic decision-making power within the global production chains. Brand merchants, international buyers and retailers determine the global distribution of production.

a variety of developing countries. It is an industrialization aimed at common trade in consumer goods companies that require labor-intensive products such as clothing, shoes, toys, household items and electronics. In general, production is carried out by a network of subcontracted suppliers located in developing countries. In such cases, specifications, product guidelines as well as production prices are passed on by the merchants who order the items.

Corporations such as retailer Wal-Mart, Apple, Nike and Inditex-Zara fit the model of supply chains aimed at the buyer since they plan and/or market, but do not manufacture their products. According to Gereffi (1999) they are part of a new class of factories without factories as the production process segregates the manufacture from the planning and commercialization stages. In this model of production chain, the added value does not come from scale, volume or technological advances, as occurs in chains aimed at the producer. Major retailers (*lead firms*) control how, where and when production will occur while determining what portion of profit each stage of production will have, despite having no productive apparatus and not being directly responsible for hiring (as workers (Gereffi, 2001).

Therefore, the theme of management technologies for decent work in production chains directed at the buyer is particularly relevant: *lead firms* subcontract production to a vast network of suppliers located in countries whose working conditions as well as legislation are effectively heterogeneous.

Management Technologies in Global Productive Chains Management

Technologies can be understood as ways of rationalizing work such as the principles created by the Taylor production system, that is, studies of time and movement, sequence of labor movements, organization and disposition of machinery in the productive unit. In this sense, they are instrumental management technologies. On the other hand, part of the list of management technologies, the set of ideologies and behavioral techniques that seek to introject in individuals the basic and fundamental values in the performance of tasks. They are seminars, training plans, group work and motivation mechanisms created by management researchers with the objective of incorporating individual action in the company's projects and that form behavioral and ideological management technologies (Faria, 1997).

Araújo (2001: 17) highlights that management technologies have as their central objective "to improve business performance, in order to allow the survival of competitive organizations with so many turbulences and constant break of paradigms." It becomes evident from the definitions cited that the authors, when stating that management technologies assist managers in maximizing what companies are able to do and improve business performance, are necessarily referring to the process of valuing the value, vital to the perpetuation of capital. The definition in question expands the possibilities for the use and effectiveness of management technologies in the organizational scope, starting from the creation and application of management methods in all companies, as long as they contribute to its ultimate goal.

Gurgel (2003) when dealing with the issue of subjective control made possible by the various constituent tools from social and applied sciences, the term 'management technologies' is equivalent to 'contemporary management technologies', adopting as a foundation the same logic as Faria (1997) in his concept.

According to the authors that support us and their diverse interpretations and appropriations about the concept of management technologies, we understand as management technologies a set of methods and techniques for organizing and controlling work, which, working internally, externally and inter-organizationally, aims to intensify and reduce the working time necessary for the capital rotation cycle, an essential process for the perpetuation of the process of valuation of value.

However, management technologies are socio-political constructions, that is, they are not restricted to business strategies but are reflexes and they depend on the relationship that capitalism establishes with the dynamics of society itself. At the beginning of the 20th century, Fordist/Taylorist management technologies brought about the coordination of labor relations, through a rigid bureaucracy that neutralized the individuality of workers in the production process. In contemporary society, the formation of interorganizational networks, as well as *clusters* and GPC's, require new logics both in instrumental management technologies and in behavioral and ideological technologies. Over the past 30 years, the development of the so-called flexible company has been accompanied by a global reorganization of the productive sphere as well as inaugurating a new international division of labor. Likewise, new behavioral and ideological technologies, such as the "corporate social responsibility" guidelines, were developed in such a way as to reproduce and legitimize the logic of capitalist accumulation.

Decent Work as a management technology for the international regulation of labor

Therefore, from the 1980s and 1990s, the world economic panorama has changed profoundly. Based on a new infrastructure, based on information and communication technologies and with the determination of the deregulation and liberalization policies operated by governments and international institutions, a truly global economy emerges. So, how to think about an international regulation for industrial relations, no longer based on national norms, but within globally sparse productive activities? There is economic globalization and production, but could we also think of a globalization of workers' rights in the 21st century? How does the ILO stand in the face of this new scenario?

In the face of changes, the concept of decent work emerges as a readjustment of ILO programs and projects. Efforts to launch the concept stem, in part, from the formulation of a fundamental document of the institution: The Declaration of Fundamental Labor Rights (1998). The prerogative is that decent work appears not only on the national agendas of member countries, but, above all, within global production chains (ILO, 2016).

In conceptual terms, decent work is the conjunction of four strategic objectives of the ILO, that is, its existence derives from the fact that it exists: respect for fundamental rights at work[2], policies aimed at promoting productive and quality employment, extension social protection and the strengthening of social dialogue.

However, how can the guidelines for decent work operate as management technologies for global production chains? The first aspect to be taken into account concerns the very functioning of the production

[2] For ILO, fundamental rights at work are: freedom of association and the right to collective bargaining, the elimination of all forms of forced labor, the effective abolition of child labor and the elimination of all forms of discrimination in matters of employment and occupation.

chains and the trend observed in some productive sectors in the formation of a network of outsourced and subcontracted companies that relate to a greater or lesser degree with the leading company.

In fact, global production chains are complex inter-country organizational structures that organize the production of goods or services in addition to distribution to consumers. They are structures that organize from the use of production factors, to the various stages of development, production and supply. In this sense, they can take the form of foreign direct investment (FDI) of multinational companies in branches in different countries or even an international supply model. In this, the participation of main companies is defined by terms and conditions of contractual agreements, or, sometimes, of tacit agreements with suppliers and subcontractors to supply specific inputs, goods and services. In the case of IDEs, multinational companies have direct responsibility for labor relations and the configurations of the workforce (gender composition, earnings, profit sharing, benefits, etc.) are exposed to decent work management technologies represented by employment reports. sustainability in a broader corporate governance framework. The international supply model, which is increasingly widespread, may present deficits in decent work. Difficulties arise when leading companies - namely, brand traders or large retailers based in countries with central capitalism and who have no direct responsibility for jobs in companies participating in the supply chain - make decisions regarding investment or even in relation to to production that affect working conditions in global production chains (ILO, 2016). It is precisely in this model of the productive chain that the guidelines for decent work have been set as management technology for monitoring working conditions.

In fact, the creation of management technologies aimed at promoting decent work in global production chains transcends the limits of national public labor regulation. In this sense, it is not enough to state that the companies that make up the supply network complies with the national legislation. It is necessary to make sure that the entire global production chain operates based on minimum requirements regarding respect for fundamental labor rights (ILO, 1998).

The occurrence of violations of workers' fundamental rights in global production chains is accompanied by increasing pressures on multinational companies and brand traders to ensure compliance with minimum working conditions in developing countries. Sectors of civil society, non-governmental organizations, media, consumers, multilateral organizations and international union federations are the agents most directly involved with monitoring business behavior in matters of decent work. Above all, through pressure from international union federations, multinationals and brand traders have developed a risk management system and expanded the scope of monitoring working conditions in the subcontracting network (Miller, 2004; Bair; Dickson et al., 2013). It is in this context that the “Codes of Conduct for Suppliers" and the International Framework Agreements for decent work in global production chains appear (Industriall Global Union, 2014; ILO, 2016).

The textile and clothing industry, in scope overall, has been the scene of reports of poor working conditions, low wages and unhealthy conditions for health and safety of (the) workers. Major brands were associated with so-called "sweat factories"*(sweatshops)*and lost reputation in the face of scrutiny society (Bernstein, 1997, Repórter Brasil, 2011; Clean and Clothes Campaign, 2017). As a result, some companies started promoting the “social responsibility” discourse as a form of risk management (Heal, 2008).

In the next section , we highlight the operation of management technologies based on decent work guidelines and the limits and scope in terms of reducing precariousness of work in the sector based on field research carried out at the clothing production pole in southern Santa Catarina.

Results: Textile and Clothing Production Chain in the South of Santa Catarina and Management Technologies for Decent Work

Except for designer fashion, until the 1980s, the textile sector was characterized by mass production that did not suffer great variations from one season to the next. another. However, in the 1990s, retail companies began to expand the range of their products by combining more modern designs with the development of differentiated brands. Thus, the strategy of manufacturing products in developing countries has proved to be profitable in order to lower production costs. The increase in competitiveness forced retailers into merger and incorporation processes and this scenario increased the bargaining power of lead *companies in* relation to manufacturers. The brands started to dispatch production to other countries and subcontract manufacturing, aiming to reduce labor and production costs, thus forming the GPC's of the textile and clothing sector (Gereffi, 1994; 2001). However, the subcontracting of production can reach several levels, generating a true pulverization of textile factions. In these companies, which may even operate informally, state control over working conditions is often inexistent or insufficient.

Brazil is the sixth largest producer in the world, the second largest in the denim (jeans) segment and the third in knitwear production. In the state of Santa Catarina, the textile sector is concentrated in the northern region, with 78.3% of companies in the state and 68.8% of jobs generated. As for clothing and accessories, the largest number of companies is concentrated in the southern region of Santa Catarina. There are 2,072 companies that generate 15,217 direct jobs (SEBRAE, 2010). However, surveys carried out with the employers' sector in the southern region reveal that the number of companies doubles when considering informal units of clothing production (home textile factions).

In fact, the textile-making complex in the city of Criciúma is characterized by the presence of companies of different sizes and with different commercial projects. Most are micro and small companies, about 95% of the total and only 5% are large or medium-sized companies. In Santa Catarina, qualification by business size regarding micro and small companies is governed by Complementary Law 123/2006 of Simples Nacional and refers to annual gross revenue of up to R $ 3.6 million. The main advantage of taxation relates to bureaucracy and reduction of the tax burden by up to 40% depending on the conditions of the company. Thus, in our interviews, we found that the strong presence of micro and small companies in the region hides a business strategy *sui generis*. Due to the tax advantage of Simples Nacional, businessmen in the industry choose to manage a larger number of micro and small companies instead of fostering a medium or large company. On the other hand, the strategy of relocating production from Brazil to other Latin American countries has proved to be profitable. In our interview with the employers' sector, the advantage of medium and large companies in transferring manufacturing plants to countries such as Paraguay was mentioned, where taxation reaches 17% while in Brazil it can reach 47% of revenues.

Regarding the dynamics of the production chain, it was found that leading companies such as large national and international retailers direct orders to local companies that redistribute and subcontract the production steps to smaller textile factions. In fact, the use of subcontracting has been a practice in the

textile and clothing sector since the 1990s, when global manufacturing companies started production restructuring processes (Hagenauer et al., 2001). The national literature devoted to the theme presents different patterns in relation to its adoption. Navarro (2003) and Lima (2009) state that, according to a first "structuring" model, outsourcing aims at reducing costs associated with technological and organizational determinants; however, a second "predatory" model seeks to reduce costs based on precarious labor relations, which is, therefore, subcontracting labor, temporary work contracts, homeworking, part-time work and unregistered work (socially unprotected).

The recurring media exposure of cases of violation of fundamental rights at work in the textile factions and the registration of large fashion magazines in the so-called "Dirty List of Slave Labor" of the Ministry of Labor and Employment made the Brazilian Textile Retail Association (ABVTEX) to create, in the 2000s, management technologies for decent work for suppliers. The general objective of the certification, according to the entity, is to allow retailers that are members of ABVTEX effective control of suppliers and subcontracted factions regarding the fulfillment of minimum requirements in terms of relations and working conditions. ABVTEX's certification of decent work therefore becomes a management technology that aims to control working conditions throughout the production chain. According to the union of workers in the clothing sector interviewed in the survey, about 30% of companies in the southern region of Santa Catarina have already joined the certification.

In addition to promoting the regularization of companies and standardization in relation to compliance with working conditions, certification has the merit of mapping and identifying the structure of the production chain. In addition, if the companies really observe the certification guidelines, the technology will allow to block the so-called uncontrolled spraying of the production chain and the consequent formation of *sweatshops*.

Finally, we conducted an interview with an owner of a textile faction certified by ABVTEX. We questioned in particularly the effectiveness of certification for improving working conditions at the production unit. The administrator stressed that during the seal implementation process, independent audits carried out visits to verify the compliance with the agreed clauses. The interviewee pointed out that compliance with labor legislation was specially monitored. Formal hiring, income according to the category floor, legal work hours, holidays, social security, Guarantee Fund for length of service (FGTS), are part of the criteria evaluated by the auditors. We investigate the administrator's perception of the process and the advantages of certification. However, the administrator made a point of highlighting that the certification process is not accompanied by a greater financial appreciation on the part of the service borrowing companies. On the contrary, the interviewee pointed out that the sector's profit margins have been declining over the years and that there is no negotiation by the *lead firms* to increase the amount paid for the garments produced. The manager even claimed that he intends to change his field of activity because production costs and labor costs - guaranteed by the certification process - have become unsustainable within the dynamics of the subcontracted textile factions.

Conclusion

The aim of this article was to understand how the concept and guidelines of decent work became a management technology in the social construction of markets. The research found out how companies use the concept and its guidelines to improve working conditions in a historically precarious production chain. We take as an example the productive chain of the textile and clothing sector in southern Santa Catarina.

In fact, management technologies have followed capitalist development since its inception. They are a set of techniques and methods for organizing and controlling work that can act both internally and externally and inter-organizationally. The management technologies allow us to intensify and reduce the working time necessary for the capital rotation cycle, an essential process for the process of valuing value.

Likewise, the processes of outsourcing and subcontracting the workforce in the textile and clothing sector are strategies to intensify the profitability indexes of large retail companies. However, the formation of an extensive production chain and the use of "predatory" outsourcing has dispersed informal textile factions both in the world and in Brazil and Santa Catarina.

However, labor inspections by the State and public monitoring by non-governmental organizations, media sectors and unions have put pressure on multinationals and clothing retailers to create management technologies to keep up with working conditions throughout the network of contracted suppliers and subcontractors. These are, above all, management technologies for managing the reputation of brands before consumers.

In formal terms, the existence of decent work certification like ABVTEX has the merit of 1) inserting decent work guidelines in contractual relationships between suppliers and subcontractors; 2) effectively map the economic actors that are part of the production chain and 3) curb uncontrolled spraying processes, the existence of informal companies and the precariousness of work in the final links of the production chain. However, our field research revealed the weaknesses inherent in the model. In fact, certification has been seen by suppliers as a gateway to the lead firms' production chain. Nevertheless, unequal power relations and the lack of price negotiation by retailers place a burden on textile factions. In this sense, it is worth highlighting the impasse surrounding certifications: while retailers demand the rules due to risk management and brand reputation, asymmetries in financial negotiations impel textile factions to operate in illegality. Without mentioning clauses that specify revision and rectification of production prices over time, certification is fragile in preventing precariousness and informality in the production chain of the textile and clothing sector.

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A Comparative Analysis on The Educational Perspective of Students and Professors in Stem Courses Regarding Industry 4.0 Competencies

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Abstract

This work consists of an investigation in the form of a comparative analysis between students and professors from the STEM field (Science, Technology, Engineering and Mathematics), about their educational perspective in the context of the current industrial revolution - Industry 4.0 (I4.0). This research aims to investigate, in particular, how professors and students from a Control and Automation Engineering (CAE), Information Systems (SI) and Mechatronics Engineering perceive the educational process in relation to the development of skills needed for the upcoming job market. As future professionals, students need technical knowledge to deal with emerging trends, such as Big Data, Internet of Things (IoT) and Robotics. In addition, social skills, such as solving complex problems, dealing with conflicts, creativity, innovation and communication, leadership and collaborative work, are paramount. The research methodology adopted in this work is based on mixed methods, quali-quant research. Data collection was carried out through research based on questions related to three categories: intrapersonal, interpersonal and didactic. The study found that, although students claim to be prepared for Industry 4.0 challenges, professors think otherwise. There seems to be a pedagogical challenge to fully achieve the requirements for the development of future I4.0 professionals. In addition, this research identified that active learning methods, focused on the development of 21st century skills, are poorly applied by professors, which may indicate that students are not being exposed to real life situations necessary to better prepare themselves for the future challenges of I4.0.

Keywords: Industry 4.0; Competencies; Student training; Student-centered learning;

1. Introduction

The reality of today's Industry is rapidly changing. The Internet and the multitude of new approaches arising from Information and Communication Technology (ICT) have penetrated the industrial world, bringing disruptive potential. Innovations linked to the Internet of Things, Data Science, Cloud Computing, 3D Printing, Artificial Intelligence and Robotics have become part of the range of possibilities to bring more agility, economy and productivity to the industrial world - a new industrial revolution (Freeman et al ., 2014).

Industry 4.0 is characterized by advances in ICTs throughout the supply chain (Rüßmann et al., 2015). Allied to ICT innovations, a boost in additive and hybrid manufacturing technologies as well as the integration of horizontal and vertical systems in intelligent supply chains (Huba & Kozák, 2016). The combination of Materials, *Big Data*, cyber-physical systems, results in the formation of "smart factories" (Assunção Pereira et al., 2018, p. 1).

The impact of Industry 4.0 goes beyond the processes associated with production and distribution, going through a more complex form of innovation based on the combination of multiple technologies, encouraging companies to rethink the way they manage their businesses and processes. From this perspective, new business models can emerge: the reformulation in production, consumption (customized products in a shorter time) as well as transportation and logistics systems. According to the National Confederation of Industry (CNI, 2016, p. 12), in these "smart industries", machines and inputs "talk" throughout industrial operations with scale and flexibility in the manufacturing process, which, in turn, occurs in a relatively autonomous and integrated fashion. Therefore, there are great challenges ranging from investing in these technologies, changing processes, as well as in the relationship between the production chain and the development of new skills in employees.

Despite the revolution taking place in the industry, the same movement cannot be affirmed from the standpoint of the teaching-learning process in higher education. Still rooted in the traditional model of education, which inherits several historical practices (Freeman et al., 2014), the current higher education system (professors, students, management) remains, for the most part, far from the reality of companies and industry. Thus, it is necessary to promote initiatives to change education so that it adapts to this new model of work. The latest report from the world Economic Forum, called "*The future Jobs Report*" (WEF, 2018), lists the skills that will be valued in the coming years, and many of them are behavioral.

Thus, university-industry dialogue is essential to seek integration between those in the academic world, which possess a strong scientific and technological structure, along with those in the market, whose bias is more pragmatic. Thus, the focus of education becomes the development of the so-called 21st century skills in the training of students (Rugarcia et al., 2000). As a result, it might be possible for students to experience situations of their future work environment, bringing authenticity to the teaching-learning process and creating relevant bridges between the job market and the academic environment.

Alarcon et.al. (2018, p. 2) claims that education must be connected with the realities of the industry, technology and social innovation, as we live in a networked society (Castells & Spain, 2007).

Corroborating with Alarcon's ideas, there is a need for several initiatives including industry and academia. Thus, it is necessary to train future professionals and requalify the current ones, according to the new demands of the world of work. Therefore, it is necessary to think about the learning processes focused on the formation of 21st century skills, such as: "creativity, innovation, communication, problem solving and technical knowledge" (AIRES et al., 2017).

In order to develop 21st century skills, a focus must exist during their academic training. In this context, we raised the research question: "how do professors and students from the STEM field perceive academic training in the face of the new Industry 4.0 context?"

The challenges raised by I4.0 involve multidisciplinarity and extensive use of innovative technologies: robots, artificial intelligence and additive manufacturing. With an IT infrastructure based on Cloud and information distributed among numerous devices, the Internet of Things promises to be a great ally within the scope of I4.0. Thus, it is clear that technical training is important, but interpersonal, intrapersonal and cognitive skills are equally important and must be developed during your training.

Based on this context, the work aims to verify how the students are doing in the STEM field for this new industry, based on the comparison between their perspective and the professors.

Thus, the rest of this article is divided as follows. Section 2 presents a theoretical basis for this work. In section 3, student education and the role of universities and professors are discussed. Section 4 describes the results and discussions from the questionnaires applied to the research subjects. Finally, in section 5, the final considerations are presented.

2. Background and Related Work

This section presents fundamental concepts regarding competencies and their relationship to the I4.0 professional demands.

2.1 The Competence Concept

The concept of competence has reappeared in the literature in areas as diverse as Medicine, Nursing, Computing and Engineering (Burnette, 2016). There is a strong movement towards *Competency-based Education / Learning (CBE / CBL)*, where the fundamental premise is that students must demonstrate mastery of certain competencies in order to progress in their field of study and become a professional. Thus, instead of organizing learning around credit / hour, as it is traditionally done, CBE makes time flexible and fixes what should be effectively mastered: skills (Henri et al., 2017).

According to Perrenoud (2013, p. 13), "the definition of competences is not new, but lacks precision, often varying according to the scope of a discipline or field". Thus, several researchers have provided different definitions over the years, causing a debate that is still ongoing. The first definition of competencies emerged in the 1970s, within a debate in the area of human resources, challenging the efficiency of intelligence tests for professional selection and entry into higher education (McClelland, 1973). Competence was then defined as a personal trait or set of habits that lead to a more effective or superior job performance, which could not be captured by tests widely used at the time. McClelland's research developed a list of managerial competencies, assuming that competencies are stronger predictors of

managers' future performance than traditional psychological tests widely applied at the time to measure intelligence(Van Klink & Boon, 2003).

In later years, this definition had been criticized for focusing too much on learning isolated behaviors, neglecting professional performance as a whole, in addition to not paying attention to specific elements in the context of a profession, making this perspective extremely behaviorist.

A more succinct and pragmatic comparison on the evolution of the competence concept can be found in (Van Klink & Boon, 2003). Table 1 summarizes three perspectives on the concept of competencies:

Table 1 - Three perspectives on competences

Perspective		Differences observed in the definition
Geographical	USA	Competences referring to performance excellence
	United Kingdom	Competences referring to the performance standard defined by consensus of a group
	Germany	Competences referring to action programs that include the adoption of new developments and transfer to other professions
Learning Theory	Constructivist paradigm	Focuses on norms, values and beliefs as important elements of competences; pays attention to the participation of professionals and their daily situations for the development of competency-based systems; questions the transferability of skills to other contexts
	Cognitive paradigm	Links skills with performance; “top-down” development of competency-based systems
Field of Application	Training and Education	Competencies are defined as groups of skills and knowledge that can be learned through

		training
	Selection for employment	Competencies are defined as partially trainable
	Performance Evaluation	Performance (output) is perceived as a substitute for competencies

Source:(Van Klink & Boon, 2003)(adapted)

Thus, we see that geographically, there are clear differences, since each country has historically different educational policies and different types of relations between education and labor market. In the British approach, competence refers to the ability to meet performance standards for roles and professions. In the USA, competencies refer to the skills, knowledge and characteristics of people: traits, motives and self-concept, which contribute to the excellence of professional performance. This differs somewhat from the German perspective, where the notion of competence refers to a person's ability to perform various tasks within a given profession. More than in the UK or the USA, the German perspective emphasizes a holistic view of competence: it's not just a random collection of skills and knowledge. Competencies are defined as integrated action programs that allow individuals to perform adequately in various work contexts within a specific profession.

When analyzed from the point of view of learning theories, there are clear disagreements. As stated earlier, having an essentially behaviorist origin in the 1970s, which had been discarded due to its limitations, the concept of competence evolved within the constructivist and cognitivist paradigms. The second source of conceptual disagreement stems from the theory of learning. The constructivist paradigm emphasizes the importance of values, motives and beliefs and questions the premise that competencies are transferable to other contexts, including work contexts. The cognitivist paradigm is based emphatically on *top-down* development in an organization and the application of competencies or competence systems. There is a tendency in the cognitive approach to link competences with observable performance (thus having behaviorist elements), while in the constructivist view the subjective perspective and the individual preferences (attitudes and values) of the professional receive more attention in the development and assessment of competences (Simons, 2000).

When viewed from the point of view of practical application of skills, there are different views, in line with what was initially said by Perrenoud (2013). The definitions differ with respect to the elements that are highlighted. For example, applications of the competence concept to education and training assume that competencies can be considered as a set of trainable skills, knowledge and attitudes. Competency definitions for job selection procedures generally define competencies as individual capacities for future jobs, which may be partially trainable. In addition to knowledge and skills, selections often also include individual characteristics and traits, such as intellectual skills and abilities, beliefs and self-concept, which are immutable or very difficult to change. In the accepted definition of performance appraisal, the focus is not so much on the elements of competencies according to observable output. This presupposes a close

relationship between competencies and results, and competence operates roughly as a substitute for performance.

Thus, it should be noted that these three perspectives are not mutually exclusive. In practice, the definitions of competence commonly used in the literature combine the various perspectives within a specific perspective. In this work, when we refer to the concept of competence, we adopt the definition as being a set of knowledge, skills, attitudes and values (Figure 1) (Weinert, 2001)

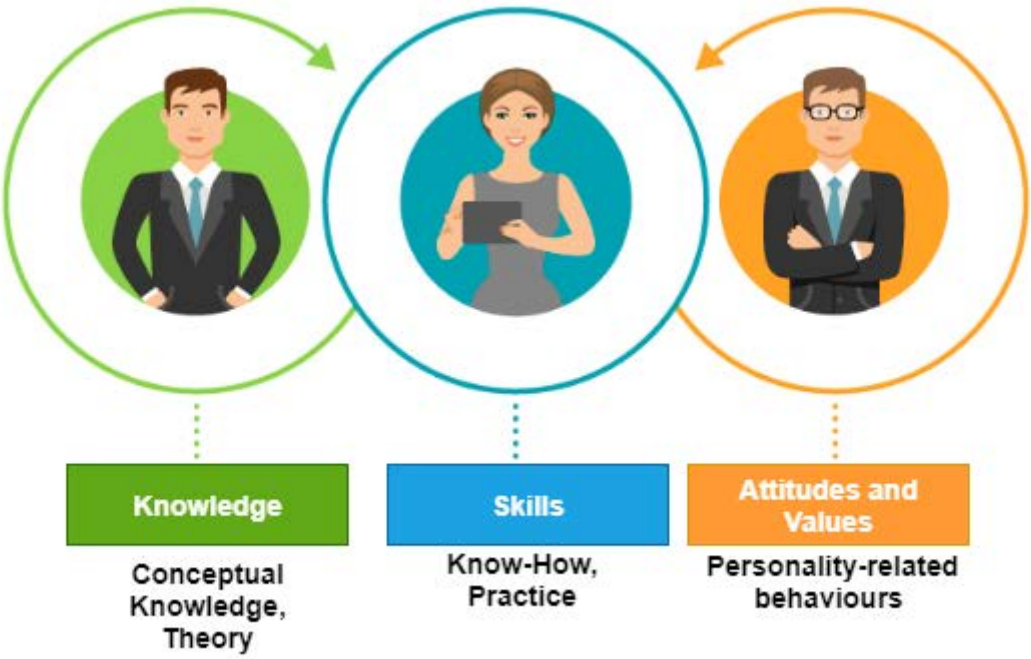

Figure 1 - Competence concept definition
Source: Authors themselves.

Therefore, we follow in line with Perrenoud (2013) where a competence is composed of resources (Figure 1) to be mobilized in a given situation in real life. This set of situations is known in the literature as *competency frameworks* or competency models. Such a concept has been used to establish competency-based curricula in areas as diverse as veterinary medicine (Vandeweerd et al., 2014). Considering the context of Industry 4.0, it is necessary to list the set of skills for this scenario, which has already been proposed in the literature (de Souza Silva & de Andrade Morais, 2018; Huba & Kozák, 2016; Prifti et al., 2017).

Finally, it is important to highlight how competencies should be embedded in current higher education educational systems and what types of pedagogical strategies can be implemented with a view to their development and evaluation. Lectures and exams hardly fit the central concept of competence defined here - real life situations - focusing too much on the theoretical elements of learning and lacking the authenticity necessary to develop competencies.

To acquire skills in areas such as in engineering, educational models must be reformulated with a view to learning real-world situations (Brown et al., 1989) . To solve a real problem, it is necessary to generate a solid learning environment, which includes techniques, methodologies and resources that develop the

necessary skills in students to face the problems in the world of work. Approaches such as Problem-Based Learning (PBL) (Barrows, 1986), Project-Based Learning (PjBL) (Kokotsaki et al., 2016) and Challenge-Based Learning (ChBL) (Clegg & Diller, 2019) are methodologies that have been shown to be appropriate to educate within this perspective. In addition, these approaches are directly related to Competency-Based Education (CBE) (Burnette, 2016), which we mentioned at the beginning of this section and is one of the drivers seeking alignment of the academic world and the world of work.

2.2 Industry 4.0 Competencies

At the beginning of the 21st century and the development of the Internet there was a new revolution and transformation in the industry: the improvement of smaller and more powerful sensors, *software* and *hardware* increasingly sophisticated, the use of artificial intelligence and the ability to gather and filter a huge amount of data (*Big Data*). Erik Brynjolfsson and Andrew McAfee of the *Massachusetts Institute of Technology* (MIT), in their book "*The Second Machine Age: Work, Progress, and Prosperity in a time of Brilliant Technologies"* published in 2014, stated that the world is at an inflection point in which the effect of these digital technologies will be manifested with "full force" through automation and "unprecedented things" (Brynjolfsson & McAfee, 2014). This revolution will profoundly change the way we live, work and relate: it is the fusion of various technologies and the interaction between the physical, digital and biological domains. Figure 2 provides some skills needed by professionals for the 21st century.

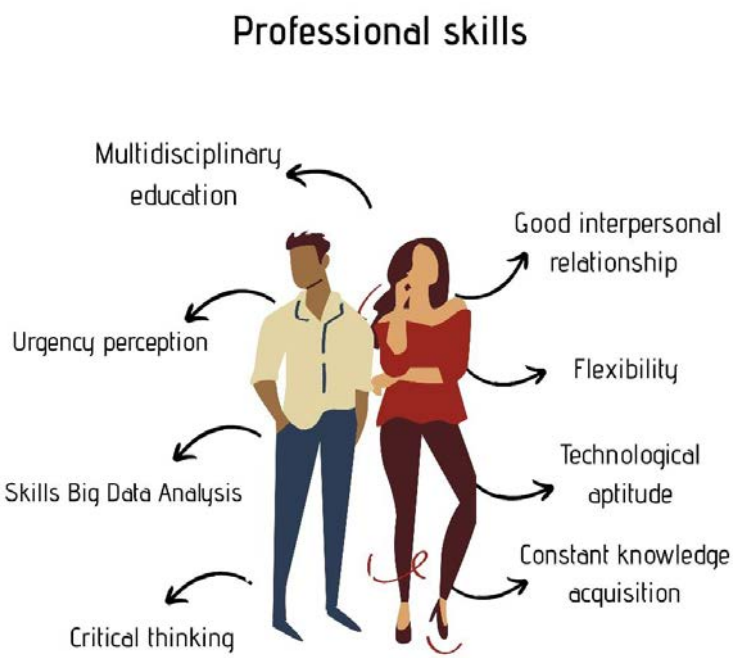

Fig 2 - Professional skills for the 21st century
Source: authors themselves

Industry 4.0 describes the growing digitalization of the entire value chain and the resulting interconnection of people, objects and systems through the exchange of data in real time. This can also be described as the

advent of "cyber-physical systems" (Davies, 2015; Liu & Xu, 2017). Digitization gradually increased in manufacturing is optimizing the fabric floor with integrated technologies and communication technologies. The Internet serves as a common point of all these technologies, as an information exchange platform, allowing the communication of an unlimited number of devices, gving birth to the Internet of Things (IoT - *Internet of Things*).

In this new industrial revolution, extensive use of technology in the labor markets will cause a decline in routine jobs and intensive tasks. Some professions will disappear and others will emerge. Thus, professionals need to qualify for such a change. According to Assunção Pereira et al. (2018, p. 1), "we know that this new industrial revolution brings to life smart factories, allowing the customization of products with the optimization of a large part of the production processes, interfering in professional competences and in work relations". Thus, professionals inserted in industry 4.0 will have to seek new skills and qualifications, as they must have a more strategic vision, be versatile, agile and mainly know how to deal with the new technologies. Thus, students will have to work and develop these new skills, while professionals already in the market will need an adaptation phase. This professional will need to know how to work with computers, applications and robots, in a collaborative way, to add to the organizational productivity. For Tozzi (2010), the professional of this new market that opens must have eight successful attitudes: communication; meaningfulness (the subjective importance of work); analysis skills (knowing how to interpret different variables, relate them and create a plan); didactic (knowing how to share what you know with your team); connection with the world (knowing how to deal with different fields of work and with different people and cultures); optimism (facing crisis situations with positive attitudes); high energy (working with liveliness); and engagement (believing and committing to the objectives inherent to work activity and being able to mobilize your team).

Thus, considering the perspective of the teaching-learning process to prepare for the above mentioned challenges, this work considers three dimensions (Grzybowska & Lupicka, 2017), defined as follows:

- **Intrapersonal :** deals with questions of how a subject (professor or student) sees himself as well as how one relates to communication, creativity, problem solving and conflicts are observed;
- **Interpersonal:** seeks the subject's interaction with the parties involved in the learning process, collaborative work and leadership;
- **Didactics:** analyzes how the professors' methodology variables, ICTs, theory / practice relationship, extra-class activities (seminars, extension projects and research) influence the formation of the subject for this new job market.

The Future of Jobs from the World Economic Forum (WEF, 2018) brings several statistics related to redundant roles, new professions and also the division of labor man versus machine professional profiles. In addition, it reports on emerging and declining professions in the 2018 - 2022 range in various areas, such as: automotive, aerospace, supply chain, transportation, aviation, travel and tourism, chemistry, biotechnology, energy, financial services , medical, infrastructure, mining and metals, oil and gas. Table 2 synthesizes the jobs that will continue, the new ones and the ones that will be redundant in all sectors.

Table 2 - Stable, new and redundant roles in all sectors

Stable	New roles	Redundant roles
• Managing directors and chief executives • General and operations managers • Software and application developers and analysts • Data analysts and scientists • Sales and marketing professionals • Sales, Wholesale and Manufacturing Representatives, Technical and Scientific Products. • Human Resources Specialists • Financial and Investment Consultants • Database and network professionals • Supply chain and logistics • specialistsRisk Management specialists • Information security • Analysts • Management and organization analysts. • Electrotechnology engineers. • Specialists in Organizational	• Data Analysts and scientist • Experts in AI and Machine Learning. • General and operations managers. • Big Data Experts • Digital Transformation Experts • Sales and marketing professionals. • Experts in new technologies • Specialists in Organizational Development • Software and application developers and analysts • Information Technology Services • Experts in process automation • Innovation professionals • Information security analysts • Specialists in e-commerce and social media • User experience and human machine • Interaction designers • Training and development • Specialists	• Data Entry Staff • Accounting, Bookkeeping and Payroll Staff • Administrative and Executive Secretaries • Assembly and Workers • Information and customer service workers • Service managers and business administration Accountants and Auditors. • Employees for material registration and stock maintenance • General and operations managers • Postal service employees • Financial analysts • Cashiers and clerks • Mechanics and machine repairers • Telemarketing operators • Electronics and telecommunications installers and repairers • Banking and related employees • Car, van and motorcycle drivers

Development ● Operators of chemical processing plants ● University and Higher Education Professors ● Compliance Directors ● Energy and Petroleum ● Engineers ● Engineers and robotics specialists ● Operators of oil and natural gas refining plants	● Engineers and robotics specialists. ● People and Culture Experts ● Information and Customer Service Workers ● Service and Solution Designers ● Specialists in Digital Marketing and Strategy	● Sales and purchasing agents and brokers ● Door to door sales workers, street and street vendors and related workers ● Statistical, financial and insurance employees ● Lawyers

Source: (WEF, 2018, p.21, adapted)

This report emphasizes that the requirement for future professional skills is multifaceted. On the one hand, it demands an understanding of new technologies and their applications within the scope of I4.0. On the other hand, it demands a set of technical skills, such as data analysis, processing and interpretation, as well as interpersonal (soft) skills: teamwork, collaboration and constant learning. The impacts on organizations' professionals demonstrate that Industry 4.0 will bring a new reality to work relationships, through new forms of interactions between humans and machines. The result of this may be greater efficiency in the industry, provided that professionals are in fact prepared for these new challenges.

Current companies look for skilled professionals, predisposed to teamwork, with a macro view, who have initiative, an entrepreneurial, responsible, creative and disciplined spirit. For this to happen, higher education institutions need to prepare this citizen for the job market.

A research carried out by (AIRES et al., 2017, p. 12), brought a set of skills, such as: basic skills (content and process) and transversal skills (social, systemic, complex problem solving) , resource and technical management), which were related based on the authors (Chen & Zhang, 2015; CNI, 2016; Voronina & Moroz, 2017; WEF, 2018). Considering all the skills cited by the authors, the most frequent ones were: creativity, innovation, communication, problem solving and technical knowledge. For Pires da Costa (2018, p. 75) transversal competences "are basically associated with socio-emotional and behavioral competencies, such as: time management, assertiveness, initiative, teamwork, planning or stress tolerance".

According to Aires (2017, p. 13), it is evident that in addition to technical knowledge, professionals need to know how to put their knowledge into practice, solving problems with creativity and innovation, generating value for the organization in which they are working, contributing to the construction of necessary competitive advantage for organizations of the fourth industrial revolution. These skills must be

developed throughout the student's academic life, with more student-centered methodologies, such as project-based learning, flipped classroom, problem-based learning, gamification, among others(Prince & Felder, 2006).

All these transformations both in the use of technologies and in the development of skills affect the reality of organizations and work, impacting on the education systems and social life.

3. Student training: the role of universities and professors

The problem of student training can be considered as multifactorial. Curriculum, physical structure, methodologies, interpersonal and intrapersonal skills, different work environments, as well as the involvement of projects between industry and academia are factors that have been considered for years in the literature(Cruz et al., 2019).

Higher education institutions, together with business and industry, need to find common solutions so that these students can qualify for I4.0. Learning should become active, interactive, where practice is present, and didactic content can be shared, using information and communication technologies. For Pires da Costa (2018), "the integration of new technologies and pedagogies needs to be placed at the center of the teaching and learning strategies of institutions, and these must become an integral component of everyday institutional methods".

Schools and universities will demand, according to Fava (2017, p. 263):

[...] an adapted academic system, with strong use of the *just-in-time* methodologies, development of relational skills that allow collaborative value-added actions, communication, innovation that meet individual needs, develop skills not thought for this range of mobile professionals.

Higher education institutions will have the responsibility to guarantee opportunities and learning conditions so that students can develop the skills necessary for their professional practice. However, partnerships with the job market are crucial so that these students graduate and feel ready for this new reality. Professors will be responsible for aligning talents, technologies and spaces with the aim of creating both a culture and a teaching and learning environment that attracts *millennials*[1] (generation Y), promote an integrated experience between personal life, study and work. Education will have to undergo mutations to adapt teaching to this new generation, with the student-centered learning process having flexible, informal schedules, several learning spaces and the content organized in small modules.

According to Alarcon *et al.* (2018, p. 3),

In the 21st century education, the university, according to Boaventura de Souza Santos (2008) will no longer be the monopoly of knowledge, due to market demands and, therefore, will need to undergo significant transformations in its knowledge construction processes, seeking an innovative pedagogical model, through the inter-multidisciplinary curriculum and the transfer of knowledge from universities and research institutions in an integrated and networked way.

[1] Avid, restless young people, skilled in the use of technologies, few experienced, forcing companies to charge educational institutions with differentiated qualifications, in addition to spending millions of dollars in training.

As Professors get acquainted in student-centered methodologies, students will be led to reflect, analyze, solve problems, and seek solutions for case studies. The use of these methodologies presents itself as a potential alternative to resolve the difficulties in relation to the assimilation of content and to integrate competences required by today's society in the training of professionals(Kokotsaki et al., 2016).

Active learning methodologies seek to create learning situations in which students put knowledge into action, think and conceptualize what they do, build knowledge about the content involved in the activities they perform, as well as develop cognitive strategies, critical thinking and reflection on their practices, provide and receive feedback, learn to interact with colleagues and professors, explore attitudes and values, both personal and social (Berbel, 2011; da Silva Pinto et al., 2014; Morán, 2015).

The I4.0 era requires high cognitive skills, which requires transformation in the higher education system. Based on these reflections, this work sought to investigate how students feel prepared for this challenge, and how professors see this academic formation in the face of so many changes.

4. Results and Discussion

This study is based on a qualitative research of an applied nature, in which it was sought to discover what the students and professors think regarding the competencies for this new revolution in the industry. As a data collection instrument, a questionnaire consisting of thirty-five (35) questions was built, divided into three dimensions: intrapersonal (12), interpersonal (9) and didactic (14). These dimensions were based on the necessary soft-skills to be developed, such as communication, attitude, interaction with peers, autonomy, creativity, problem solving and collaborative work.

The research took place in two public, federal institutions in Brazil. One in the city of Salvador Bahia, and the other in Maceió, Alagoas. The target audience were three groups of students. The first consisted of Control and Automation Engineering undergraduate students and the second, graduate (Master and PhD in Mechatronics), both from the Federal University of Bahia (UFBA). The third was composed of students from the Bachelor of Information Systems (SI) course at the Federal Institute of Alagoas (IFAL), totaling 106 people. The profile of the population was traced: regarding gender (14 women and 92 men); as for age (up to 21 years old - 27; between 22 and 30 years old - 53; between 31 and 40 years old - 17; over 40 years old - 9); as to the modality - all in person.

A questionnaire was also applied to the professors of the two public institutions, totaling 28 responses, of which 12 professors from UFBA and 16 from IFAL. Their profile is summarized as follows: regarding gender (6 women and 22 men); as for age (up to 30 years - 1; between 30 and 40 years - 14; between 40 and 50 years - 8; over 50 years - 5; as for training (2 specialists, 12 masters and 14 doctors).

4.1 Data Analysis

In the questionnaire, all questions were of a linear scale[2] (5 - Totally agreed; 4 - Partially agreed; 3 - Relatively; 2 - Partially disagreed and 1 - Totally disagreed). The data analysis was based on the skills

[2] Created in 1932 by the American psychologist Rensis Likert, the Likert Scale is a psychometric response scale used most often in customer opinion surveys. Being one of the main KPI's (*Key Performance Indicator*) of research in the world, the scale is one of the oldest and most traditional indicators.

needed to this professional from industry 4.0 and whether they are being developed in the context of undergraduate and graduate higher education.

The analysis of the intrapersonal dimension was based on questions that seek to investigate how the skills that are so necessary for this new professional in I4.0 are being developed, which are: communication, autonomy, discipline, creativity, proactivity, problem solving, conflict resolution and analytical resolution. Regarding the communication competence, the question inquired if the subject is easy to communicate. Figure 3 shows the professor and student perspective about this competence:

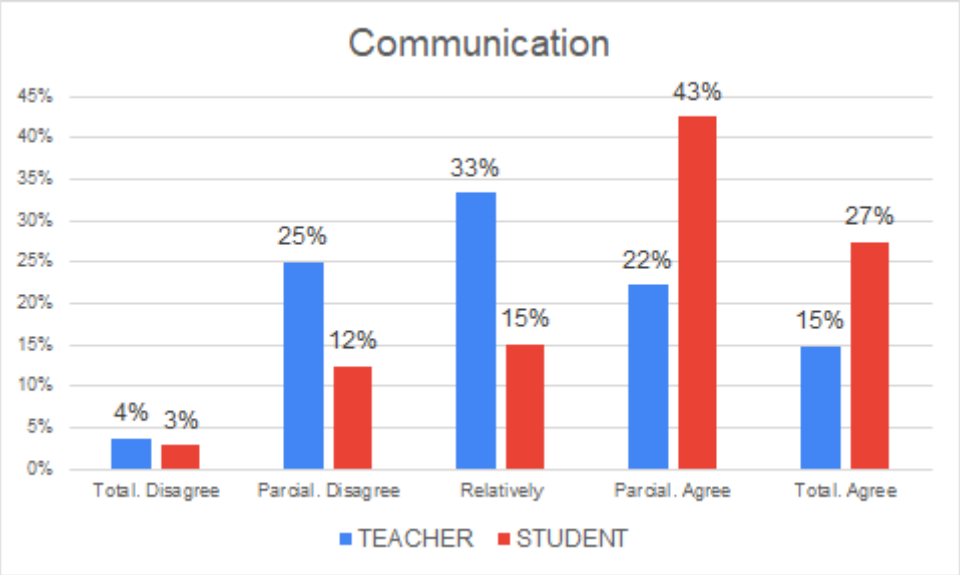

Figure 3 - Communication competence

Source: Authors

A significant difference can be seen in practically all responses from professors and students, the largest of which is 21% in the "partially in agreement". In this new revolution, communication is essential among its professionals, including interpretations from systems and machines. In the industry, instant communication of the various links in the production chain must take place from development to post-sale of the product. When you have good communication in the company, collaborative work is facilitated. For Wilson and Daugherty (2018), engineers will have to form a symbiotic partnership with intelligent machines, requiring some social skills such as emotional intelligence, communication, critical thinking, collaboration, leadership and teamwork.

As for the creativity competence, students and professors responded as shown in Figure 4:

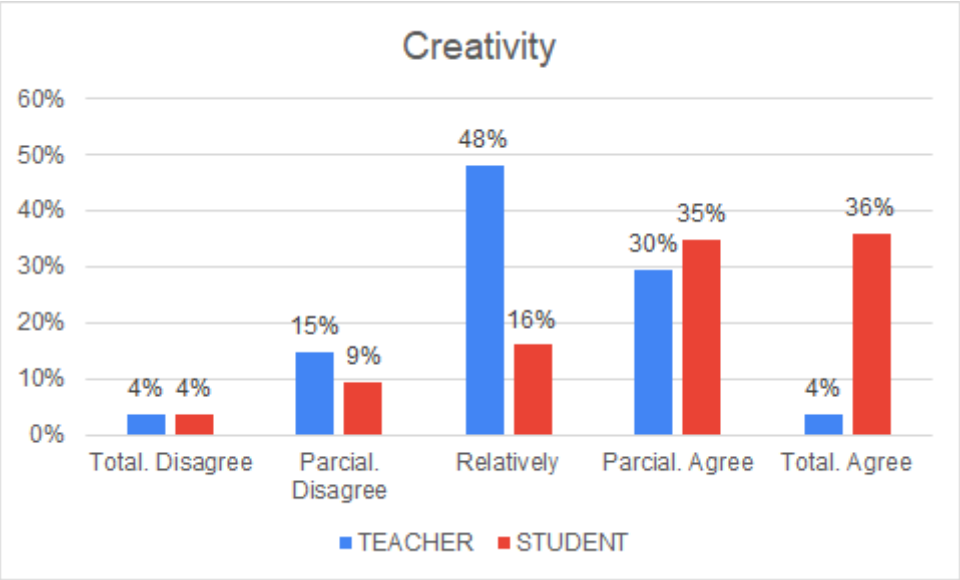

Figure 4 - Creativity Competence

Source: own authors

In the perception of professors, 4% of students are "totally creative", while 36% students perceive themselves as creative. Once again, there is a difference in perspectives of more than 32%. Considering that traditional methods are based on repetition, there is little room to develop creativity (McCharty & Anderson, 2000). Educational curricula needs to guide learning in order to develop creativity and innovation in the context of I4.0 (Lensing & Friedhoff, 2018).

As for the problem solving competence, the question raised was about the ease of solving problems. Once again, there is a discrepancy between the responses, as shown in Figure 5.

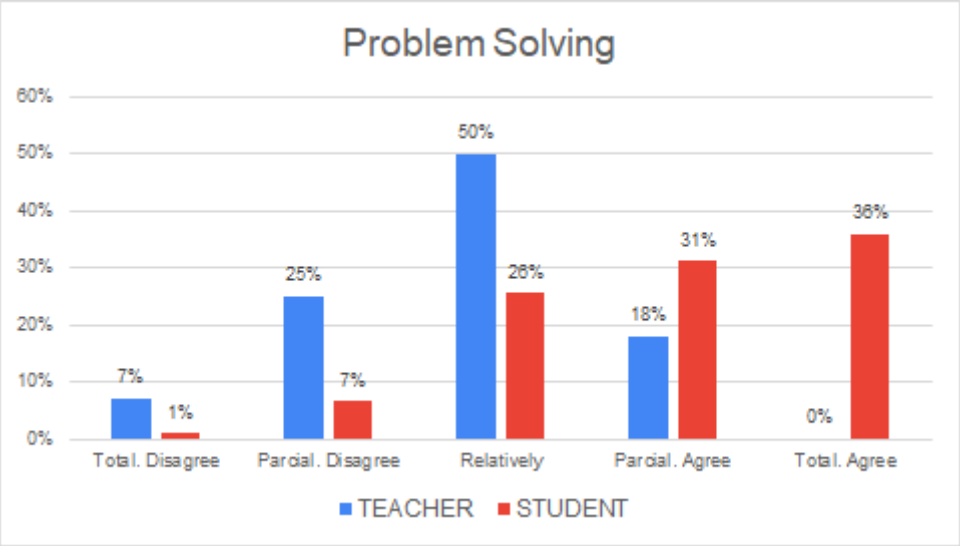

Figure 5 - Problem Solving Competence

Source: authors themselves.

As for this competence, 36% of the students believe they are fully able to solve problems, and 31% partially, however, their professors do not see anyone fully fit, only 18% partially fit and 50% relatively

against 26% of the students. This competence is extremely important in this new market context. For Aires (2017, p. 13) :

"In addition to technical knowledge, professionals need to know how to put their knowledge into practice, solving problems with creativity and innovation, generating value for the organization in which they are working, contributing to the construction of the competitive advantage necessary for the organizations of the fourth industrial revolution ".

As for the conflict resolution competency, the differences are even greater between the perspective of professors and students, as shown in Figure 6:

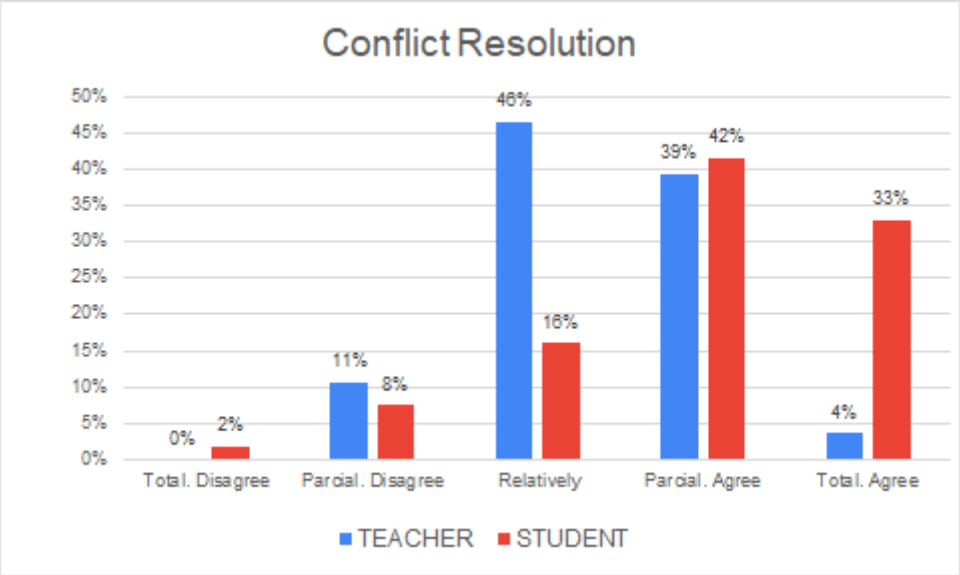

Figure 6 - Conflict Resolution competence.
Source: authors themselves.

According to professors, 46% of students are relatively able to resolve conflicts, 39% partially able and only 4% fully qualified. On the contrary, 33% of students feel totally fit, 42% partially and only 16% relatively. This difference of 30% is quite significant and needs to be investigated further in order to discover if students feel ready for the work environment or have issues within the scope of learning with colleagues.

A very important competence in this new context is the analytical resolution of data, as shown in figure 7:

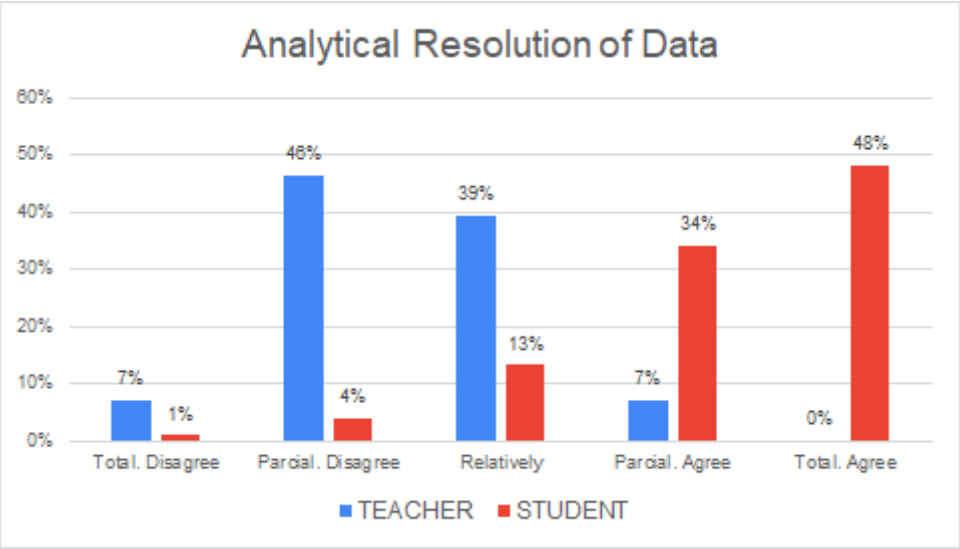

Figure 7 - Analytical Data Resolution competence
Source: authors themselves.

Regarding the analytical resolution of data, there is a huge discrepancy between the perspective of the student and the professor. According to Figure 7, 48% of students claim to be “totally in agreement”, 34% “partially” and 13% “relatively”, 4% “partially disagree”. Their professors, on the other hand, provide discrepant data: 0% “totally agree”, 7% “partially”, 39% “relatively” and 46% “partially disagreed.

According to Grybowska and Lupicka (2017, p. 3) "analytical skills are the ability to visualize, collect information, articulate, analyze, solve complex problems and make decisions". For engineering and computer science professionals, to which the questionnaire was applied, this is an essential competence to be developed.

As for the interpersonal relationship, we consider the concept defined in the field of sociology that means a relationship between two or more people. It is inserted in several contexts: family, school and work. In this work, we evaluated this concept through observations regarding the competencies of collaboration, leadership and autonomy.

In this context of collaboration, the responses remain divergent between the groups, as shown in Figure 8:

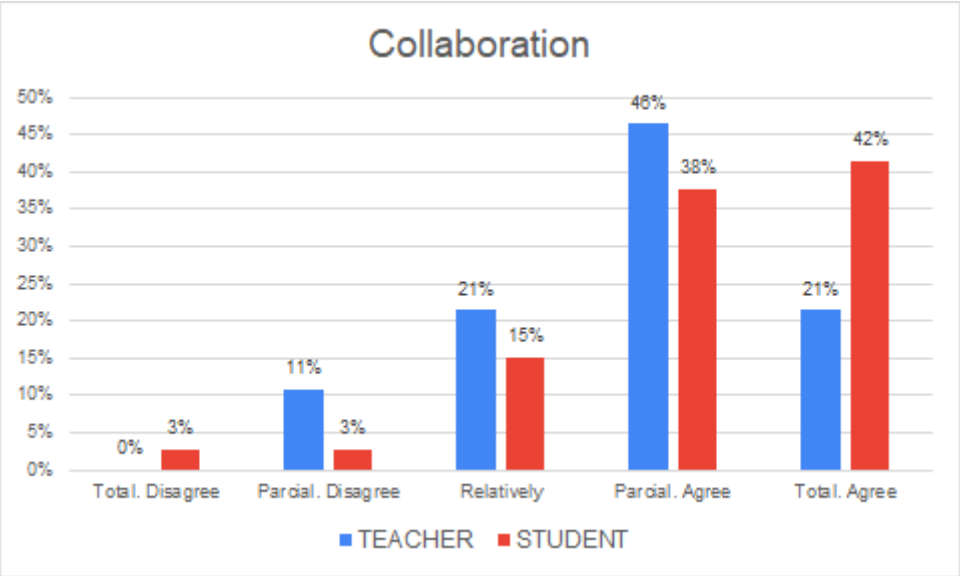

Figure 8 - Collaboration Competence
Source: authors themselves ..

In this competence, there is a significant difference of 21% in the “totally agree” response, contrasting to 7% and 8% compared to other responses. In higher education, it is necessary to encourage collaborative work, as well as the use of tools that help in this process, such as project and activity management in order to foster communication skills between participants.

Thus, it is necessary to build a more flexible educational system, supporting learning for life, seeking to guide the student towards a collective production path, but, at the same time, opening the paths for self-regulated learning. According to the authors (Brockett & Hiemstra, 1991; Candy, 1991; Knowles, 1975), in self-directed learning the learner has a goal to be fulfilled, thus establishing his needs, defining his goals, searching for physical and virtual resources and monitoring his progress. In addition, the interaction among other apprentices and the commitment to the development of individual skills such as: morality, motivation, engagement, proactivity and autonomy. Figure 9 shows the answers related to autonomy skills, referring to the idea of a student guiding his own self-directed learning processes. There was a minor difference in some responses from students and professors. This chart consists of three (3) common questions for students and professors (Q1, Q2 and Q3), totaling 6 answers.

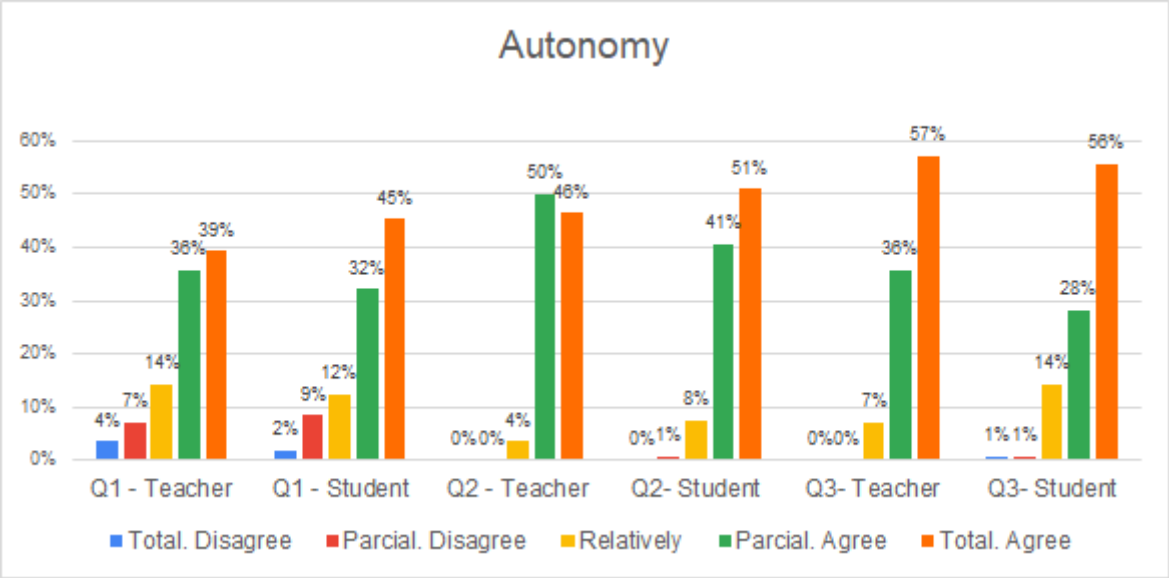

Figure 9 - Autonomy competence.
Source: authors themselves.

The first question (Q1) was whether the subject believes that the interaction with colleagues in the classroom or virtually, positively influences the development of their autonomy. The result was 39% of professors and 45% of students totally in agreement. In the second question (Q2), they were asked whether the use of information and communication technologies (ICT) influences autonomy in the learning process. In this question, the difference was smaller, with 11% in the "partially agreed" and 5% in the "totally agree" response. The third question (Q3) was whether they believe that by participating in extra-class activities, such as research projects, results in greater autonomy in their learning. In the answer “totally in

agreement", it was practically the same percentage of professors (57%) against 56% of students. Vygostky (1980) and Piaget (1973) postulated that the individual's learning process occurs through interactions with the world, considering, as a criterion, the individual's age related to the context. These new generations learn through interactions, the collaboration of networks, using technological resources. They want to understand how things happen and not just walk into a room and passively listen to a professor lecturing Figure 10 provides a summary of the questions (Q1, Q2 and Q3) of professors and students related to proactivity: Q1) In general, you realize that students are interested in knowing what happens in the labor market in order to be able to seek new knowledge? Q2) Do students suggest texts, bibliographies, websites, videos and films that are related to the course subjects for their colleagues? Q3) Do they suggest to the professor other subjects that he would like to learn related to the discipline?

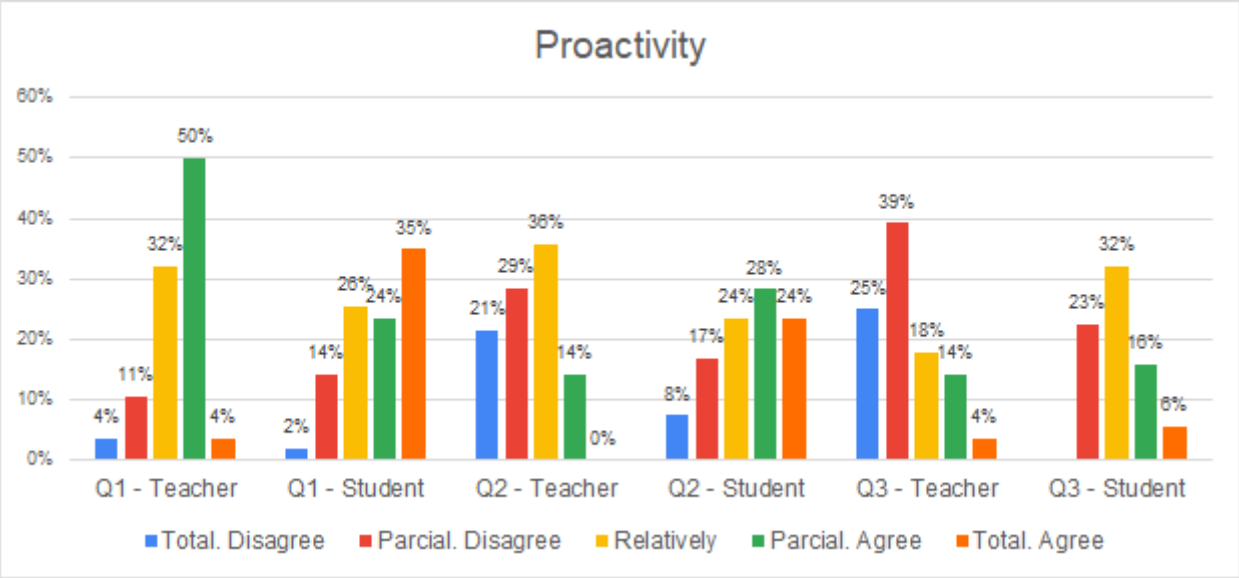

Figure 10 - Proactivity competence

Source: Authors themselves.

Once again the answers are quite divergent. In Q1, only 4% of professors are "totally in agreement", against 35% of students. In Q2, the difference narrowed to 24%, but they are practically opposite in the answer "totally in agreement". 24% of the students claim that they suggest books, websites, videos for their colleagues, whereas for the professors the percentage was zero (0%). In Q3 there is also a difference of 24%, but now the opposite, in the "totally disagree" answer, students 0% against 24% of professors.

For Cotet et al. apud Maisiri et al. (2019, p. 15), "the three main social skills required to an employee in the Industry 4.0 era are: creativity, emotional intelligence and proactive thinking".

Finally, to the technical knowledge competence analysis, a group of 3 questions for both groups were selected: Q1) Is there a balance between theory and practice in your course ?; Q2) Is the course curriculum geared towards the job market ? Q3) In the course, subjects related to industry 4.0 are approached and contextualized, such as: Cloud Computing, Big Data, IoT, Artificial Intelligence ? The answers are shown in Figure 11:

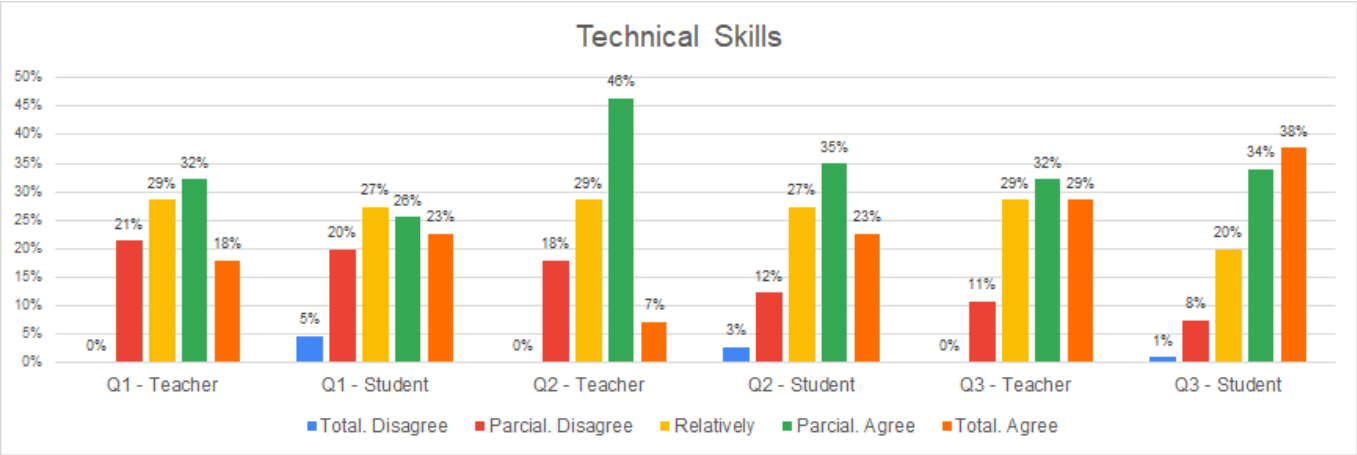

Figure 11 - Technical Skills

Source: authors themselves.

In figure 11, the answers to Q1 differ slightly between them, the biggest difference being 6%. However, in Q2 there were significant differences in the two responses. In the answer "totally in agreement", the difference was 16% in the responses of the students in relation to the professors, in the "partially in agreement" it was the opposite, 35% of the students believe that the course is geared towards the market, against 46% of the professors . And in Q3, two responses in "totally agree" and "relatively", the difference was 9%. This analysis raises relevant questions, such as: do students know the real needs of the market? Are the labor market issues discussed in the courses? Are there joint actions between companies and universities? These issues need to be further explored in each educational institution with the reality of each course.

Thus, this section presented the analysis on the point of view of professors and students in relation to the competencies required for I4.0. However, considering several divergences between the answers, we consider the need for another comparative parameter. Section 4.2 contrasts the result collected here with another dataset from a national test applied in Brazil to undergraduate students. The data collected are related to the Control and Automation Engineering (CAE) and Information Systems(IS) courses that are part of our study population.

4.2 Considerations on the Data Analysis

Based on the skills needed by professionals for industry 4.0, the perspective of CAE and IS students is positive. They believe to be prepared for this new market reality. However, there is a disagreement in some responses from students and professors. In order to improve our data analysis, the results of the National Student Performance Exam (ENADE), which is part of SINAES (National Higher Education Assessment System). According to Nascimento et al. (2019) , "ENADE comprises a test with questions that assess general training skills (GTS) and the specific component (SC)". TS has content related to ethics, citizenship, democracy, environment, sustainability, globalization, multiculturalism, accessibility and social inclusion, encompassing skills such as collaboration, problem solving, autonomy, communication and conflict resolution. The SC, on the other hand, aims to gauge the competences, skills and mastery of knowledge necessary for each profession. In order to obtain this knowledge, didactic issues are involved.

Thus, to better clarify the students' answers, we sought ENADE data from the courses surveyed in the last two years that were evaluated, 2014 and 2017.

In the questionnaire, there were questions that correspond to some general training skills (7 questions) and about specific knowledge of the area (4 questions). Based on the students' and professors' responses, an arithmetic average of the responses "totally in agreement" and "partially in agreement" was created to compare with the results of ENADE in the courses of control engineering and automation (UFBA) and Information Systems (IFAL). Figure 12 shows the averages of the general education of ENADE in the years 2014 and 2017, and figure 13 the average of the responses of students and professors.

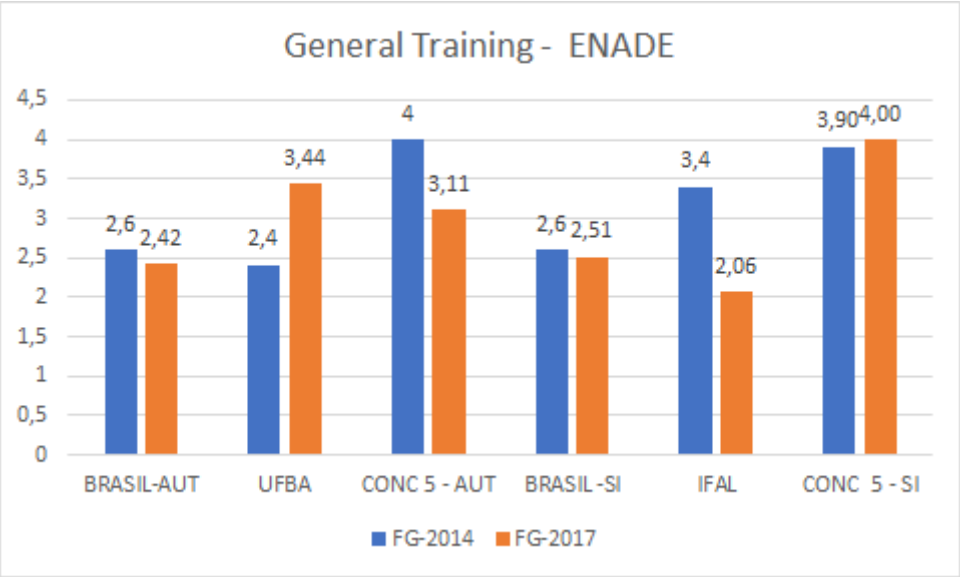

Figure 12 - Average FG ENADE

Source: INEP data elaborated by the authors

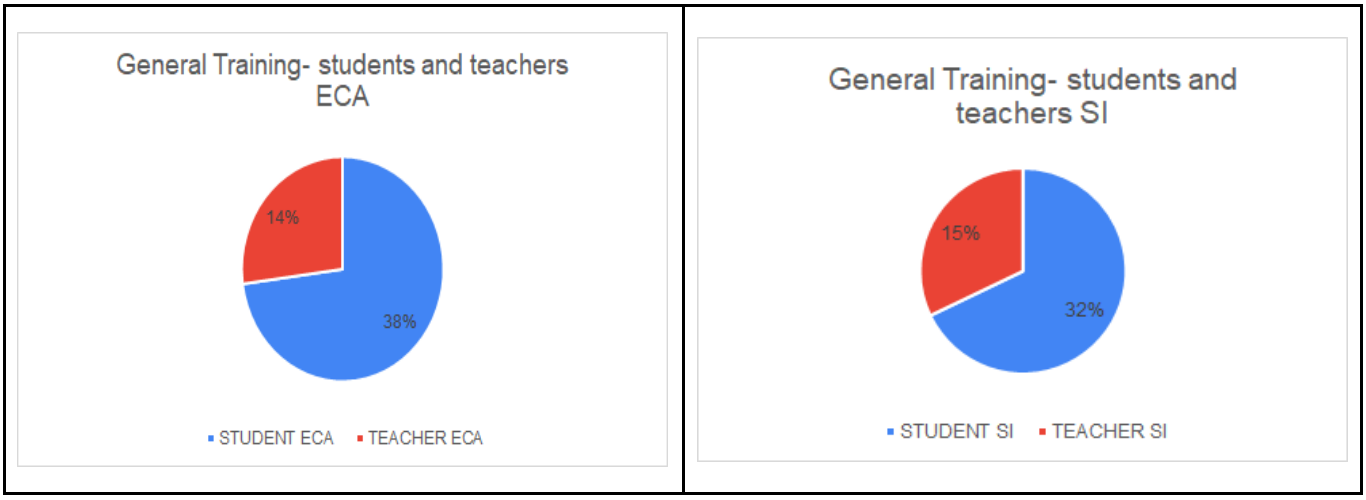

Figure 13 - Average TS students and professors surveyed.

Source: authors themselves

Regarding general education, 38% of CAE students said they were "totally or partially agreed" on issues related to competencies, whereas professors only agree on 14%. Comparing these results with ENADE, in 2014 the CAE course was 7.7% lower than the national average. Thus, in 2017 it had a big increase, getting

42% higher. CAE also had a significant improvement, since in 2014 it was -40%, and in 2017 it was + 10.6%, with an increase of 50.6%. According to Nascimento et al. (2019, p.5), "in this scenario, only UFBA obtained a sharp increase in the GTS grade, suggesting that students had more access to content related to democracy, culture, globalization and the environment, among others addressed in this section of test". Thus, there is a significant increase in the grades of the students' general education, confirming the positive perception of the students surveyed.

In the IS course, the average was 32% of students versus 15% of professors. In the results of ENADE in 2014, the average was 30.7% higher than the national average. Therefore, in 2017 it was down by 18%. In the case of SI, the results contradict the students 'perspective and are in line with the professors'.

Figure 14 shows the average of the specific knowledge of the CAE and SI courses at ENADE in the years 2014 and 2017, and figure 15 and the average of the students and professors surveyed.

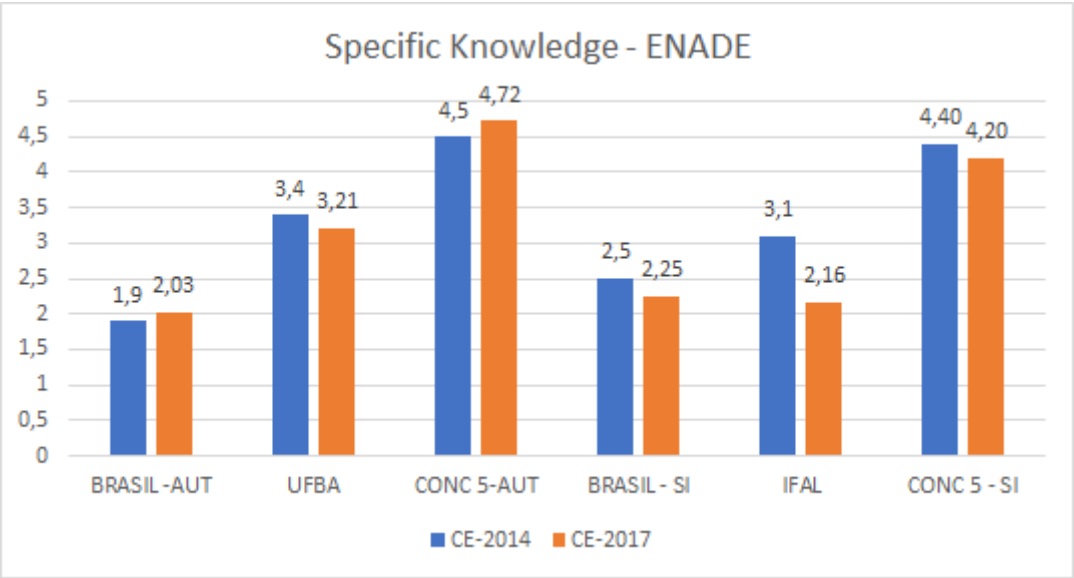

Figure 14 - Average SC of the CAE and SI courses

Source: INEP data elaborated by the authors

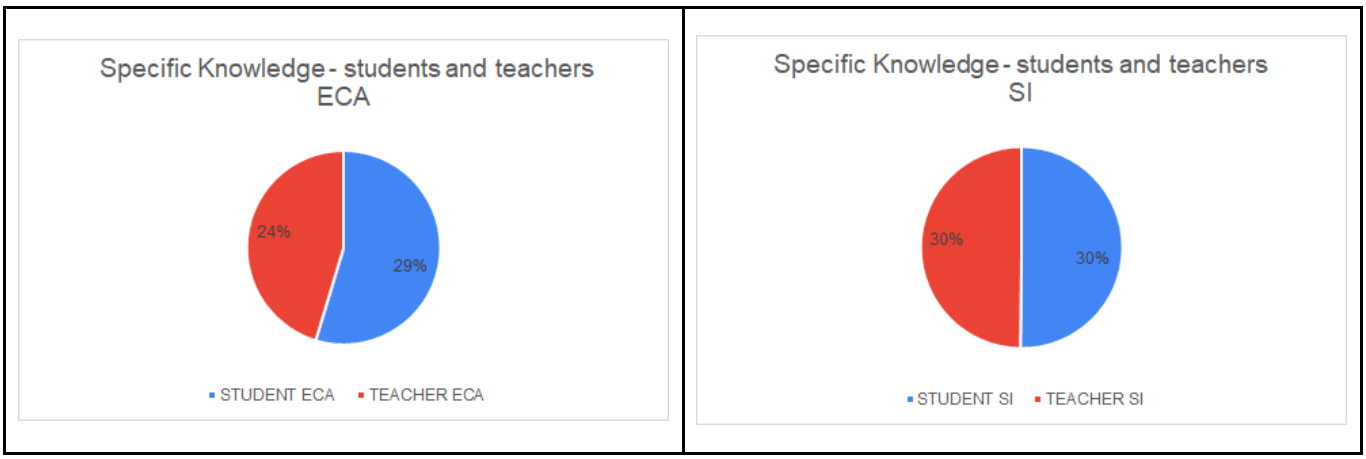

Figure 15 - Average SC of the students and professors surveyed.

Source: authors themselves.

In terms of specific knowledge, the responses of those surveyed were similar in both courses, 29% of CAE professors agree that students have "totally or partially" technical skills, this percentage is very close to students 24%. In 2014, CAE (UFBA) compared to the average in Brazil had a score of 78.95% higher (which is an excellent result), and in relation to courses with a grade 5 it was -25%. In 2017, the grade fell compared to 2014, but it was still above the national average by 58.13%. It can be seen, therefore, that despite decreasing 7.5% in relation to 2014, it was above the average of Brazil, with the respondents' responses being consistent with the ENADE results.

In the IS course, professors and students agree when talking about specific knowledge, 30% was the average of the two groups. As for ENADE, in 2014 the average was 24% higher than the national average, so in 2017 there was a significant drop and it was below 4%, a difference of -28% in relation to 2014. In this case of the information systems course, the research results differ significantly from ENADE.

In view of the results discussed, it is considered that higher education institutions and professors need to align themselves with the cognitive and emotional skills that are part of general education. Some actions can be taken, such as: performing a diagnostic evaluation; make use of active methodologies in the learning process; make partnerships with companies so that there is a greater exchange between academia and the productive sector.

Selamat, Taspir, Puteh, and Alias (2017) claim that teaching methods and organizational structures in future higher institutions will change significantly. There will be interdisciplinary training, massive open learning and personalized learning. Technological advancement is happening rapidly; thus, educational institutions must adapt to correspond to innovation cycles.

5. Conclusion

The fourth industrial revolution is here to stay. The purpose of facilitating and expanding the productive processes, making the interaction between men and systems, based on the latest technologies such as cloud computing, robotics, artificial intelligence, *big data*,systems *cyber* physical, among others. The great need for digitization points out that workers in these areas that will be impacted by this revolution will need to develop skills that meet the requirements demanded by the different sectors to keep up with the advances of this new industrial revolution. Therefore, a consultation to courses in the STEM field that are directly related to I-4.0, which will be essential for the preparation of these professionals for this new market.

According to CNI (2016) , there are still many challenges to be overcome, ranging from "investing in equipment that incorporates these technologies, changing the layout, processes and forms of relationship between companies along the production chain, without forgetting the training of employees who have new skills ". These competencies are linked to the ability to deal with the new technology.

The profile of the contemporary professional requires a person with ethics, who is environmentally conscious, disciplined, willing to do things differently, knows how to lead, solve problems and conflicts, who works collaboratively, adding organizational productivity. Along with the technological innovation that underlies each industrial revolution, a new worker profile is required (Teixeira Filho, 2000), mainly in relation to his knowledge and skills to deal with new technologies. For Maisiri et al. (2019, p. 6), "there

must be collaboration between industry and higher education institutions must be fostered to promote real-world problem solving".

The study shows that, in the student's view, they are able to face I4.0, however, this reality contradicts the view of the professors and the results of the ENADE test. It is necessary to work on the development of behavioral and emotional skills in their academic life, as well as making alliances with the industry so that students work closer to their reality.

As a matter of fact, we live in a society with information overload, generating anxiety and distress. There's little space to our inner, emotional life. The intrapersonal dimension looks into how attitudes can be managed and improved, in order to develop them throughout academic life. It was noticed that the biggest divergences happened in the intrapersonal dimension where the communication competence 42.5% of the students "partially agree", different from the 22.2% of the professors. In creativity, the divergence is huge, only 3.7% of professors are "totally in agreement" against 35.8% of students. The differences become more significant in problem solving (PR), conflicts (CR) and analytical data resolution (RAD), where the students' responses in the "totally agree" option are, respectively, 35.8% (PR) , 33% (RC) and 48.1% (RAD) against 0% of professors.

In collaboration, 41.5% believe they are "fully collaborative" against 21.4% of professors. With regard to autonomy, proactivity and technical skills, there was greater agreement in all responses from both groups. Some other variables such as curriculum, infrastructure, methodologies, use of digital information and communication technologies (TDIC) influence this student's training process, therefore, the focus of the study was to know how students feel about this new professional profile for industry 4.0 .

With the effective use of technologies, many physical and mechanical jobs will be replaced by computers. Industry 4.0's advanced technologies and automated systems are increasing the level of complexity of the skills required in the workforce of the future. This interaction requires strong skills, not only from technical specializations, but also from non-technical ones, such as emotional intelligence, critical thinking, creativity, innovative communication, proactivity, collaboration, and teamwork.

After analyzing the data, some actions are suggested to help in the development of this professional profile based on the interpersonal and interpersonal dimensions. With regard to the interpersonal dimension, issues such as collaboration, proactivity and autonomy can be developed together with the didactic dimension in the use of active methodologies. Two questions were related to methodology, the first asked whether the professor's methodology influences his learning process, 67% of the students were "totally in agreement" versus 42% in the professors' opinion, a significant difference of 25%. As for the second question, if the use of active methodologies in the evaluation process contributes to the student's autonomy, 49% of the students are "totally in agreement" versus 42% of the professors. The use of these active methodologies collaborate in the development of intrapersonal and didactic skills such as problem and conflict resolution, collaboration, proactivity and communication. (Baygin et al., 2016).

As future works, a more in-depth study including the employers of I4.0 is crucial. Their view will help define and compare the skills considered in the literature with the real world. In addition, complementing the vision of employers with students and professors can add a more precise understanding of the reasons for so many differences over professional training and a greater interaction between industry and academia to solve real problems.

6. Acknowledgement

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Public Policies and Innovation Ecosystem within the Technological Innovation Center of the Federal Institute Baiano: strategic analysis of actions, programs and projects

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Abstract

Innovation policies have been gaining ground in the Brazilian scenario, requiring a strategic look at innovation activities by organizations in the conception of technologies. The article aimed to analyze the actions, programs and projects that are driving the innovation ecosystem of the Technological Innovation Center of the Federal Institute of Bahia (NIT IF Baiano) with a view to strengthening Innovation Policies for local and regional development. The research had a qualitative, descriptive, exploratory approach, documentary research and content analysis. Several actions were found to foster innovation, the main ones being: scientific and technological dialogues, seminars. Thus, it was evidenced in this research that

within the scope of IF Bahia the Innovation Policy for the management of Intellectual Property (IP) and Technology Transfer was recently regulated and, as a reflex, it was found that its IP indicators are retracted, for example the patents, trademarks and software. On the other hand, the scientific initiation programs received scholarships and the research projects developed managed to exceed the programmed goals. Finally, the NIT IF Baiano must remain supporting innovation policies to support the institutional Innovation Policy in order to leverage its technological indicators.

Keywords: public policies; innovation ecosystem; technological innovation nucleus; strategic analysis.

1. Introduction

The importance given to innovation is currently growing, which makes it necessary to adopt strategies that make them more competitive by Scientific, Technological and Innovation Institutions (STIIs), since innovation ecosystem drives the creation of entrepreneurial and innovative environments. Thus, Public Policies are essential elements to achieve objectives and direct technologies to the productive sector, as these norms lead STIIs to maximize their actions (Ikenami et al., 2016).

In Brazil, public policies on innovation are being encouraged, in order to promote the strengthening of the innovation system, which links several organizations, with the intention of regulating their actions and following guidelines for socioeconomic development (MCFS Pires et al., 2020). According to Avellar and Botelho (2018), the interaction programs among companies and public members of the Innovation System (IS) have gained relevance. The stimulus of Research and Development (R&D) by the productive sector and internationalization of public STIIs represent some of the challenges in the development and consolidation of the IS (Sidone et al., 2016).

In this context, there are Federal Institutes (FIs) that offer professional education and which are structured in pluricurricular and multicampi format in many provincial cities located in different states of Brazil. They have the purpose of training and qualifying citizens to work in different sectors of the economy, emphasizing national development (Brazil, 2008). It should be noted that the FIs are STIIs, and they are part of the Federal Education Network, being leaders of the organizational innovation policy, strengthening the consolidation of the National Innovation System (Souza, 2020).

Innovation systems encourage creation and development of technologies, providing socioeconomic impacts (Manjarrez et. Al., 2016). In the face of social demands, several technological innovations were presented as essential actions to regulate the culture of entrepreneurship and innovation in organizations, based on the expansion of activities of FIs and universities (Monteiro et al., 2019). According to Coelho and Dias (2016), several Technological Innovation Centers (NITs) disseminate the innovation culture and file many patents, without worrying about the financial share provided by the Technology Transfer.

Therefore, FIs have a primary role in stimulating innovation in order to promote scientific and technological production. Thus, the FIs aim to encourage the creation of environments for innovation and development oriented to entrepreneurship activities in technological parks and centers (Brasil, 2018). To this end, FIs shall be more prepared to offer entrepreneurship incentive programs with the approach of agents who encourage such actions (Rodrigues & Gava, 2016).

Therefore, this strengthening of FIs is contributed by the institutional innovation policy, reflecting positively on the actions, programs and projects carried out on innovation. Public policy makers of innovation in developing countries are investing in science, technology and innovation (S, T & I) aiming at achieving sustainable development, creating startups of S, T & I stimulating entrepreneurship (Surana et al., 2020). Thus, startups are considered as companies that arise involving new business supported by technology, using innovative ideas oriented to the market (Hernández & González, 2016).

It should be noted that the Law no. 11,892/08 regulated the Federal Institutes of Education in Bahia, as it was in this context that the Federal Institute of Education, Science and Technology Baiano (IF Baiano) was born, in 2008 (Brazil, 2008). This organization has a fundamental role in local and regional development in Bahia. According to the IF Baiano (2019), the institution has fourteen *Campi,* it subsidizes fourteen online education centers, in addition to having an administrative unit in Salvador, called Rectory and a Reference Center.

In view of the above, the Federal Institute of Education, Science and Technology Baiano is one of the key actors in activities aimed at teaching, research and extension available to the community, contributing to the production of knowledge and technologies. Thus, the strengthening of Technological Innovation Center of the Federal Institute Baiano (NIT IF Baiano) due to the innovation legislation and the increase of new responsibilities listed in the New Legal Framework for Science, Technology and Innovation (S, T & I) are essential in fostering innovation.

The New Legal Framework of S, T & I strengthened the NITs to manage the innovation policy in STIIs, as well as to make agreements aimed at technology transfer (Rodrigues & Gava, 2016). Among their attributions, they shall promote interaction with the productive sector, performing strategic actions aimed at scientific and technological promotion, contributing to research evolution in Brazil (Brazil, 2016).

In this context, from the growing search for innovation based on its public policies, and considering regulations of the new legal framework of S, T & I, the IF Baiano postures the question: **what actions, programs and projects are driving the innovation ecosystem of the NIT IF Baiano with a view to strengthening Innovation Policies for local and regional development?**

This study aimed to analyze which actions, programs and projects are driving the innovation ecosystem of the NIT IF Baiano aiming to strengthen innovation policies for local and regional development. Therefore, a strategic analysis of the arsenal of activities oriented to innovation of the NIT IF Baiano, can contribute to the interaction of the innovation ecosystem and its Public Innovation Policy.

This work sought to corroborate the Public Innovation Policies of IF Baiano, which are essential tools for fostering innovation and for providing interaction among different actors. S, T & I policies are essential in improving democracy and the STIIs involved aim to cooperate in the optimization of interactions, government and society (Garcia et al., 2017). In view of the above, the NIT IF Baiano will have subsidies to improve the institutional Innovation Policy, as well as providing the sector with a holistic view of innovation activities, making it possible to strengthen its interaction with the innovation ecosystem.

The results of this study demonstrate that S, T & I policies and the connection of institutions in innovation ecosystems are promising strategies for the progress of technological innovation and for the constitution of entrepreneurial environments in Brazil. Thus, this research has theoretical and practical relevance, both for the IF Baiano and for Federal Institutes in the northeast region of Brazil that are overcoming challenges in

fostering innovation.

In theoretical terms, it is expected to advance in discussions regarding the maximization of FIs' ecosystems in boosting their public policies. Regarding practical contributions, this research will seek to elucidate strategies to IF Baiano's managers, in order to strengthen decision making, with the objective of leveraging their Intellectual Property indicators and transmitting them to the market.

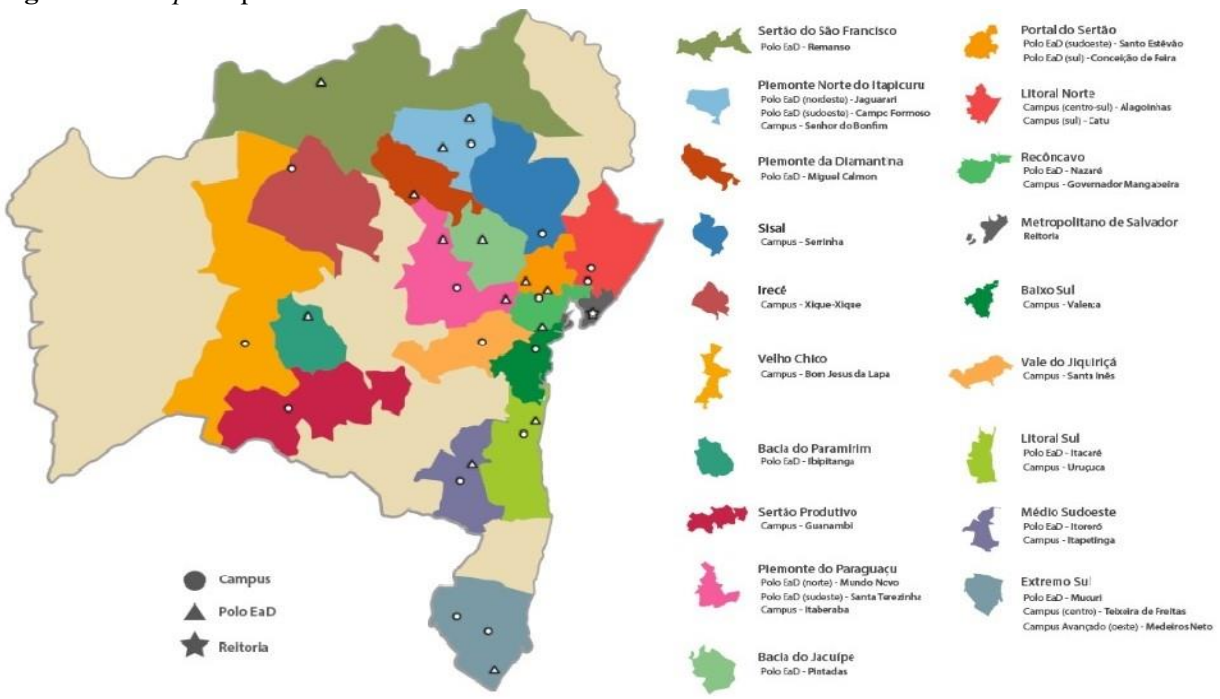
Thus, this work has an introductory structure, followed by the methodology section. After, there is the third section represented by the literature review that addresses public policies and innovation ecosystem in Brazil, and another section encouraging technological innovation cases of NITs of the FIs in the Northeast region. The fourth section refers to the results and discussions, and lastly there is the final considerations.

2. Methodology

2.1 Analysis unit

The NIT IF Baiano was analyzed between the years 2015 and 2019, the period of constitution of institutional documents of IF Baiano. It is worth mentioning that it has been verified that, to date, the 2019 Management Report data has not yet been made available to reference the activities related to this period. This public STII is located in Bahia, being formed by the former Federal Agrotechnical Schools and the Regional Agricultural Medium Schools of CEPLAC (Executive Committee of the Cacao Plantation Plan).

Figure 1- *Campi* map of IF Baiano.



Source: IF BAIANO (2019).

2.2 Research characterization

In order to analyze actions, programs and projects that are driving the innovation ecosystem of the Technological Innovation Center of the Federal Institute Baiano (NIT IF Baiano) aiming to strengthen

Innovation Policies for local and regional development, a qualitative approach was used, with a descriptive and exploratory nature, as well as documentary research and content analysis.

The research was built addressing the subjects: innovation policies and ecosystem in Brazil and incentive to technological innovation: cases of NITs of the FIs in the Northeast region, through literature review and documentary survey of the IF Baiano. These themes enabled the content analysis of the NIT IF Baiano's strategic innovation actions and the exposure of bottlenecks that hinder innovation promotion.

The study had a qualitative approach, as it aims to provide a broad and approximate view of a fact (Gil, 2008). According to the author, the descriptive character can be determined by its objectives, enabling a new perspective of the problem, approaching the exploratory nature. Then, the description of S, T & I activities of the NIT IF Baiano for being strategic in the institution and for managing intellectual capital. The research is characterized as exploratory, since it deepen the study on the actions of NIT IF Baiano, being able to verify its challenges aiming to boost the innovation ecosystem.

The article is characterized as a documentary research, because it uses documents of any nature, generated and maintained by public institutions as well as private ones (Vergara, 2016). Therefore, information on the 2018 Management Report, General Regulation, Institutional Development Plan (PDI), NIT Internal Regulation was verified on the IF Baiano's website. Thus, for the analysis, discussion and scope of the research results, the technique of content analysis was used in order to interpret the data.

According to Bardin (2011), content analysis is a grouping of methodological resources in permanent improvement, which can be applied to extremely different discourses; this instrument makes an objective description of the information for its interpretation. Hence, scientific evidence and S, T & I regulations that collaborated in the information analysis of official documents of the NIT IF Baiano's activities concerning the innovation can contribute for the relevance of the present study.

2.3 Stages, procedure and methodological strategy

The research presented was divided into six stages to achieve the proposed objective. The initial stage included an exploratory research with a theoretical survey to carry out a literature and documentary review aimed at collecting data oriented to innovation, extracted from the IF Baiano's website and official documents. In the second stage, a filter of the theoretical survey was carried out, selecting studies that were related to the theme, as well as identifying innovation activities in official documents of the institution.

In the third step, the IF Baiano's patent, trademark and software registrations at the National Institute of Industrial Property (INPI) from 2011 to 2020, were analyzed. Thus, a search was carried out in this database, including the Registration Depositor's National Legal Entity Number (CNPJ), number "107.249.030.001/79" in the search engine, collecting data on Intellectual Property (PI) and interaction with the innovation ecosystem.

The fourth stage, on the other hand, was carried out on the website of the National Council for Scientific and Technological Development of Brazil (CNPq) in the Research Group Directory, and on the Lattes Platform. In this stage, the institution's research group was first investigated, verifying data such as: quantitative, knowledge field and *Campi* location; these data were obtained in the search field using the expressions: "IFBAIANO" and "baiano". Afterwards, a research was carried out on the Lattes Platform collecting data on the number of professors with exclusive dedication (DE) and doctorate degree who

contributed to the Intellectual Property (PI) of the IF Baiano; those who had registered patents' orders at INPI were used in this search.

In the fifth stage, content analysis was used to compare the information collected to foster innovation related to expected goals, actions performed in the PDI and the institution's management report, with other works that demonstrated practical and realistic evidence. Thus, this analysis will inform if the actions were effective and served as support in the identification of strategic actions: those that are already carried out in the institution, as well as those that can be implemented to leverage Intellectual Property (IP) and stimulate innovation.

In the last stage, the research result identified that the NIT IF Baiano carries out several actions, programs and projects that are drivers of the innovation ecosystem with a view to strengthening Innovation Policies for local and regional development. Despite this, it was also shown that this sector experiences the same challenges as other NITs in the Northeast region. Thus, boosting its innovation ecosystem, generating new technologies and enabling its transfer to the market is essential for economic and technological development.

3. Literature review

3.1 Innovation Policies and Ecosystem in Brazil

Due to the need to leverage socioeconomic development and minimize regional inequalities generated by insufficient resources and demand required by society, the real inclusion of innovation and technological growth in organizations has been verified as important elements in order to sustain competitive advantages in the secondary sector of the economy (MCFS Pires et al., 2020). Szopik-Depczyńska et al. (2020) considers that the regions represent relevant areas for the conception, absorption and propagation of innovation, in addition to being a key element of competitiveness for the centers at national and international level.

Given this context, public policies can be considered fundamental instruments to drive innovation, as well as collaborating to strengthen competitive advantages in organizations. Therefore, innovation policies in the regions must be developed based on the characteristics of innovation environment, assessment of investment sources in Research and Development (R&D), network dimension, among other aspects (Min et al., 2020).

Public Policies that foster innovation have guidelines related to actions that encourage innovation, scientific research and emergence of technologies in organizations, strengthening and stimulating their engagement with the Brazilian productive sector. For this reason, the increase in R&D in institutions and the relentless search for knowledge are essential elements to reverse Brazil's low performance, requiring cooperation among public organizations and productive sector (Arbix & Miranda, 2017).

The Innovation Law (Law n. 10,973 / 2004) established that Brazilian Scientific, Technological and Innovation Institutions (STIIs) institute Technological Innovation Centers (NITs) in order to implement and manage their innovation policies (Machado et al., 2017). In addition, forecasts for concession of business incubators and possible sharing of infrastructure, instruments, personnel, public and private resources aimed at development and design of innovative products were included in the legislation on innovation

(MCFS Pires et al., 2020). Business incubators have the purpose of establishing companies and creating products/services through knowledge (MC Silva, et al., 2018).

In this context, there is the New Legal Framework for Science, Technology and Innovation (S, T & I) established by Law n. 13.243/2016, that was regulated in 2018 by Decree n. 9,283/2018, aiming at reducing the bureaucratization of public-private partnerships to encourage the development of technologies and scientific research in Brazil (Brazil, 2016; 2018). Given that, one of the purposes of the Legal Framework is to bring public STIIs closer to the private sector, stimulating innovation, and technological growth in the country (Sicsú & Silveira, 2016). The regulatory framework for innovation aims to boost Brazil in the innovation ecosystem, encouraging the creation of innovative spaces (Souza, 2020).

Innovation ecosystems have a fundamental role in technological development oriented to their members and influential regions. According to Marchini and Pereira (2019), these environments provide a cooperation among organizations, through strategic partnerships aimed at innovation processes, such as Research, Development and Innovation (RD&I), entrepreneurship, experience exchange with the productive sector, and business incubation (Spinosa et al., 2015).

Society is based on knowledge, and providing ways to improve the innovation ecosystem has become a relevant factor for economic progress. Therefore, Santos and Zattar (2019) report that the interaction among academia, entrepreneurs, productive sector and other actors of the innovation ecosystem can institute a knowledge flow in these places. Public STIIs, such as Universities and Federal Institutes (FIs) are considered to have sources of scientific and technological knowledge, as well as pieces of innovation ecosystems. In this context, these institutions can contribute to the growth of innovation systems in regions of several countries (Sun et al., 2019).

According to Kon (2016), interaction within an innovation ecosystem occurs in two ways of economic interconnection, through either knowledge economy that requires research and teaching, or commercial economy directed by the productive sector. For Bittencourt and Figueiró (2020), the innovation ecosystem establishment and its integration in networks of actors aiming at innovation, has the purpose of contributing to value generation for society. Therefore, the various interactions among innovation agents are essential with regard to S, T & I development, with the objective of promoting business-oriented competitiveness and improvements in a given territory benefiting its residents (Manjarrez et al., 2016).

For Garcia et al. (2017), the NIT has the competence to develop innovation policies focused on scientific and technological development. This NIT assignment requires the sector to structure itself internally, through staff training and qualification in order to perform interaction in various sectors of the economy. Given this context, the sector can promote partnerships, agreements and attract investments in R&D through strategic actions.

Hence, the sector can focus on structuring the innovation ecosystem and assist in strengthening institutional innovation policy by strategically analyzing institutional actions, programs and projects. Strategic analysis is carried out through performance indicators for innovation and scientific research. These benchmarks contribute to the evaluation of planned goals and whether they have been achieved. Accordingly, the innovation ecosystem establishment and its integration in networks of actors contributes to value generation (Bittencourt & Figueiró, 2020).

3.2 Fostering technological innovation: Cases of NITs of FIs in the Northeast region

Technological innovation in Federal Institutes (FIs) has been driven by the promotion of Intellectual Property (IP) and its strengthening in the innovation ecosystem can contribute to development of the region where they operate. STIIs through FIs seek to manage and value generated innovations by research, and the creation of NITs is a motivating factor (Oliveira & Santos, 2017).

Currently, there are 38 Federal Institutes (FI) in Brazil, increasing scientific research, technological innovation and integrating the innovation ecosystem, the majority of which are located in the Northeast region, representing 11 FIs. Thus, one can mention the state of Maranhão (Federal Institute of Piauí), in Bahia (Federal Institute of Bahia and Federal Institute Baiano). The FIs' competencies, in addition to teaching, research and extension, are responsible for contributing to economy development through scientific knowledge generation and applied technologies, leveraging innovation (Rodrigues & Gava, 2016).

The FIs in the Northeast region of Brazil have been implementing actions, programs and projects aimed at technological advances and consolidation of the innovation ecosystem. Thus, the growing transformation of this region demonstrates that science, technology and innovation are essential elements for regional development (Silva, Milani et al., 2019). Therefore, interaction through production in knowledge networks is considered one of the challenges of Science, Technology and Innovation (S, T & I) policies, as it generally favors scientific research quality and adds value to the results (Sidone et al. , 2016).

Within organizations there is a great concern in creation and conservation of knowledge, as the incentive in research and development (R&D) contributes to the emergence of programs to stimulate innovation, where an adequate knowledge management is an improvement factor to their performance (Mendes et al., 2020). Therefore, an innovation policy must be responsible for the establishment of a strong society, enabling innovative potential of localities, since in Brazil public policies are generally limited to regulations of financial support (Silva, Serio et al., 2019).

It should be noted that most NITs located in the Northeast need to leverage their IP indicators. Thus, it is possible to verify some bottlenecks and low IP results in the FIs in the Northeastern region, for example, the Federal Institute Baiano that needs to leverage its IP order numbers. According to Araujo et al. (2018), registration requests for patents, brands and software are not homogeneous in Northeastern FIs, because of its recent creation, as well as its different competence areas. Despite this, the author points out that Bahia is the largest depositor in the Northeast and the only one with a patent granted.

FIs located in the Northeast need to seek economic resources through innovation policies to increase IP production, in order to foster technological development. This is due to the lack of considerable investments in this country's region when compared with the South and Southeast regions, where larger amounts of resources were allocated (Guimarães, et al., 2016). For this reason, budget constraints can make investments that aim to streamline marketing procedures unfeasible, which often impact on expected results and technology transfer (Coelho & Dias, 2016).

Paranhos et al. (2018) describe that structuring NITs is considered difficult because the average number of human resources is low. As a result, STIIs need to insert professionals in this space to carry out strategic actions for innovation, which may increase their IP indicators. Thus, STIIs through NITs shall create IP

management and technology transfer policies by elaborating regulations at the juncture of regulatory innovation frameworks (Fonseca, 2017).

Over time, FIs seek to increase the offer of *Lato Sensu* and *Stricto Sensu* graduate programs. This growth includes the areas of Multidisciplinary knowledge and Applied Sciences, and policies in Exact Sciences, Earth Sciences, Agrarian Sciences and Engineering can be suggested (Cirani et al., 2015). However, FIs' current scenario does not contemplate doctorate courses in a professional modality; then, it is natural that these institutions pursue the academic modality (Alves & DelPino, 2015).

The Brazilian states shall not limit themselves to assuring large amounts of investment, nonetheless it is necessary to permanently improve their intervention, in order to guarantee the allocation of resources in public policy, with the purpose of bringing the productive sector closer to investing significantly in innovation in the regions (Gonçalves & Santana, 2020). Consequently, one can invest in the design of environments aimed at entrepreneurship, with the aim of minimizing social inequalities. In the face of the Brazilian reality, entrepreneurship is one of the decisive elements oriented at problems arising from worker unemployment and can create business opportunities (MC Silva et al., 2018).

Therefore, to foster technological innovation in FIs, it is important to have an ecosystem shaped with effective practices aimed at innovation and entrepreneurship. According to Moraes et al. (2020), these practices can be included in the development of organizational partnerships linked to entrepreneurship, for example pursuing the support of local companies, universities, city halls, and associations. The intra-business perspective is also an important aspect to support entrepreneurship practice, as it may involve business centers, interaction with business schools with coverage in other areas of knowledge in the institution.

4. Results and discussions

Over the course of a decade, the NIT IF Baiano was conceived (4 years ago), but it still has few professionals to manage Intellectual Property (IP) and promote its transfer to the productive sector, aiming at inducing technological innovation (Coelho & Dias, 2016). Over time, there has been an intense implementation of NITs in Brazil, characterizing a development in institution process of NITs by public organizations (Marchini & Pereira, 2019). However, staff shortages occur in most NITs, which makes it difficult to apply innovation policy in the organization.

The NIT IF Baiano is part of the Dean of Research and Innovation (*Pró-reitora de Pesquisa e Inovação* - PROPES), and it is regulated by the Resolution/CONSUP n. 35, 2016 (IF BAIANO, 2016). The article 5 of this resolution reinforces that the NIT IF Baiano aims to formalize, forward and monitor requests for IP registrations at the National Institute of Industrial Property (INPI), referring to requests for technologies generated by the internal or external community (IF BAIANO, 2016). Institutionalization contributes to legitimation of processes representing the standardization of policies and procedures (Machado et al., 2017). Accordingly, such regulation and the innovation framework are essential for strategic management of the sector that aims at partnerships and agreements in order to have greater interaction with the market.

The design of innovative spaces encourages actions that favor innovation and entrepreneurship, and the institution's Innovation Policy regulates the relationship with the productive sector. The Innovation Law

(Law no.10,973/2004) enabled the formation of the Technological Innovation Center (NIT), which has competence in managing innovation policy, and promotion of events for innovation and entrepreneurship. (Guimarães et al., 2016).

The management of the institutional innovation policy by the NIT requires that the sector be structured internally, through staff training and qualification to enable interaction in various economy sectors. The sector relies on the protection of immaterial goods and their transfer to society, technological prospection and competitive intelligence studies aiming to guide innovation activities and strategies for IP (Garcia et al., 2017).

Hence, the NIT IF Baiano is in accordance with the Innovation Law and the Industrial Property Law (LPI) for promoting local, regional and national technological innovation. It was observed that **within the scope of IF Baiano, the Innovation Policy for the management of Intellectual Property (IP) and Technology Transfer was recently regulated** (emphasis added). This policy was regulated by resolution 73/2020 CONSUP/IF BAIANO of 29 June 2020, a legal instrument that has guidelines regarding innovation incentive aimed at the development of the country (IF BAIANO, 2020). Therefore, this article can provide support to the NIT IF Baiano by strengthening its innovation policy in order to create a strong ecosystem that provides innovative spaces. Thus, according to Oliveira and Santos (2017), the Innovation Law sought to promote research increase and approximation of STIIs with companies, enabling the formation of partnerships.

The result is structured in a subsection referring to the analysis of actions, programs and projects that aim to foster innovation in the IF Baiano. It is divided into three topics: actions, programs and research projects related to fostering innovation in the organization. It can be seen that the challenges of the NIT IF Baiano are similar to other NITs in the Northeast in order to overcome barriers and boost technological development in Brazil.

4.1 Analysis of actions, programs and projects aimed at encouraging innovation in the NIT IF Baiano

According to DeMoura et al. (2019), the public STII has the complex task of providing environments that promote innovation. These spaces shall be structured and systematized, in order to provide assistance and service to workers who seek to undertake new ideas and innovate. It is recommended to know the ecosystem in which an organization is inserted, analyzing its behavior and its interaction, since it is possible to obtain examples of good practices enabling alternative strategies in stimulating entrepreneurship (Hernández & González, 2016).

In this context, the strategic analysis of actions, programs and projects carried out by the NIT IF Baiano serve as support to rethink new innovative activities and implementation of entrepreneurial spaces. This analysis is based on the PDI goals, as well as other related studies. Thus, Public Innovation Policies can be considered a driving force behind scientific and technological production. EA Pires and Quintella (2015) describe that these policies were proposed based on government discussions about the fundamental role of scientific knowledge and technological innovation in accelerating Brazilian socioeconomic development.

4.1.1 Actions

The IF Baiano carried out several interaction actions aimed at interdisciplinary themes with the community

between 2015 and 2019, in order to bring internal and external community together with the purpose of strengthening the innovation ecosystem. These events represented a strategy to bring together different audiences and contribute to the innovation culture. Table 1 shows the goals of actions developed by IF Baiano.

Table 1- Expected goals x Executed goals of actions.

PERIOD	2015	2016	2017	2018	2019
Expected goals: seminars, fairs, congresses	19	22	28	28	28
Goals achieved from actions taken: seminars, fairs, congresses	49	192	63	268	*
Variation of actions implemented by the institution	**30**	**170**	**35**	**240**	*

Source: Own elaboration based in data from 2014 PDI and 2018 Management Report.

It is worth mentioning that the 2018 Management Report accounts that the IF Baiano, in order to bring the internal and external community closer together, held events with several interdisciplinary themes, through: scientific and technological dialogues, workshops, seminars, exhibition, congresses, fairs, among others, between 2015 and 2019 (IF BAIANO, 2018). The culture of innovation provides dynamics to ecosystems, raising organizational energy, and motivating those involved through its promotion (DeMoura et al., 2019). Therefore, it was demonstrated that the actions carried out exceeded the expected goals between 2015 and 2018, reaching the greatest numbers of actions carried out in 2016 and 2018, with a variation of actions implemented in the institution of 170 and 240 respectively, observing a disproportion in values in this period. Rodrigues and Gava (2016) state that lectures aimed at raising awareness are commonly used resources in FIs and universities in order to disseminate the culture of innovation and IP. Thus, it can be seen that IF Baiano promotes the culture of innovation in its actions to innovate, bringing the community closer and raising awareness.

That is why innovation ecosystems are designed to create links of interaction among STIIs, business and government. Spinosa et al. (2015) report that several recent initiatives, encompassing academia, government and the private sector in Brazil, seek to leverage the country's technological indicators, establishing innovation ecosystems in emerging cities, employing them as one of the essential strategies. Therefore, the structuring of an innovation ecosystem, intermediated by interrelationship and network connection of actors in the innovation generation, can favor this consolidation process (Bittencourt & Figueiró, 2019).

It can be emphasized that, despite its 4 years of regulation, the NIT IF Baiano must pay attention to an effective strategic management for structuring the Innovation Policy according to the legislation directed to innovation, as well as aligned with the organizational mission. Despite this, the IF Baiano regulated the Resolution n.31 of November, 2015, which establishes guidelines for activities aimed at research and innovation in the institution's *Campi* (IF BAIANO, 2015).

According to Monteiro et al. (2015), innovation centers provide organized environments, have services that can interconnect and strengthen companies, in addition to providing regional development through innovation. With this reflection, it can be inferred that the research and innovation units in *Campi* work as

innovation centers, since they aim to collaborate with the NIT IF Baiano in innovation activities, enabling intermediation with local actors contributing to regional development.

To verify the quantity of the IF Baiano's Intellectual Property (IP), a survey was conducted to collect data from the National Institute of Industrial Property (INPI) from 2011 to 2020, with regard to patents, brands and software. Table 2 shows the result of this research.

Table 2- The IF Baiano's Intellectual Property recorded at INPI from 2011 to 2020.

Item	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Patent Application	0	0	0	0	5	7	0	4	2	1	19
Trademark Registration	1	0	0	0	0	2	0	0	0	0	3
Software Registration	0	0	0	0	0	1	0	1	2	1	5
Total	1	0	0	0	5	10	0	5	4	2	27

Source: Own elaboration.

According to Fonseca (2017), information dissemination related to registration of patents, trademarks and computer programs contributes in the long term to raising innovation indicators of a certain sector. In this context, in the period between 2011 and 2014 no patent application requests were identified at the IF Baiano, however, there were applications in 2015.

Therefore, it can be seen that in 2016 there was a greater number of requests for IP protection relative to the study's time cut (2015 to 2019). The authors Coelho and Dias (2016) reinforce that the recent increase in patent filings by institutions may be an effect related to the Brazilian Innovation Law. Due to this, regulations of the NIT IF Baiano must also have favored this increase.

In the Institutional Development Plan (PDI), the indicator of patents number had intermediate targets of 3 and 12 patent filings forecasted respectively in 2018 and 2019, with a total of 6 patent applications being protected (IF BAIANO, 2014). Therefore, in this period there was a reduction in patent applications in relation to the time cut of the research. Araújo et al. (2018) points out that patent applications require an 18-month confidentiality period according to INPI rules.

It should be noted that in the period from 2011 to 2020 the institution had 27 requests for IP protections, consisting of patents, trademarks and software. Thus, the following IP protection requests could be taken as examples on the INPI website: patents (development of cookies with the addition of mushroom flour); trademarks (Bem Baiano); software (Fitness & Health).

Thus, it became evident that out of the sum of IP protection requests, about 70% of them are patent registrations filed at INPI. Out of the number of patent application requests, 11 of them were published and currently they are waiting analysis of the regulatory body, 5 of them were annulled, and 3 of them are confidential. Accordingly, there is no patents granted at the IF Baiano until nowadays. Motta and Pereira (2019) report that patent application is inexpressive and without continuous growth it can be suggested the lack of actions or policies that encourage the protection of intellectual property in the organization.

In this context, out of the institution's 19 patent applications, it was found that 3 of them contribute to interaction of the innovation ecosystem because it has public institutions involved, such as: the Federal University of Bahia (UFBA) and the Federal University of Recôncavo da Bahia (UFRB). Among these, there is a patent application of 2019, which is confidential, with interaction between public institutions, cooperatives and associations aimed at regional development. One of the NITs' challenges is the execution oriented to entrepreneurial culture, regarding the acceptance of incorporation directed to the productive sector (Machado et al., 2017).

Thus, inventors and/or innovative researchers need support in terms of assuring IP protection, since it has the possibility of generating profitability from their innovative knowledge. Therefore, the concern regarded to the economic and technological development is born in Brazil due to the importance of this protection (Amorim, 2019). In view of the analyzed data, one can take as an example the relation between the low IP number versus the number of professors with Exclusive Dedication (ED) with Doctorate degree in order to maximize technological indicators in public STIIs. Table 3 displays the relationship between the amount of intellectual property and professors with exclusive dedication with a doctorate degree at the IF Baiano.

Table 3- IP *x* Professors (ED) with doctorate degree.

PERIOD	2015	2016	2017	2018	2019	TOTAL
IP Registration Quantity (patents and *software*)	5	8	0	5	4	22
Professors (ED) with doctorate degree	3	6	0	2	0	11

Source: Own elaboration based in data from INPI and CNPq.

Until 2019, the IF Baiano has 525 professors, out of which 502 ED professors, and out of these professors, 134 of them have PhD level, 274 MSc level, 92 specialist course, 5 improvement course, and 20 undergraduate level (IF BAIANO, 2014). In general, training at the doctoral level is essential in acting in graduate programs and participating in calls for research support in Brazil (TMR Dias et al., 2019). The data show that the sum of these professors represents half of the total IP of the analyzed period, therefore it is important to seek strategies to improve this relationship. From this perspective, it can be seen that in 2015, the list of doctors and patent registration in the Northeast region stood out in Bahia, Ceará and Pernambuco, surpassing the other states in this region (Gonçalves & Santana, 2020).

The PDI portrays a strategic objective of improving and expanding policies to qualify and train staff, as well as an indicator related to teaching staff's degree index (IF BAIANO, 2014). This indicator shows how many teachers are trained to foster innovation in the IF Baiano, through knowledge application in research groups aiming at providing technological development. The qualification for entrepreneurship of teachers, can be considered a prosperity factor in the ecosystems of public education entities, because these professionals can provide connection between the academy and entrepreneurial environments, in addition to spread this knowledge to students (MORAES et al., 2020).

Table 4 – Expected goals x achieved goals related to academic degree index of teaching staff.

PERÍODO	2015	2016	2017	2018	2019
Expected goals: academic degree index of teaching staff	4,0	4,1	4,2	4,4	4,5
Achieved goals: academic degree index of teaching staff	3,82	3,87	4,1	3,94	*
Variation in the academic degree index of teaching staff	0,18	0,23	0,1	0,46	*

Source: Own elaboration based in data from 2014 PDI and 2018 Management Report.

The data reveal that the IF Baiano was close to the goal set in relation to its teaching staff's qualification between 2015 and 2019. It should be noted that in 2018 there was a small decrease, due to staff hiring, who are still likely to have access to the Institutional Qualification Policy (IF BAIANO, 2018). In the last decade, there has been an increase in the number of professors and vacancies for who have master's and doctoral degrees, with a diversified geographical distribution, with predominance in the most developed regions of Brazil (Cirani et al., 2015).

Between 2011 and 2020, three trademark registrations were filed by the INPI regarding the name of the institution and sector. Regarding software registration, there was a sum of 5 requests in the highlighted period. The low number of protections made by the IF Baiano of trademarks and software may be influenced by the teachers' lack of IP technical knowledge. For Fonseca (2017), the NIT should encourage the culture of IP protection, contributing to management improvement of its intellectual capital.

4.1.2 Programs

The IF Baiano provides the internal community with scientific initiation programs on technological development and innovation, to encourage graduate programs, among others. Therefore, these programs are intended to encourage innovation, and entrepreneurship practice (IF BAIANO, 2018). According to Alves and Del Pino (2015), when comparing the increase in *stricto sensu* graduate programs offered at FIs and the increase in available graduate programs in Brazil, it is evident that the growth of these courses in these institutions is great.

In addition, these programs strengthen interaction and bring together innovation actors (STII, companies, government and society), with the aim of minimizing inequalities in the areas where they are implemented seeking the country's growth (Amorim, 2019). As evidenced, scientific initiation programs have the purpose of qualifying the community and favoring the potential to innovate and create products, narrowing the relationship with companies. As a result, the IF Baiano grants scientific initiation scholarships with internal funding, as well as scholarships to promote research and technological innovation to students. (IF BAIANO, 2019).

Scientific initiation programs aimed to foster innovation in the organization have as main objectives to encourage students: to exercise entrepreneurship, to innovate and to promote technologies (IF BAIANO, 2018). Thus, this program fostered by CNPq, has as one of its purposes to contribute to the scientific culture with presentation of researches by undergraduate students (Araújo, 2018). Therefore, it was found that the

organization has been fulfilling its function to provide programs that stimulate innovation and entrepreneurship. Moraes et al. (2020) points out that entrepreneurship insertion as a research area comes to represent a fundamental point that can facilitate conditions for growth in the practice of entrepreneurial culture and bring academia closer to companies.

It is worth mentioning that the institution offers 23 graduate courses in different areas: multidisciplinary, humanities, agrarian sciences, among others; out of which 18 are directed to teacher training (IF BAIANO, 2018). Federal Education Institutions believe that stimulating graduate education is considered a qualification resource for their staff, contributing to teaching and research practices (Araújo, 2018).

Regarding *stricto sensu* graduate programs, the IF Baiano offers the community Professional Master's vacancies in: Vegetable Production in the Semiarid Region; Professional and Technological Education (PROFEPT) and Professional Master in Environmental Sciences. In view of this, regional inequalities in Brazil are accentuated with regard to the number of graduate programs by region, with a tendency towards convergence (Cirani et al., 2015).

The IF Baiano offers an initial training program for teachers to integrate with basic education institutions, in order for them to have greater interaction with these organizations (IF BAIANO, 2018). In addition, it offers the Program that grants productivity incentives to teachers, in order to encourage innovation and productive arrangements in the regions (IF BAIANO, 2019). Motta and Pereira (2019) reinforce that the patent is an important innovation indicator directed to the Brazilian state, and notes that registration of patents itself does not bring benefits, as it shall be launched to the market for innovation.

The Extension Dean (PROEX) of the IF Baiano in 2018 made the Pro-extension Program public, an instrument aimed at promoting student extension activities, stimulating *Campi* interaction with local productive sector, strengthening the identity territory and its productive arrangement in the offer of continuing education courses, among others (IF BAIANO, 2018). For Figuerêdo et al. (2020) continuing education to update professional practices and didactic changes can be part of extension activities. The authors describe that the offer of these courses to pedagogical coordinators and teachers, aiming at building educational goals and actions contributes to technical and theoretical skills of those involved and to quality education consequently.

The IF Baiano has an Extension Policy that aims to combine scientific and cultural education with teaching and research, with the scope of transforming society through education (IF BAIANO, 2014). Thus, the extension activity meets plural and differentiated demands, since these actions dialogue with research and teaching, instigating interference and interactions with the population (Ribeiro et al., 2018).

The IF Baiano provides the Initiation Scholarship Program aimed at extension with the purpose of promoting interaction between students and staff in extension actions aimed at institution integration with society seeking regional development (IF BAIANO, 2018). The institution also offers the Margaridas Project, which is a proposal for extension actions that promotes activities to qualify women, aimed at women's empowerment and the fight against domestic violence (IF BAIANO, 2020).

4.1.3 Research projects

In the Institutional Development Plan (PDI) between 2015 and 2019 it was demonstrated that the process indicators and intermediate goals related to the total number of research projects forecasted in 2015 resulted in 58

projects, increasing until 120 projects in 2019 (IF BAIANO, 2014). Table 5 presents the indicators and intermediate goals regarding the strategic objective that strengthens research and innovation actions.

Table 5 – Expected goals x achieved goals related to research projects.

PERIOD	2015	2016	2017	2018	2019
Expected goals of the total number of research projects carried out at the institution	58	79	90	104	120
Achieved goals of the total number of research projects carried out at the institution	58	321	190	180	*
Variation in the increase of research projects	0	242	100	76	*

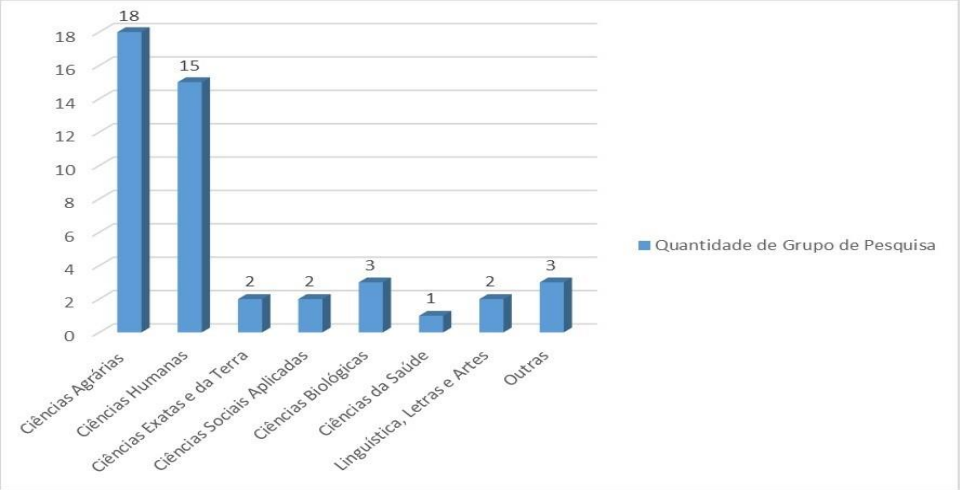
Source: Own elaboration based in data from 2014 PDI and 2018 Management Report.

Comparing the data above, it can be seen that the goals achieved of the number of projects executed by the institution exceeded the goals forecasted by the PDI, except in 2015. In 2016, this data had a considerable variation of 242 research projects in relation to the goal predicted, but this variation dropped by more than 50% compared to 2016, in consecutive years. Thus, it is evident that in 2016 with the regulation of the NIT IF Baiano and the legislation, innovation may have contributed to the increase of these data related to projects.

Research groups are a springboard for innovation, as they can act in several knowledge fields, once they facilitate fundraising for STIIs, empower involved researchers, and can structure their research laboratories (Garcia et al., 2017). In view of this, care should be taken to design research groups aligned with the NIT and in compliance with community demands so that they can provide local and regional improvements.

Resolution no. 39, 2018 was instituted to regulate research and innovation activities at the IF Baiano. This instrument has the purpose of delineating the attributions of those involved in a research project, providing guidance on procedures related to the monitoring and execution of projects (IF BAIANO, 2018). The development process to innovation, research actions and a favorable environment enable entrepreneurs' interaction from different sectors, favoring the development of a given region (Marchini & Pereira, 2019). Therefore, it can maximize knowledge exchange among participants of research groups in order to make their activities efficient and boost research projects directed to innovation in educational institutions. In this context, most PhD level professors have conducted research at FIs and worked in graduate courses in the country, and several of them have high scientific production (TMR Dias et al., 2019). Figure 2 shows the number of research groups by fields of knowledge.

Figure 2- Number of research groups by fields of knowledge.

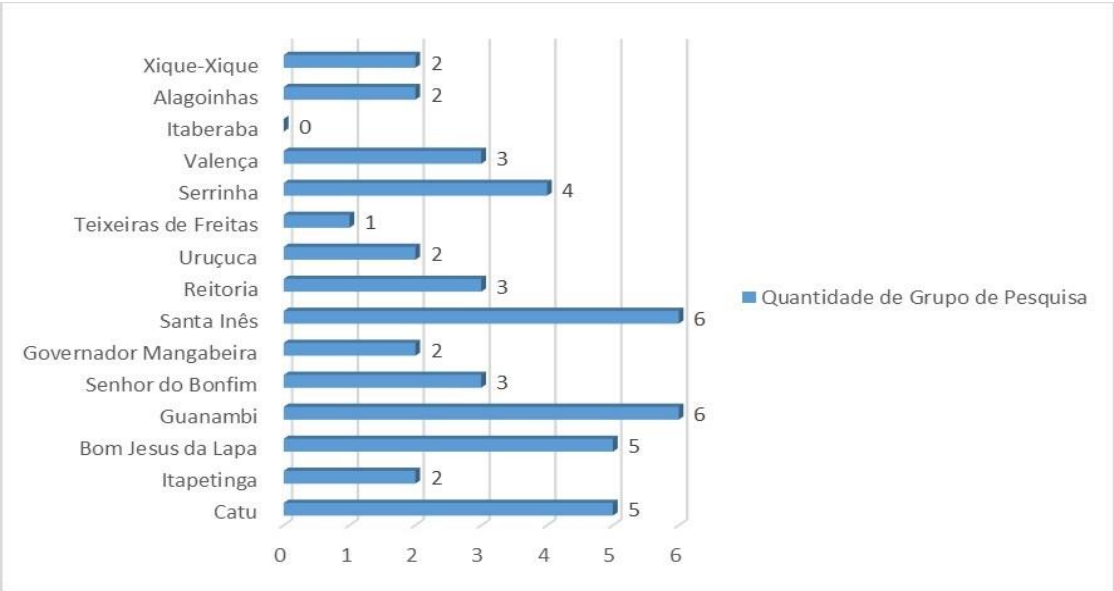


Source: Own elaboration based in data from CNPq (2020).

In the survey carried out on the CNPq website, it is possible to have a view of the distribution of Research Groups and knowledge fields in the IF Baiano's *Campi*. Therefore, it is noted that 46 research groups represent 8 fields of knowledge, in which highlights agrarian sciences and human sciences. Respectively, these fields house the Food Science and Technology Study Group, and the Research Group in Education, Diversity, Languages and Technologies, for example.

These predominant fields represent about 39% and 33% of the total research groups respectively, adding up to about 72% of the total research groups, which reveal a quantitative disproportionality among the knowledge fields. It should be noted that the fields of knowledge: exact and earth sciences, agrarian and engineering symbolize the technological knowledge that the population craves in periods of growth (Alves & DelPino, 2015).

Figure 3 - Research groups by *Campi*.



Source: Own elaboration based in data from CNPq (2020).

It is worth mentioning that the IF Baiano *Campi* that have the largest number of research groups are located in Santa Inês and Guanambi, representing about 13% in each region. Thus, it is evident that among 14 institution's *Campi*, the unit located in Itaberaba has no research groups in the research analysis period, which may be due to the fact that this *Campi* is being implemented. For Souza (2020), the institution may be more focused on teaching and academic practice, reflecting in few or lack of research groups in some units of the institution, and inequality among scientific and technological production.

5. Final considerations

Public Innovation Policies play a fundamental role in expansion of innovation ecosystems of STIIs, through NITs. In view of this, this study aimed to analyze the actions, programs and projects that are driving the innovation ecosystem of NIT IF Baiano with a view to strengthening Innovation Policies for local and regional development. In order to carry out this study, a qualitative approach of an exploratory nature was used, along with a documentary research and content analysis.

In this research, it was possible to have as a result the composition of innovation promotion actions of the NIT IF Baiano that collaborate in the innovation ecosystem's interaction, despite the institution having recently regulated its Innovation Policy. Thus, its implementation can contribute to IP management, as well as to technology transfer.

Thus, it was verified that the NIT FI Baiano goes through the same bottlenecks experienced by other NITs in the Northeast region. Among their main obstacles, there are: personnel shortage; lack of considerable investments; registrations of patents, trademarks and software are considered inexpressive and are not homogeneous; inexistence of a professional doctorate, but greater adherence to the academic doctorate; predominant research groups in multidisciplinary area, and little interaction with the productive sector.

Therefore, the objective of this research was reached, through a documentary research and content analysis based on other studies. It is evident that the IF Baiano carries out several activities related to innovation, such as scientific and technological dialogues, workshops, among others. Thus, the IF Baiano uses the culture of innovation, since it is considered a major factor in innovation, motivation and interaction among ecosystem actors.

From INPI data analysis, one can obtain technological indicators such as: patent, trademarks and software that are still retracted in the IF Baiano. Therefore, the recent regulation of its innovation policy has the purpose of positively influencing the technological innovation generation.

At this juncture, this study revealed that the NIT IF Baiano needs to structure itself with strategies to manage intellectual capital and innovation activities, through the design of an institutional innovation policy with a view to local, regional and national development. In this way, the IF Baiano *Campi* units can collaborate with the NIT IF Baiano, through actions that strengthen the innovation ecosystem and enable intermediation with local actors.

As noted, the institution promotes training and education for its community by providing scientific initiation programs and teacher training initiation programs aiming at producing knowledge oriented to innovation, entrepreneurship and technological development. Regarding the number of research projects between 2015 and 2019, it was demonstrated that the number of projects exceeded the expected goal in

2016. In this context, the regulation of the NIT IF Baiano, the innovation legislation and the NIT alignment with research groups can induce innovation.

It is concluded that, in spite of the timid data demonstrated, the NIT IF Baiano complies with innovation laws, because it enables means to stimulate scientific research and technological innovation, uses the innovation culture to increase the capacity of the community to innovate and to undertake new ideas, contributing to the development of new technologies. Thus, there is a beneficial interaction in *Campi* with networking, strengthening the innovation ecosystem and approaching the productive sector. Therefore, strategies' implementation in the context of the New Legal Framework of S, T & I for the NIT IF Baiano will be essential to structure its institutional actions and consolidate its Innovation Policy.

Despite the study limitation regarding the time cut between 2015 and 2019, it is possible to have a diagnosis of the innovation sector in this period, so that its managers and members can implement or enhance strategic actions for local and regional development. Therefore, this work can serve as a basis for other studies, in addition to motivate the innovation culture in the institution, since it demonstrates the possibility of creating innovation centers to strengthen the innovation ecosystem, providing interaction and knowledge exchange. Finally, an in-depth study at the NIT IF Baiano is recommended for future research, through a case study aimed at contributing to the institutional innovation policy in the context of the New Legal Framework of S, T & I. Thus, it has the purpose to provide support to leverage scientific and technological production indicators of the organization, with a view to strengthening the innovation ecosystem and contributing to technology transfer progress.

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Construction and calibration of Time Domain Reflectometry probes for assessing soil humidity in distropheric red latosol

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Abstract

Among the indirect methods of assessing soil moisture, Time Domain Reflectometry (TDR) stands out, which uses the soil dielectric constant to provide volumetric moisture efficiently, quickly and non-destructively. Despite a practical and precise method, TDR has a high cost due to the probes and its Data Logger. In view of this, the present work aims to build and calibrate TDR probes to assess moisture in a Dystrophic Red Latosol. The present work was carried out in the experimental area of the hydraulics laboratory of the Federal University of Grande Dourados (UFGD), located in Dourados-MS, at latitude 22º 12 'south, longitude 54º 59' west and altitude of 434 meters. Each probe built consisted of 3 stainless steel rods (Ø = 3 mm; L = 230 mm) RG 98 cable with 90% mesh and 50 ohm impedance, 4.7 pF ceramic capacitor and BNC connector. The construction procedures followed the following steps: 1- Making the cable, 2- Preparing the rods, 3- Welding the rods to the wires, 4 -Operating test and 5 - finishing phase. After construction, they were calibrated with the characteristic soil of the Region, proceeding with the Probe Reading in two depths (10 and 30 cm) and simultaneous collection of deformed soil samples to determine the moisture based on mass in Laboratory. Subsequently, calibrations with cubic polynomial adjustment were performed. The results showed adjustments with high determination coefficients, and the probes developed showed satisfactory performances.

Keywords: *Irrigation management; capacitive sensors; water use efficiency; time domain reflectometry; moisture profiles*

1. Introduction

Irrigated agriculture represents the use of more than 70% of the world's fresh water, with competition for domestic and industrial use of intense water, so to ensure global food security, water use in agriculture must become sustainable (Du et al., 2015). Due to the increase in the world population, associated with intense capitalist exploitation, water resources are being degraded, making water a limiting factor for the development of a region (Gomes Filho et al., 2020). Thus, knowledge of soil moisture is of fundamental importance in the management of any irrigation system, in order to replenish the necessary amount of water (Gheysari et al., 2017). Therefore, because irrigated agriculture requires large volumes of water, devices capable of accurately assessing local water conditions can be of great help.

Irrigation brings great benefits, such as increased production, less dependence on climatic factors, decreased production risks, in addition to making unproductive areas productive. However, when we use irrigation inappropriately, it can cause harm and environmental damage such as leaching of nutrients,

unnecessary expenses with electricity and soil compaction, reducing the production and useful life of the forage. Thus, knowledge of the dynamics of water in the soil becomes a fundamental factor for success and sustainable production (Souza et al., 2016).

According to El-Naggar et al. (2020) there are two techniques for measuring the water condition of the soil, the direct and indirect techniques. The direct ones consist of the removal of water from the soil matrix for later measurement. Indirect techniques are well adhered to irrigation systems and use the physical and chemical properties of the soil such as electrical conductivity, dielectric constant, thermal capacity, H content or magnetic susceptibility to determine soil moisture. Among the indirect methods, Time Domain Reflectometry (TDR) stands out, which uses the soil dielectric constant to provide volumetric moisture in an efficient, fast and non-destructive way.

The apparent soil dielectric constant (Ka) expresses the electrical permittivity that the air-soil-water system has when it is affected by an electric field. In this system, water, air and soil have different electrical permittivities. For air, K (dielectric constant) is practically 1, for dry soil, it varies from 2 to 5, while for water (20 ºC) its value is approximately 81. Thus, due to the great influence of water conductivity in relation to the other components of the soil system can be found through the dielectric constant of the system the volumetric humidity (Souza et al., 2016).

The TDR technique basically consists of measuring the propagation time of an electromagnetic pulse at the beginning of its probe nailed to the ground until the end of it. The pulse is emitted by a device and travels through a 50 OMHS impedance coaxial cable until it reaches the transmission rods (probe) it undergoes a reflection continuing the route until the end of the rods, where it is reflected and the pulse emitter returns. This time and the speed of the pulse are closely linked to the dielectric constant of the soil. The values of the apparent dielectric constant are converted into volumetric humidity units through equations inserted in commercialized TDR equipment.

The use of TDR provides a series of advantages, such as speed in obtaining volumetric humidity (Tommaselli and Bacchi, 2001), allows the removal of accurate readings without affecting or destroying the region that was sampled, the readings can have great repeatability without changes, the emission of ionizing rays does not occur and, in addition, the equipment is easy to connect to data collection devices. Sanches et al (2020), on the other hand, indicates that the equipment has possibilities to carry out measurements vertically from the soil profile in the same way as horizontally and maintaining the same precision. Other authors cite advantages such as ease of operation and security provided to the operator (Miyata et al., 2020). Finally, because TDR is a method that uses GHz operating frequencies, it is more suitable for soils with greater electrical conductivity than Reflectometry in the frequency domain (FDR) that works with MHz frequencies, since the soil ions that interfere with the measurement of the apparent dielectric constant are less influenced by GHz frequencies (Souza et al., 2013).

However, TDR devices have a high acquisition cost (Tommaselli and Bacchi, 2001), as well as their probes coupled to them to transmit the pulse. Another disadvantage is that these devices have universal and unique equations that transform Ka into volumetric units for different types of soil, which generates limitations to some types of soil and to ensure accuracy, calibration must be performed, that is, to develop an equation for the studied soil. As done by Topp et al. (1980), who developed an equation that has been used for several studies showing that it is adequate for determining the water condition of the soil.

Tommaselli and Bacchi (2001) performed the calibration of the TDR Trase system for 5 soil textures (Neossolo, Argilossolo, Latossolo and Nitossolo) and realized that the equation of Topp et al. (1980) was not accurate for different types of soil. Thus, a series of researchers carried out the calibration for the reality of the soils present in Brazil. Coelho et al. (2016), verified the equations of two equipments (Trase and TDR 100) for 3 types of soil (Eutrophic Red Latosol, Fulvic Latosol, Cohesive Dystrophic Yellow Latosol) and realized that the equations provided by these devices presented terrible performances and that the equations cubic meters developed in their calibrations were the ones that most fit the reality of Brazilian soils. However, they continued to see limitations regarding the use of the equation in the TDR for soils with high levels of organic matter, expansive soils, saline soils and soils containing magnetic minerals such as magnetite (Vaz, 2008).

Therefore, in view of the importance of Reflectometry in the Domain of Time for the conservation of water resources, the lack of conformity of the equations provided by these devices, the high cost of their probes and the large amount of magnetic minerals forming the soil of our region , the present work has as objective the construction and calibration of TDR probes for moisture assessment in a Dystrophic Red Latosol.

2. Material and Methods

The present work was conducted in the experimental area of the hydraulics laboratory of the Federal University of Grande Dourados (UFGD), located in Dourados-MS, at latitude 22 de 12 'south, longitude 54 de 59' west and altitude of 434 meters with the ground classified as Distrossic Red Latosol (EMBRAPA, 2018). The construction and calibration steps are presented below.

2.1. Probe Construction

Each probe built consisted of 3 stainless steel rods (Ø = 3 mm; L = 230 mm) RG 98 cable with 90% mesh and 50 ohm impedance, 4.7 pF ceramic capacitor and BNC connector. The procedures for making the probe were as follows:

a) Making the Cable: The RG 98 cable was cut into lengths of three and eight meters, one of its ends was stripped in 2 cm to insert the BNC connector (Figure 1.a). The other end was blasted at 4 cm from its first face (cover) then the mesh was cut into two parts rolled up, both separated to create 2 threads. The second face (conductor and insulator) was blasted 0.5 in its final part and the rest remained with the insulator (Figure 1.b).

b) Preparation of the stems: The stems were left with their sharp non-bridge ends in hydrochloric acid solution for 24 hours (Figure 1.c). After that period they were washed in running water and sanded on the ends that received the acidic solution so that in this way they do not cause problems with the weld.

c) Welding the rods to the wires: This process 3 rods were welded with the second end of the cable. For this, we welded the 2 wires from the mesh one on each side rod with Sn 60/40 tin alloy and soldering iron for approximately 60 seconds, the last wire (inner conductor) is soldered on the inner rod (Figure 1.d). With the cable already close to the rod and these rods spaced 22 mm apart (Figure 1.e), we soldered the 4.7 pF ceramic capacitor, with one pole present on an external rod and another on the internal rod.

d) Function test: After formation of the probe skeleton (Figure 1.e), we use the multimeter to check if the

circuit is not interrupted by loose wires, touching or due to incomplete fusion of the weld.

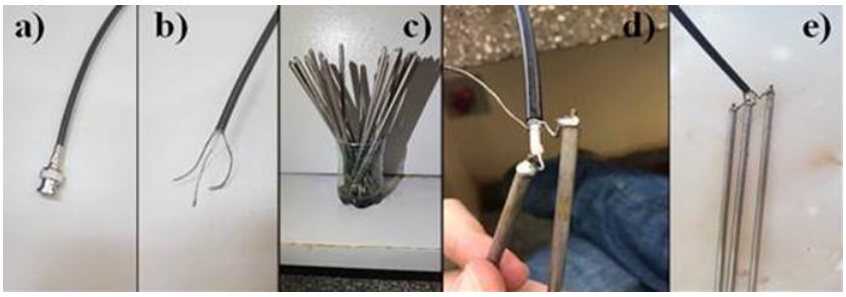

Figure 1. Probe preparation procedures. Dourados, 2020. 1.a) End of the cable connected to the BNC connector, b) End of the cable intended for the rods, c) HCl rods, d) Conductor welded to the interior rod, e) End of the already welded rods spaced in 22 mm.

e) Finishing phase: The finishing phase was responsible for providing resistance to the probe through a protective layer made with the resin and hardener solution, improving the handling and durability of the equipment. This phase was divided into 6 procedures:

Preparation of the solution: Each probe formed by 3 rods required 24 cm^3 of the solution or total mixture formed by Epoxy hardener type 3154 (Figure 2.a) and Epoxy resin 2119 (Figure 2.b) according to the equation 1:

$$MT = 0.75Mr + 0.25Me \quad (1)$$

where,

MT = total mixture (final solution);

Mr = resin material (2);

Me = hardener material.

Homogenization of the solution: The solution or total mixture was stirred for about 30 minutes until the material was homogeneous

Installation of the probe skeleton in the U structure: The rods were placed in a structure (Figure 2.c) prepared to receive the solution and direct the mixture to the correct location

Stem checking: Stems when added to the structure may undergo some changes in their arrangement. In this way, we visualize the arrangement of the rods and each wire so that there is no difference in height between the rods and twisting of the wires.

Application of the resin to the stems: With the solution already prepared, homogenized and the stems already added to the structure, it was applied the solution to the structure.

Stiffening: After application to the structure, the material was kept in an environment at 20 ° C for 48 hours.

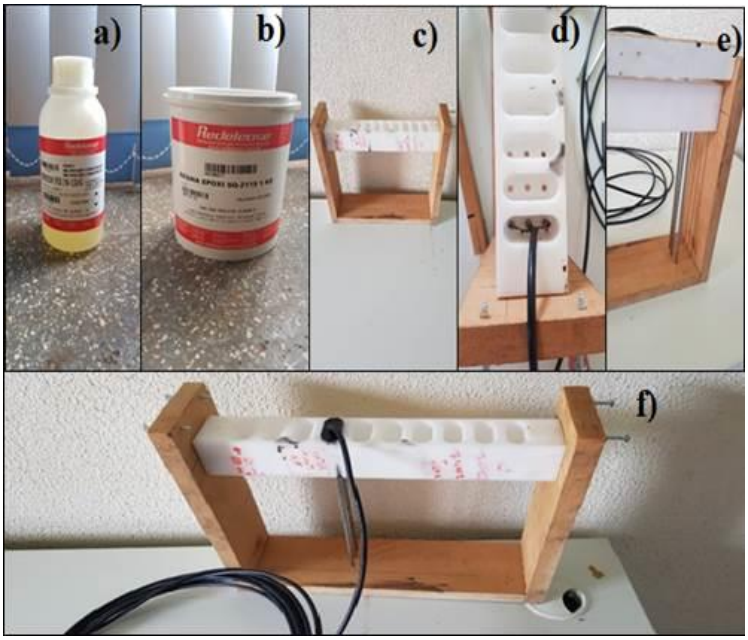

Figure 2. Finishing phase. Dourados, 2020. 2.a) Hardener, b) Resin, c) U-shape, d) Wire checking, e) Rod height check, f) Stiffening rods.

After 4 hours the skeleton of the probe was removed from the structure in one and the final result of the confection was obtained, Figures 3 show the result and dimensions.

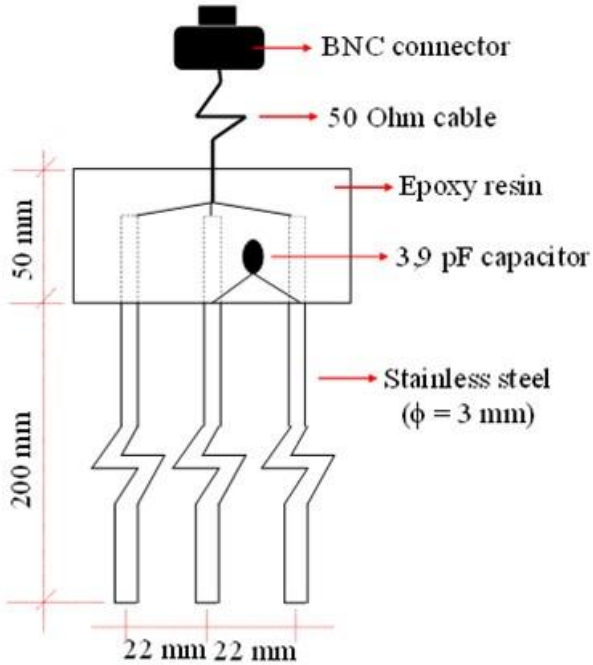

Figure 3. Probe dimensions.

2.2. Field Calibration Tests

To start the calibration, a trench 50 cm wide, 50 cm long and 50 cm deep was made as shown in Figure 4.a. In this trench we took 6 unformed samples with the aid of a volumetric ring coupled to a castel (Figure 4.b) at depths of 10 and 30 centimeters. After that, in the laboratory, the excess soil was removed, so that the

soil only fills the volume of the rings and in order to avoid any loss of soil, a thin tissue was placed, attached by elastic at the ends of the 6 rings.

Thus, with the rings already prepared, they were taken to the saturation tray and remained 24 hours inserted in a tray with water until their average height (Figure 5.a). Subsequently, they were removed from the trays to obtain the wet soil mass and placed in the greenhouse at 105ºC for 24 hours (Figure 5.b). After 24 hours in the greenhouse, the rings were removed and taken to the scale informing the dry soil mass. Once the mass of the dry soil was obtained and the volume of the volumetric rings was known, we arrived at the density value of each depth through the universal density equation.

Figure 4. Field procedures. Dourados-MS, 2020. 4.a) Hardener, b) Resin.

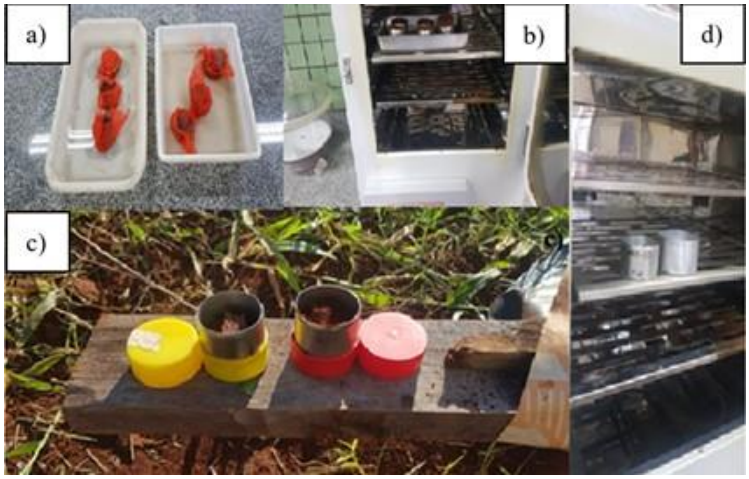

Figure 5. Laboratory procedure. Dourados-MS, 2020. 5.a) Volumetric rings in the saturation tray, b) Volumetric rings inside the greenhouse, c) Containers for transporting deformed samples, d) Deformed samples in the greenhouse.

Calibration was performed using the artisanal probe at two depths in the trench, the first 10 cm deep and the second 30 cm deep as shown in (Figure 6).

Figure 6. Probe driven at depths of 10 and 30 cm. Dourados-MS, 2020.

Soil samples to determine the exact water content in the soil were taken next to the probe and followed the standard greenhouse method, since it has simplicity, practicality and precision, being widely used in equipment and method calibrations (Buske et al., 2013). After taking the samples, they were formed in containers (Figure 6.c) taken closed to the laboratory.

Then, in the laboratory, they were weighed in a metallic container of known weight with a precision scale (4 decimal places). After that, they were taken open inside the metallic container to the greenhouse at 105ºC (Figure 6.d), until they reached constant mass and with that weighing and that of the metallic container used without the soil.

So the soil moisture was obtained according to the equation 2:

$$\text{Moisture\%} = (M1-M2) / (M2-M3) \times 100 \quad (3) \qquad (2)$$

where,

M1 = weight of wet sample;

M2 = dry sample weight;

M3 = weight of open metal container.

However, the value indicated in the TDR is based on volume like this, with the density values obtained with an unformed sample in a volumetric ring at the depths of the probes and based on the volumetric cylinder method we acquire the soil density and, therefore, the volumetric humidity as equation 3:

$$\text{Volumetric Humidity} = U \times Ds \qquad (3)$$

where,

U = actual humidity;

Ds = soil density in g / cm³.

Having obtained the values of volumetric humidity of the samples and the apparent dielectric constant presented in the equipment, it was possible to establish the calibration curve by adjusting a cubic polynomial equation using a dispersion diagram and coefficient of determination (R^2), using spreadsheets such as Microsoft Excel®.

3. Results and Discussion

The volumetric humidity obtained by the standard greenhouse method (gravimetric) ranged from 0.1295 cm³ / cm³ to 0.2933 cm³ / cm³ at a depth of 10 centimeters and 0.1280 cm³ / cm³ at 0.3126 cm³ / cm³ at a depth of 30 centimeters. In Figure 7, the cubic polynomial adjustment is presented to determine the volumetric humidity as a function of the apparent dielectric constant (Ka) at a depth of 10 centimeters.

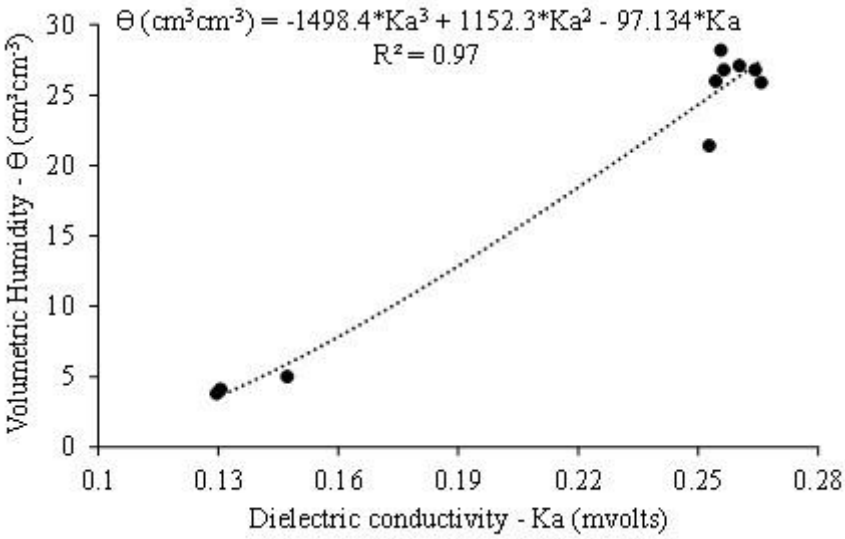

Figure 7. Water content at a depth of 10 centimeters as a function of the dielectric conductivity (Ka).

When studying hydraulic characterization of domestic taps Gomes et al. (2020) performed potential adjustments using adjustment equations with $R^2 = 0.99$, and thus managed to explain the different flow amplitudes for the tested models.

The coefficient of determination of $R^2 = 0.99$ approaches the unit (1.0) indicating the cubic polynomial equation ($6835.7 * Ka^3 – 5169.4 * Ka^2 + 1315.5 * Ka – 90.84$) for calibrating the TDR equipment. in a Dystropheric Red Latosol at a depth of 30 centimeters, Figure 9. Based on previous work, this one of the cubic polynomial model has been justified, for example, Villwock et al. (2004), in which the calibration equation model that had a coefficient of determination closest to 1 was the cubic polynomial model.

For Batista et al. (2016), the cubic polynomial equations had a calibration coefficient close to the ideal for 5 soil types with different textural classes. Regardless of the soil with a clayier texture having shown less efficiency in the cubic model, it still had a good calibration adjustment.

For Amaral et al. (2019), in its calibration performed in a typical dystrophic Red-Yellow Clay soil field,

the cubic polynomial model was the one that presented the best fit for determining the volumetric moisture obtained through the gravimetric method as a function of the dielectric constants of the soil.

In Figure 8, the cubic polynomial adjustment is presented to determine the volumetric humidity as a function of the apparent dielectric constant (Ka) at a depth of 30 centimeters.

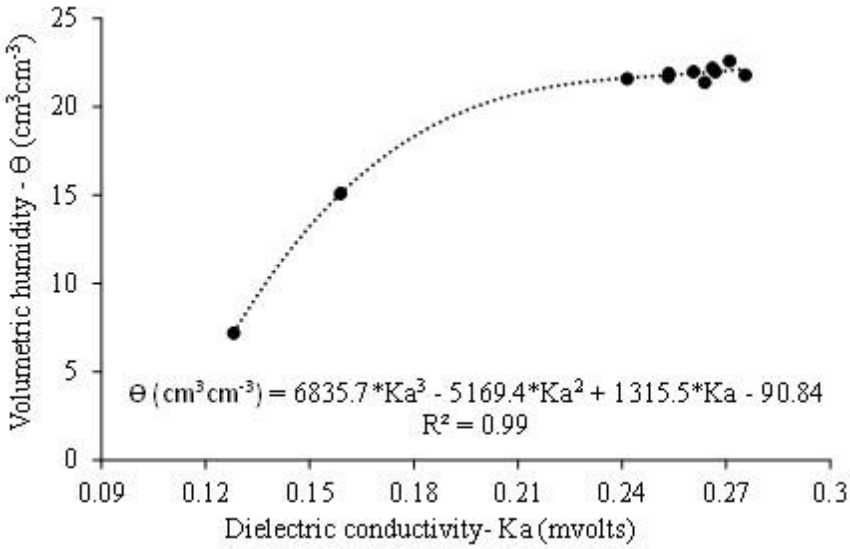

Figure 8. Water content at a depth of 10 centimeters as a function of the dielectric conductivity (Ka).

4. Conclusion

Based on the results presented, it was possible to observe that the cubic polynomial adjustments presented satisfactory results for the developed probes. Thus, artisanal probes built can be a great option for the management of irrigators due to the low cost in relation to the manufacturer's industrial probes. Reflectometry in the Time Domain is a tool that can be indicated to assess the dystrophic red latosol moisture.

5. Acknowledgement

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Analysis of the Causes of Labor Accidents in a Steel Industry in Southern Santa Catarina

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Abstract

Over the years, manufacturing industries such as the steel industry have shown a significant increase in their productivity, this growth highlights themes that make up the development framework of this segment. In this context, there is a concern with the preservation of the employee's integrity, generating a state of alert for the risks existing in the production process, and the preventive measures that organizations must put in place to eliminate or minimize these risks, avoiding accidents. For the development of this project, occupational accidents are characterized as those that occur at the service of the company causing bodily injury with temporary leave of the employee. This type of accident is referred to as a typical accident, as they are caused within the work environment and must consider all aspects related to work, such as: the machinery, the task, the environment, the instruction for carrying out the activity and the organization of the work. job. This study aimed to analyze the causes of accidents at work in a steel industry in the south of Santa Catarina, identifying the influencing factors in the causes of accidents, characterizing the types of accidents at work, highlighting the productive sectors and the frequency with which these events occur , indicating possible improvements in the development of work activities. Accident data were collected and analyzed over a 10-year period, demonstrating the nature of the injuries and the agents involved in order to make it possible to reduce the occurrences of accidents in the analyzed productive sectors.

Keywords: Labor activities; Integrity; Scratchs; Accident.

1. Introduction

The current world is in constant technological changes that has been incorporating the industrialization

process. All this advancement has made the industrial sector very competitive and has shown that relations between employees and companies go beyond the exchange between workforce and reward. In addition to financial commitments, it involves quality of life and work, promoting the preservation of man, the environment, society and the company.

One of the major indicators of economic development in a country is the production of steel, as the consumption of this material indicates a growth in other industrial segments that directly contribute to the country's economic and social turnover.

The need to provide adequate conditions for the exercise of all activities within the organization, preventing accidents, leads companies to work with the issue of safety in a comprehensive and effective way, enabling the management, prevention and control of accident risks in work environments. work and labor activities of the productive sectors of society.

The present study has as its theme the analysis of the causes of occupational accidents in a steel industry in the south of Santa Catarina, such choice is justified by the importance of identifying the causes involved in occupational accidents, in this company, in order to indicate possible improvements in the development of productive activities.

The method used started from a qualitative research, with quantitative aspects and documentary analysis, in order to characterize the groups of the sectors and their exposure to the risks of accidents specific to the activities performed.

Until the middle of the 20th century, there was no real concern with working conditions, even if this was directly linked to the risks of illness or even the death of workers, the most important was productivity. This concept was guided by an ideal that the value of human life was little more than negligible, added to a total neglect on the part of the states in creating laws that would protect the worker.

Over the years, the Federal Constitution started to guarantee workers various rights, giving scope to others that aim to improve the social condition of the worker.

This new scope gave rise to the creation of regulatory standards that enforce fundamental rights and guarantee the reduction of risks characteristic of work, through health, hygiene and safety standards.

The employer must aim above all to prevent accidents and damage to health, arising from work, seeking to eliminate or reduce risks in the workplace.

The study aimed to identify the influencing factors in the causes of occupational accidents involving employees of a steel industry in the south of Santa Catarina, classifying the types of accidents that occur in this industry, indicating possible improvements in the work environment or in the organization of individual activities or collective from the detection of the found thrusters.

The possibility of accidents in the steel industry has become increasingly significant due to the increase in production, highlighting the need for work organization, as well as the definition of stage controls to ensure the protection of workers.

It is important to emphasize that health and safety measures at work are the responsibility of the employer and the employee, since in order to be successful it is necessary to have the participation of both, thus guaranteeing the efficiency in combating and preventing accidents, eliminating the financial costs for the employer, and society.

2. Methodology

The study was divided into two stages. The first consisted of reading and reviewing the literature, part of which was inserted in the theoretical reference section, where the essential theories and concepts that served as the basis for the development of this study were exposed.

The study was carried out in a steel industry located in the extreme south of Santa Catarina, specialized in the production of parts in iron and steel alloys for the agricultural and mining sectors.

The industry has a staff of one hundred and eighty-five employees and a monthly production of two hundred tons, and of the total number of employees, only one hundred and forty-five are characterized as direct labor, the rest are classified as labor. indirect work or support sectors, such as the engineering, commercial, shipping and other sectors.

The second stage of the study began with a documentary analysis of the accident records that occurred between the years 2008 to 2018. The study included employees who were victims of occupational accidents characterized as typical accidents, who have an internal record of the accident occurring and who remained away from their work activities for a period equal to or greater than fifteen days.

To collect the data extracted from the accident records, a classificatory instrument was elaborated containing the following variables: name of the employee, number of the internal record of the accident at work, date of occurrence, place / area of work, period of absence and the classification of the employee. accident.

The study carried out is a qualitative research with quantitative, descriptive and longitudinal aspects. For the development of the project, bibliographic research was carried out. The data collected for the research had documentary origin, consulted in the work accident investigations filed in the company's occupational safety sector.

Descriptive statistics will be used for the analysis and characterization of the main variables presented with relative frequency. For this, the collected data will be displayed in an Excel spreadsheet, where the types of accidents, the causes of the accident, the agents involved and the injured part of the body will be demonstrated, thus making it possible to classify the accidents that occurred in the company during the period of 2008 to 2018.

3. Data collection and analysis procedure

To initiate the study, a documentary analysis of the accident records that occurred between the years 2008 to 2018 was carried out. Employees who were victims of occupational accidents characterized as typical accidents, who had an internal record of the occurrence of the accident, were considered part of the study. they remained away from their work activities for a period equal to or greater than fifteen days.

In the first selection of accident records made available for the study, 14 records marked as uninjured were excluded, as they caused only material damage to the company, 8 accident records characterized as commuting accidents, and 19 records for having less than 15 days' absence time . In this context of the 156 available records, 115 were considered part of the study and 41 were excluded because they did not meet the established criteria.

Accident records were filed in physical format, so the information collected was made available in an

Excel spreadsheet containing the following variables: name of the employee, number of the internal accident record at work, date of occurrence, place / work area , period of absence and accident classification.

The determination of the place / work area was given as follows: Molding, includes the sectors of modeling, machining, closing and molding, cold curing, light and heavy; Fusion, includes the sectors of scrap, furnace and demoulding; Finishing, includes the sectors of heat treatment, welding, eschareador, jet, press and deburring; machining; and dispatch that includes the quality control sector.

The accident classification variable was divided as follows: types of accidents; causes of accidents, subdivided into personal factor, unsafe act and unsafe condition; agents; and finally the injured body part.

It is important to note that for the identification of the injured body part, the personal consequence described in the accident investigation form completed by the occupational safety technician of the company where the study was conducted was considered.

The occurrences were classified in the variable accident classification based on the description of the accident that occurred together with the pre-established reasons.

After collecting and classifying data, it was necessary to identify the number of accidents recorded per year. The records used as the object of study were divided to perform the calculation of the total number of occurrences by sector and their percentage representation. In this stage, the overall average of occurrences and days of leave was also calculated.

The data were used to identify the most common types of accidents in the company's environment, the agents, the causes involved and the injured body part.

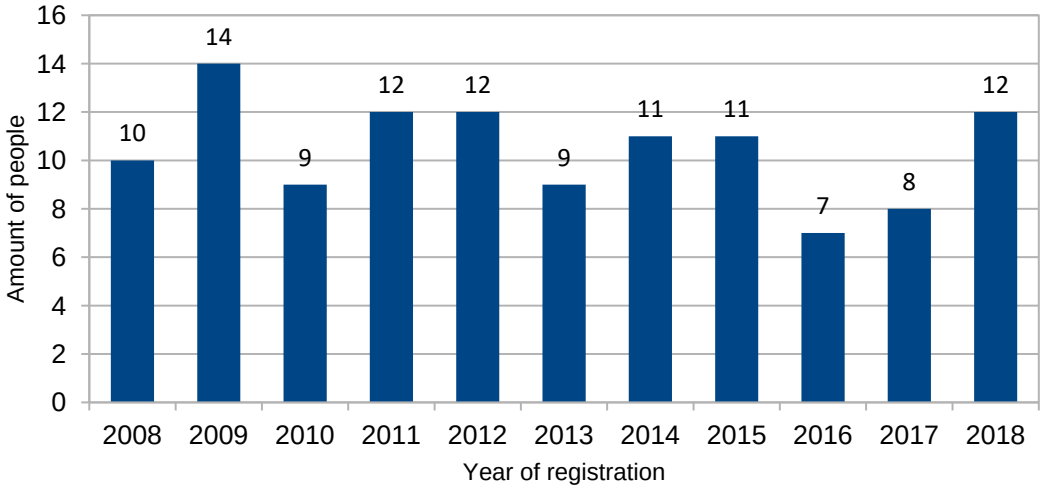
4. Analysis of results

It can be seen, in figure 1, that the highest rate of accidents with lost time occurred in 2009, 14 (12.17%) accidents with lost time greater than 15 days were recorded.

Significant indices were also recorded in the years 2011, 2012 and 2018, where each presented 12 (10.43%) of the selected records, followed by the years 2014 and 2015 with records of 11 (9.57%) leaves, the year 2008 with 10 (8.70%), the years 2010 and 2013 with 9 (7.83%), the year 2017 with 8 (6.96%) and finally the year 2016 with 7 (6, 09%) accident records, showing a total of 115 accidents that were used as the object of study.

These numbers showed an average amount of 10.45 accident records per year and an average value for the period of absence of 63 days.

Figure 1: Shows the number of registered employees with more than 15 days' leave from 2008 to 2018



Source: Authors

Figure 2 represents the distribution of accidents by sector, where it is possible to verify that the highest number of accidents occurred was predominantly in the finishing sector, which represents 54.03% (61) of registered accidents.

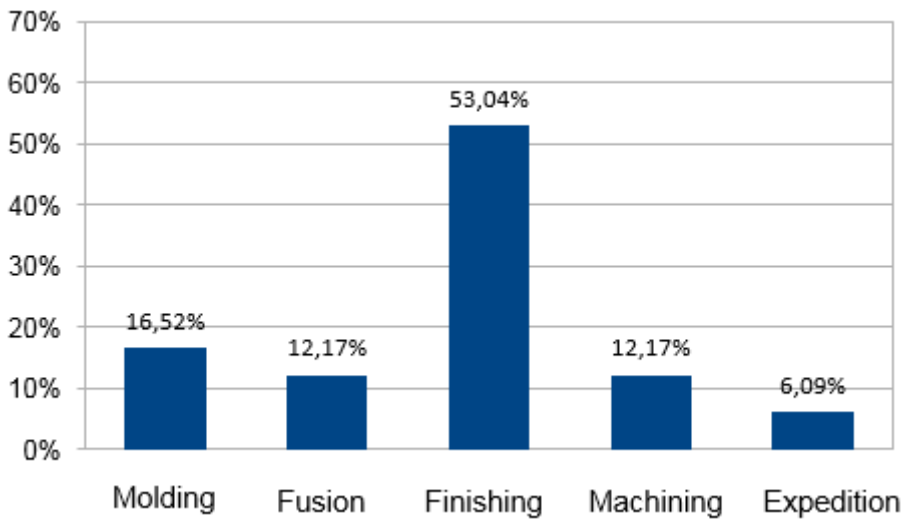
The molding sector appeared in second place representing 16.52% (19), followed by the melting and machining sectors, where each represented 12.17% (14), and finally the shipping sector, which represented 6.09% (7) of recorded accidents.

Based on graph 2, the data displayed were presented by productive sector highlighting the types, causes, main agents and injured body parts, considering the total records made for each one.

The causes recorded in the occurrences were subdivided into 3 types, these are: Personal factor, unsafe act and unsafe condition.

Based on the results presented by the productive sector, the general classification was also performed, unifying the data of the sectors.

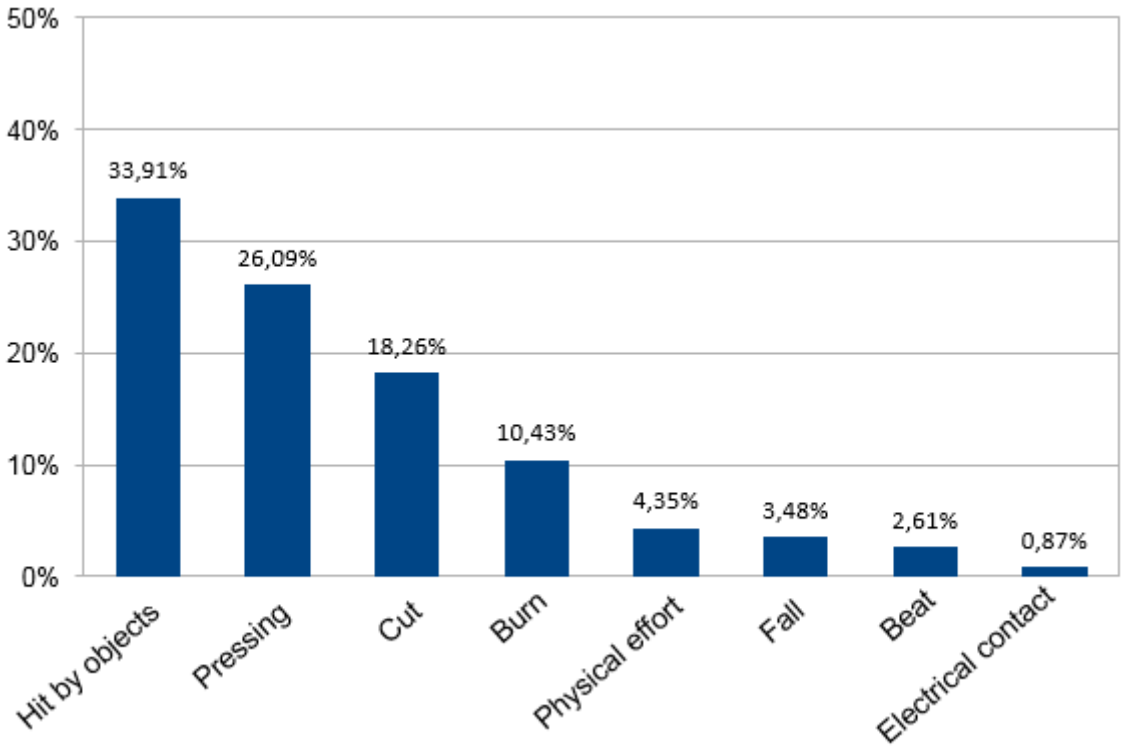
Figure 2: Percentage representation of accidents by sector in the 10-year period



Source: Authors

Through figure 3, it is possible to see that the highest rate recorded in the occurrences refers to the cases in which employees were hit by objects, parts or materials resulting from the production process. This type of occurrence represented 33.91% of the 115 records used as the object of study, that is, about 39 employees were removed from their activities due to this event.

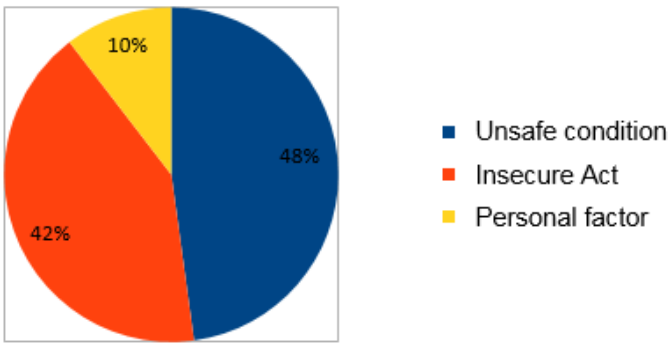
Figure 3: General classification by type of recorded occurrence



Source: Authors

Figure 4 shows the percentage representation of each of the subdivisions, where the highest index was represented by the variable unsafe condition which represents 47.83% (55) of the recorded occurrences, it is worth mentioning that the variable unsafe act has a very close value, 41.74% (48), which makes it the second highest index of records, last but not least, is the variable personal factor, which was represented by 10.43% (12) of occurrences.

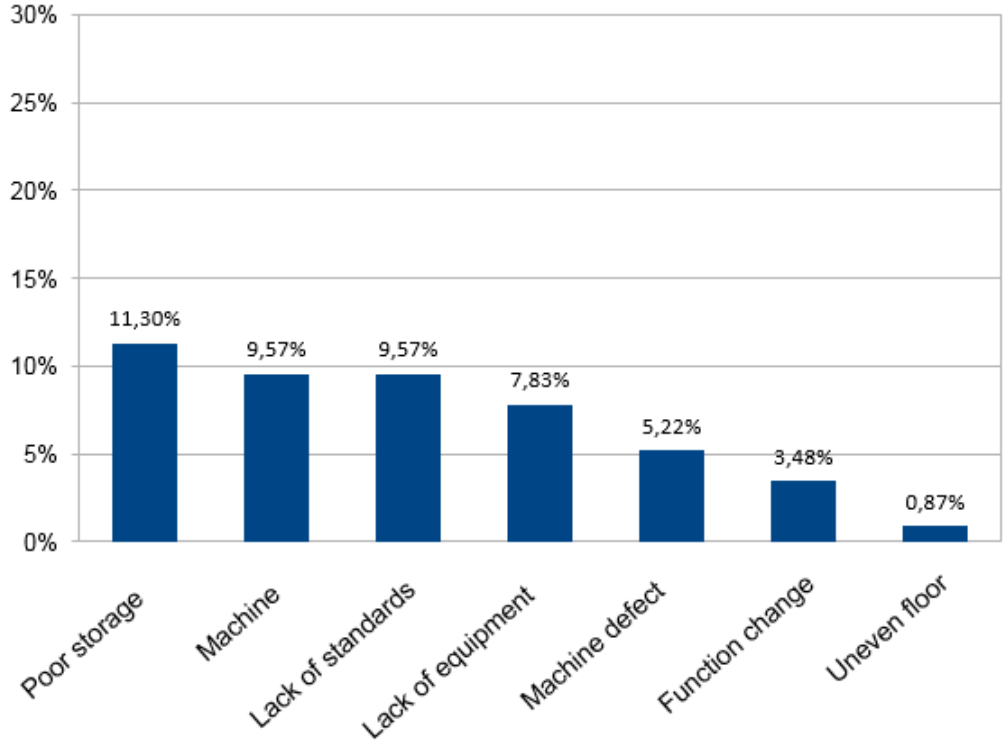
Figure 4: General classification for cause recorded in the occurrence



Source: Authors

The three variables represented were stratified and framed in pre-established reasons, as shown in figures 5, 6 and 7.

Figure 5: General classification for cause recorded in the occurrence as an unsafe condition



Source: Authors

Figure 6: General classification for cause recorded in the occurrence as an unsafe act

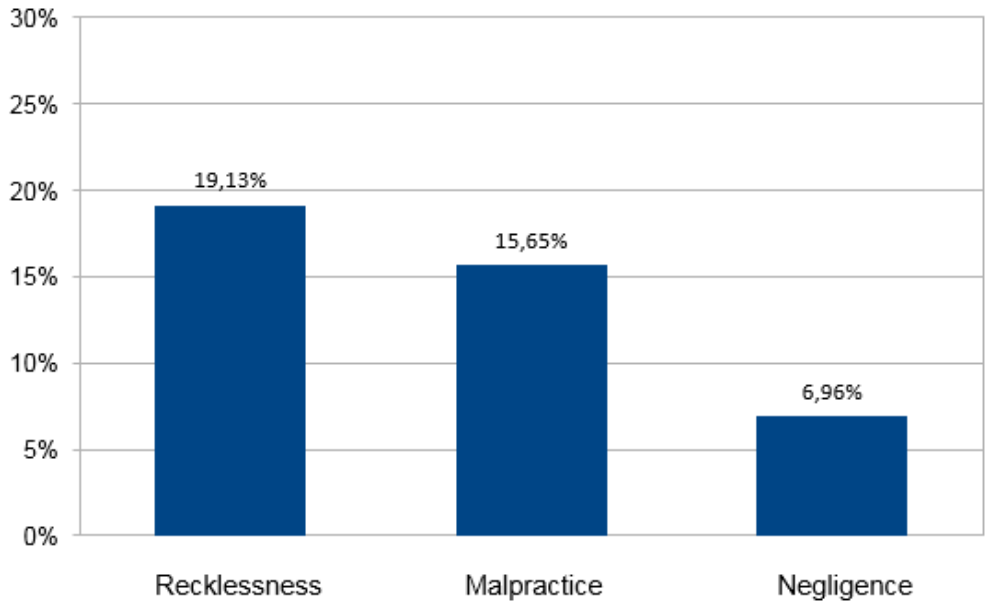


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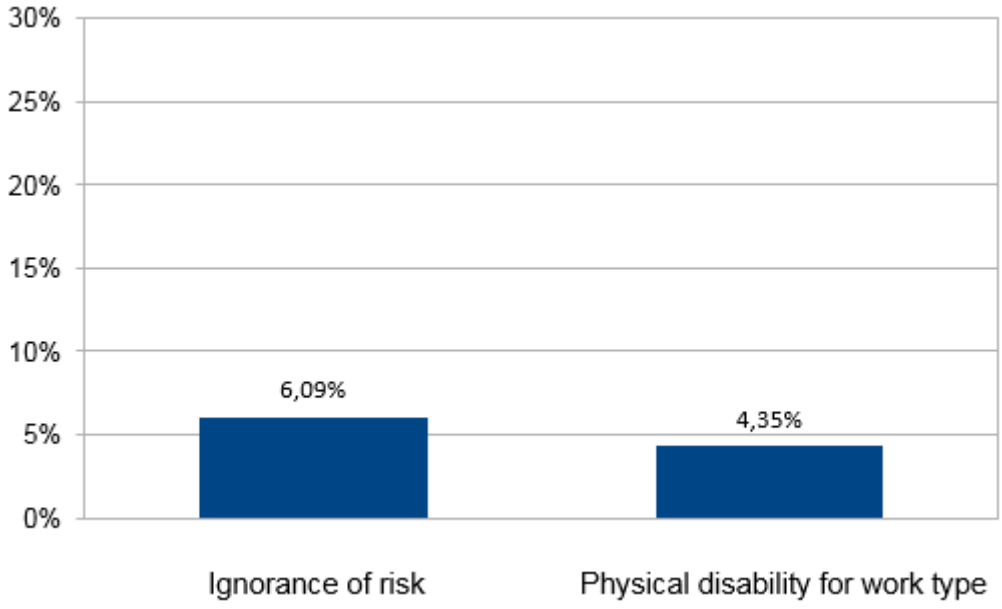
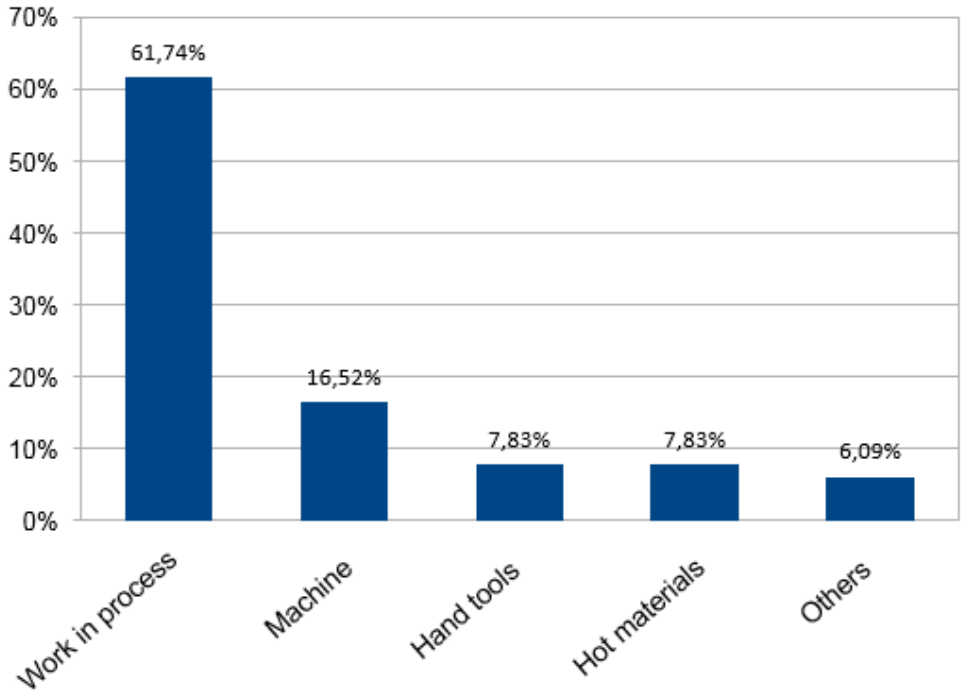
Figure 7: General classification for cause recorded in the occurrence as a personal factor



Source: Authors

Given the registered causes, the third point assessed was the agents involved in the analyzed events.

Figure 8: General classification by agent registered in the occurrence

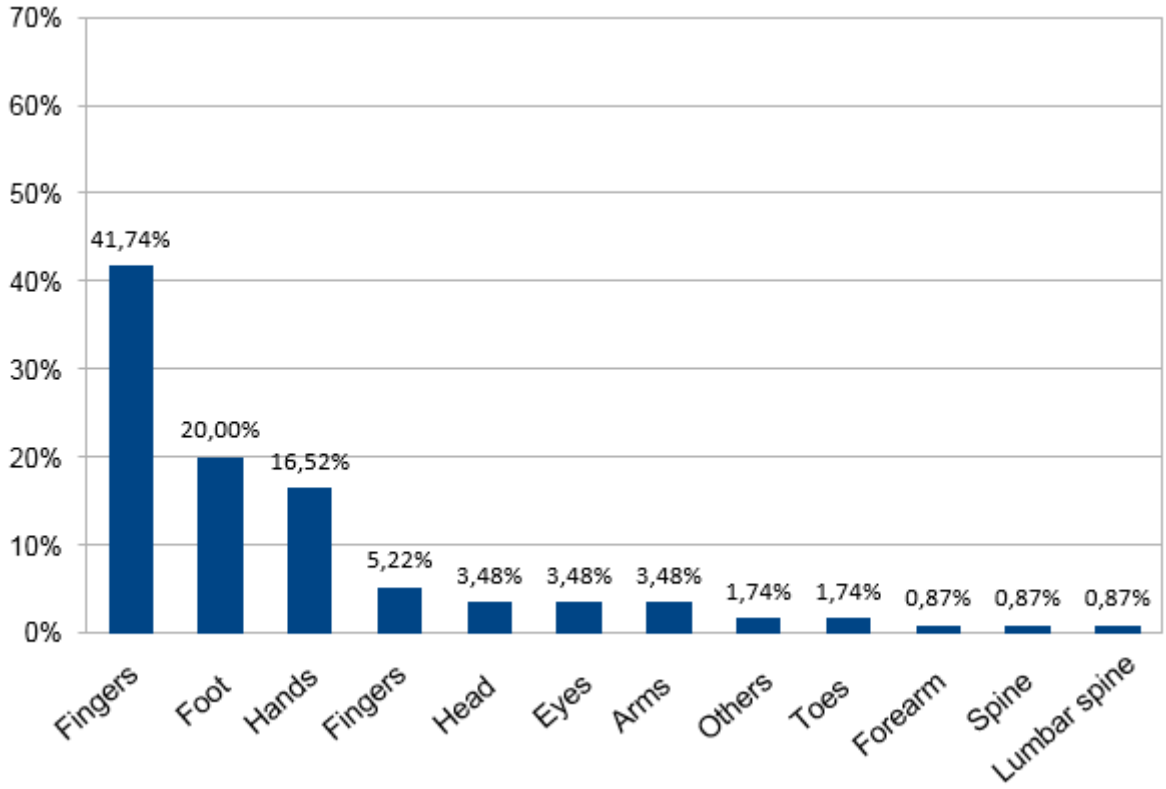


Source: Authors

Each registered occurrence has a specific type of agent, figure 8 shows the agents involved in the analyzed records, here it is possible to verify that just like figure 3, the highest percentage (61.74%) found is also related to parts and materials resulting of the production process.

Due to the wide variety of agents found, those that represented a percentage value less than 2, were classified as "others". These are: Hoisting equipment; Buildings; Pressure vessels; Chemicals and furniture.

Figure 9: General classification by the injured body part recorded in the occurrence



Source: Authors

It can be seen in figure 9 that the most affected part of the body, based on the recorded occurrences, was the fingers, which represents that 41.74% (48) of the employees were temporarily removed from their work activities.

The injured body parts indicated as "others" are those that the record made in the investigation of the accident had more than one personal consequence.

5. Conclusion

In the classification of occupational accidents that occurred in the period between the beginning of 2008 and the end of 2018, it was found that the highest accident occurrence rate was in the finishing sector, representing 53.04% (61) of the 115 records used as object of study, this sector had an average period of 60 days away from employees from their work activities. It was identified as the main type the accident whose employee was hit by an object, part or material of the process, in the general classification this type of accident represented 33.91% (39), followed by pressing by / between object, part or material that represented 26.09% (30) of the records.

Among the causes, the highest index was registered as an unsafe condition 47.83% (55), within this it was evidenced the poor storage, lack of space or poor stacking 11.30% (13), which is directly linked to the

physical structure of the company, since, over the years, there was a significant change in the production process, which resulted in increased demand and made the space available for the small process. As it is a civilian area, the company had nowhere to expand and today is looking for new facilities.

The agent with the highest recorded rate 61.74% (71) was part or material in process. This agent is directly linked to the type of accident, in this case it is possible to notice that the sum of the highest rates recorded in the type of accident, presents a value very close to that represented by the causative agent.

The main part of the body affected was the fingers of the hands, which in the general distribution represented 41.74% (48) of the absences. Even with the great technological advancement, some productive tasks in this branch are still very manual and depend on the direct participation of the employee, mainly in the finishing sector, which in the case of this study had the highest rate of occurrences in the period.

These results demonstrate a need to reorganize the company's physical arrangement and pay special attention to the handling and handling of parts in the process, as in the results presented in the causes of accidents it is possible to notice that the unsafe act factor also has a very significant index 41,74 % (48), within this the biggest cause was recklessness 19.13% (22), in this case the company understands that the employee performs the activities without the necessary preventive measures, increasing the risk of an accident occurring.

In order to determine the execution of the activity, the company needs to ensure that the information is clear to the employee, therefore, at this point it is necessary to develop work instructions, which will describe the correct way of carrying out the task, training, monitoring and charging for compliance with the necessary preventive measures for the performance of the activity, which when correctly performed minimize the employee's exposure to the risk of an accident.

The health and safety of the employee must be considered as a strategic point in the development and growth of the company. The biggest challenge is to encourage the company and the employee to understand that in addition to the legal obligation, establishing and taking preventive actions for the execution of activities is a commitment to productivity and increased profits for the company, and for the employee it is about quality of life and mainly survival.

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Digital Fluency and the Construction of Pedagogical Strategies for Distance Learning

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Abstract

The objective of the study is to identify Pedagogical Strategies (PS) that can contribute to the construction of Digital Fluency in the Distance Learning (DL) context. Technological changes in society include their own set of knowledge, skills, and attitudes called Digital Competences (DC). Specifically, in distance learning, digital fluency is considered paramount since it is related to the use of technologies where the subject feels digitally active, especially with regard to the production of content/materials for the virtual environment. This can be divided into five specific competences: Content Production, Data Protection, Networking, Virtual Resilience, and Teamwork. Thus, PS were created from the analysis of competences in order to assist the instructors to build them with their students in the DL environment. This study used a qualitative methodology based on an interpretative approach. The instrument used for data collection was an online questionnaire evaluating the Pedagogical Strategies for the Digital Fluency Competence. The target audience of the research was 90 specialists in the area of distance learning who responded and suggested changes to the PS. The results enabled the development of a framework with 46 Pedagogical Strategies divided into the 5 specific competences of Digital Fluency to aid teachers in meeting students' needs.

Keywords: Digital Competences; Digital Fluency; Pedagogical Strategies; Distance Education.

1. Introduction

Over the years the term competence has been modified with social transformations arising from new forms of communication, work, and relationships. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) was one of the first bodies to discuss and develop guiding documents on the certification and application of key competences in different sectors of education. The organization adopted the term "Knowledge Society" within its institutional policies in the late 1990s [1].

The definition of competence is a set of elements, specifically Knowledges, Skills and Attitudes, which help the subject to face certain problem situations. Competences are not taught, but conditions can be created to stimulate their development. In fact, students can be placed in complex situations that require the mobilization of their knowledge to understand, clarify, solve, develop, and make decisions when facing a problem. It should be noted that there is no single competence, in fact there are several depending on the particular situation [2].

Perrenoud [3] also analyzes the relationship of competences and the construction of knowledge, which he refers to as schemas. "Therefore, it is observed that developing, improving, building and evaluating competences requires a series of discussions and reflections, which lead to the customization of teaching and learning, according to the needs of the public involved" [4]. Thus, essential competences are linked to the use of digital technologies (DT) that allow the subject to accompany the technological and cultural evolution of society.

Hence, the definition of digital competence emerged to encompass the mobilizing elements of competence and the use of digital technologies as facilitators of the process, becoming a means for solving emerging situations [5]. According to Perrenoud and Thurler [6], this process is not simply about absorbing information, but also understanding, mobilizing, and using it in practical situations, influencing the application of competences for the construction of knowledge and individuals' integral development.

Digital competence is therefore fundamental for all subjects to participate actively, critically, and reflexively in society [7]. Yet, some digital competences are considered fundamental for current subjects, foremost being digital fluency (DF) because it encompasses not only the use of technologies, but also the possibility of authorship through the construction and sharing of digital materials [7; 8]. Thus, DF is necessary for an individual's professional and educational performance. It is also essential for distance learning (DL), because students must extrapolate their knowledge and use of DT. Moreover, they must know how to filter information, manage specific types of communication, and also develop digital materials to virtually interact and construct knowledge. However, this requires teachers to develop and apply pedagogical strategies that enable the process of building digital fluency with students.

The construction of competences must therefore be combined with the pedagogical strategies (PS) proposed by the teacher. According to Behar [9], PS combine several elements involved in the planning of a class, which are the key topics, didactic resources available, such as DT, and the needs of the students. Thus, it is important that PS promote dialogue and student participation, as well as contribute to the creation of interactive spaces to favor the construction of digital competences.

Thus, this article aims to identify PS that can contribute to the construction of the Digital Fluency Competence in the Distance Learning context. It is organized as follows: section two addresses digital fluency competences. Section three covers pedagogical strategies for building competences in DL and four describes the research methodology. The fifth presents the results and lastly the conclusions.

2. Competences: Focusing on Digital Fluency

Over the years education has been changing its teaching methodologies and looking for ways to meet the emerging needs of students due to social, cultural, and technological changes. Thus, competences have become an alternative to address not only the knowledges and content in a given class, but also the skills and attitudes that are essential for the integral development of the subject [8]. According to Behar [10], a competence is a set of Knowledges (knowing), Skills (knowing how), and Attitudes (knowing how to be), synthesized in the acronym KSA, when mobilized can help in facing problem-situations and dealing with the new, enhancing changes in the teaching and learning process in everyday life. This author argues that knowledge is acquired, that is, it is the understanding of concepts and techniques necessary to achieve

objectives and is obtained using different resources, from simple observation, readings, previous training, and academic training itself. Skill on the other hand, are knowing how to do or being able to do. For the individual they represent their aptitude in practical activities to achieve their goal and are associated with the ability to produce based on acquired knowledge, experience, and progressive improvement of skill developed with time and experience. Finally, attitude is to be or want to do. For the individual this entails the conscious and emotional decision of how to act and react on a daily basis based on facts and other people in the environment. Figure 1 illustrates the elements of Knowledges (knowing), Skills (knowing how), and Attitudes (knowing how to be).

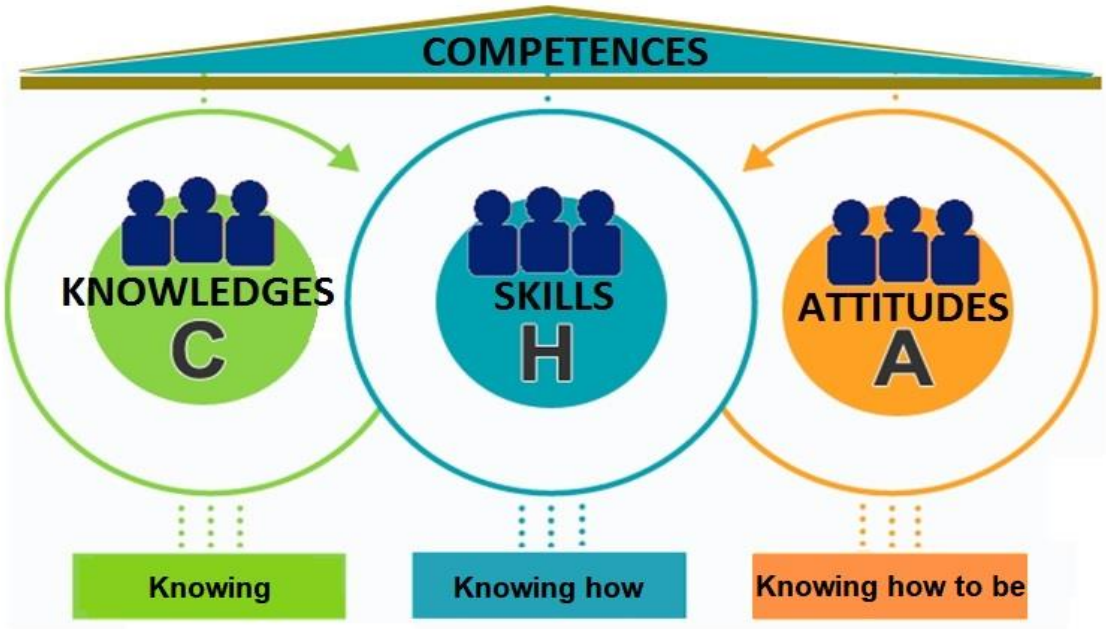

Figure 1. Elements that compose a competence. Source: Created by the authors (2020) based on Behar [10].

The mobilization of the constituent elements of a competence is part of the teaching and learning process [7; 10]. However, with the increased use of digital technologies (smartphones, notebooks, computers, among others) there is also a need to include these resources in the classroom. It is therefore pertinent to rethink competences to include the specificities of DT.

DC are fundamental in the knowledge society, since they enable the subject to use technological resources responsibly to solve real problems. Hence, DC must also be considered in DL, because the use of digital technologies are integrated and serve as the basis for interaction between students and teachers as well as among students themselves when doing activities and accessing the virtual learning environment (VLE). According to Behar [10], many DC must be addressed in distance learning, such as organization, communication, and cooperation. However, digital fluency (DF) is considered to be particularly important for this modality, due to its link to resource use as well as the challenge of planning, developing, and sharing copyrighted materials in these environments. This competence focuses on subjects' use of technology to enable them to feel digitally active or like a participant in technological advances. Fluency therefore encompasses not only use, but also the creation and production of content and materials [2].

Martins and Giraffa [11] emphasize the importance of forms of communication for this competence. They state, "digital fluency refers to the naturalness in articulating and adapting to digital language (digital forms of communication)" [11]. Hence it can be considered the most complete digital competence, because it is composed of both functional digital literacy and critical digital literacy. The subjects are not simply spectators, but can instead create, transform, and generate information on the Internet, becoming critical and reflective producers of digital content [7].

According to Machado et al. [12], "subjects will be digitally fluent only if they can go beyond knowing how to search for a text, read, write, save, and send a document through digital technologies. In other words, to be critical of how to combine the use of different digital tools". Tarouco [13] argues that DF is a personal ability, in which individuals evaluate, select, learn, and use the appropriate technologies for their personal and professional activities. According to Silva and Behar [2], it is a competence for appropriate, creative, autonomous, and authorial use of technology. The fluent subject must be critical of the information and content shared on the Internet, selecting reliable and safe sources, being proactive, curious, and flexible regarding new ideas.

Digital fluency is therefore paramount in distance learning because it includes the use of communication and learner's ability to safely search for information on the computer network, aiming to improve each subject's learning process [7]. In fact, Silva [7] highlights five specific digital competences included in digital fluency for the profile of DL students, namely: content production, data protection, networking, virtual resilience, and teamwork, as can be seen in Figure 2.

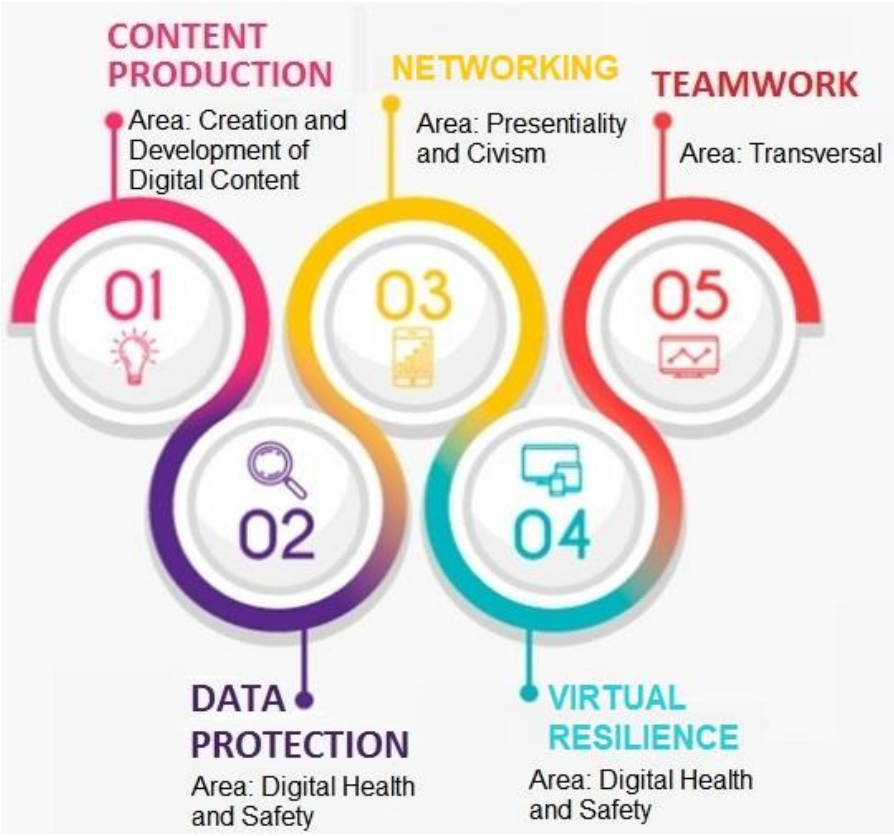

Figure 2. Specific digital competences of digital fluency. Source: The authors (2020) based on Silva [7].

These five specific digital competences of digital fluency based on Silva [7] are explained in detail below:

1. *Content Production*: The creation and development of digital content necessary for learning in different formats. It involves the (re)elaboration or integration of content modifying, refining, and combining resources for using and creating materials in the network. The goal is to express oneself creatively through digital media for learning purposes.
2. *Data Protection*: Understanding of risks, threats, and implementing security. The objective is the protection of personal data, enabling students to protect themselves from threats, cyberbullying, and fraud.
3. *Networking*: Focused on the safe and responsible use of the network for student learning, based on values such as honesty, ethics, and respect. The goal is to choose appropriate content to digitally socialize and network.
4. *Virtual Resilience*: The way students deal with changes and adapt to different obstacles and difficulties. The goal is the process of facing adversity and raising awareness.
5. *Teamwork*: Covers the intra and interpersonal relationships that allow students to express and communicate their desires, emotions, opinions, and expectations. These elements can also be addressed from an affective perspective. The objective is linked to the competences of cooperation and resilience.

Hence, according to Almeida et al. [14], distance learning is based on the use of digital technologies requiring users to have knowledge regarding resources, favoring virtual teaching and learning. It is therefore necessary to know how to develop pedagogical strategies that encourage learners to solve problems, make decisions, analyze data, discuss and apply ideas, as discussed below.

3. Pedagogical Strategies for Competence Construction in DL

Pedagogical strategies (PS) are not clearly defined in the literature. In fact, there are several quite broad explanations or related to some quite specific teaching paradigms. Strategies can refer to methods, techniques, and practices that act as resources for achieving pedagogical objectives.

Arceo et al. [15] argue that strategies are focused on the teacher's actions, the procedures or resources used by the teacher to promote meaningful learning. López and Remesal [16] and Perraudeau [17] on the other hand, understand PS as the coordinated involvement of procedures, chosen from a set of possibilities. Therefore, they are also characterized by their flexibility to meet and adapt to students' needs.

Thus, PS can be thought of as a set of educational actions that provide teachers with resources to apply to their classroom planning. They include tips and suggestions for the use of technological resources [9; 18]. Amaral [18] argues that teachers must keep in mind that each student appropriates the content at a different pace when putting PS into practice, making it necessary to consider the student's previous development and context. The author also mentions that teachers can only act in a personalized way and create PS capable of contemplating subjects' needs by observing these distinct characteristics.

Masetto [19] highlights the need for educators to come up with strategies that facilitate the process of teaching and learning in the classroom, using diverse materials, such as digital resources, teaching techniques, educational actions, etc. This author also stresses that it is necessary to: a) use the most

appropriate strategies for the intended purpose in pedagogical practice; b) have appropriate strategies for each subject or group of students; c) employ a variety of flexible PS throughout the process. Hence, it is crucial to consider the clarity of the objectives, both for the teacher and student, as well as the resources and/or techniques that are used in order to guide the actions applied to the construction of DC. The use of PS for DC is required in distance learning, because it is possible to mediate and create forms for students to build their competences through actions.

The use of Pedagogical Strategies for the construction of digital fluency requires the teacher to propose activities that instigate not only interaction and communication in the VLE, but also understanding how to plan and share the materials in order to collaborate with colleagues. Therefore, strategies must always be related to challenging situations that bring and/or raise problems that need to be solved or spur creation [8]. Thus, it is pertinent to investigate PS that can be developed for constructing digital fluency in distance learning, which is the focus of this study.

The methodology adopted for designing and evaluating the PS to construct the digital fluency competence is presented below.

4. Methodology

This is qualitative work using an interpretative approach. The target audience was 90 DL teachers who have experience using digital technologies. The study was carried out in three phases. In the first, 28 pedagogical strategies were developed to construct DC based on experience and literature [7; 20] in adult education and distance learning. The PS were created for each of the 5 specific digital fluency competences, which are: Content Production, Data Protection, Networking, Virtual Resilience, and Teamwork. Chart 1 presents the specific competences and the respective pedagogical strategies that were developed.

Chart 1 - Specific competences and their respective pedagogical strategies.

SPECIFIC DIGITAL FLUENCY COMPETENCE	PEDAGOGICAL STRATEGY
1 - Production of digital content.	• Present methodologies to produce digital materials. • Present the importance of copyrights in digital production. • Request the production of a storyboard for digital materials. • Use digital authoring tools to produce materials and share them with colleagues and teachers in distance education. • Use tools that enable the production of digital materials in the VLE. • Share original materials produced with colleagues and teachers in the VLE. • Use evaluation and self-assessment questionnaires regarding the original productions. • Produce audiovisual content for web communication.

2 - Data protection	• Present possibilities for protecting data in social networks and, specifically in the VLE. • Present and discuss good virtual etiquette (netiquette) in the VLE. • Develop an e-book to share the best practices for data protection and managing information securely. • Create self-assessment questionnaires on the practices adopted to protect individual data in the network.
3 - Networking	• Promote debate on the impact of Information and Communication Technologies on education. • Present and discuss good virtual etiquette (netiquette) in the VLE. • Promote activities that enable the sharing of materials. • Develop group activities to enable collective networking. • Include discussion forums on transversal themes regarding the topics covered.
4 - Virtual Resilience	• Develop virtual resilience using a collaborative writing tool. • Request materials to be shared in the VLE. • Present problem situations so that students can collectively discuss and solve current problems. • Include forums for discussing transversal themes on the topics covered.
5 - Teamwork	• Develop activities for the "Digital Hackathon", the programming championship. • Perform gamification activities. • Present and discuss good virtual etiquette (netiquette) in the VLE. • Promote activities that enable the sharing of materials. • Develop group activities to promote collective networking. • Request sharing of materials in the VLE. • Present case studies that enable students to reflect on the importance of conflict management in group work.

Source: The authors (2020) based on Silva [7] and Coll et al. [20].

In Phase 2 the PS was assessed by DL teachers. An online questionnaire was created based on Chart 1, consisting of seven essay questions and thirteen multiple-choice questions for teachers working on the topic. The questionnaire was disseminated through institutional groups, the social network Facebook, Whatsapp, and e-mail contacts were also used. The objective was to evaluate the PS developed for the digital fluency competences. The respondents had to accept the terms of agreement in order to access the form. It was divided into three parts: participant profile with 3 questions, assessing digital fluency competences with 6 questions, and their respective pedagogical strategies with 10 questions. In all, 90 DL specialists responded and suggested changes for the PS.

In phase 3, the information collected from the questionnaires was qualitatively analyzed, based on an interpretive approach, applying the steps outlined by Bardin [21]. According to the author, there are three phases for the organization of an analysis, which are: (1) pre-analysis, (2) exploration of the material and, (3) treatment of the results. In the initial phase, (1) the material is organized, documents are chosen, hypotheses are formulated, and indicators are developed to guide the final interpretation. The following rules must be followed: (a) exhaustiveness, examine every subject without omitting any part; (b) representativeness, concerned with samples that translate the universe; (c) homogeneity, collecting data using the same techniques and similar individuals; (d) pertinence, adapt the documents to the research objectives and; (e) exclusivity, classifying an element in only one category. In the material exploration phase (2) the data is coded; a process that transforms and aggregates in registration units (words, themes, or other units), with subsequent categorization. In the last phase (3) the treatment of the results comprises coding and inference. The researcher needs to return to the theoretical framework and ground the analysis to justify the interpretation.

The following section presents the results of the research.

5. Results

This article identifies pedagogical strategies that can contribute to the construction of the digital fluency competence in the DL context. The suggestions and observations made by the 90 participants when answering the questionnaire were examined, making it possible to reflect on and implement the changes that were suggested in the PS. The responses were therefore categorized into: a) Participant profile; b) Evaluation of digital fluency competence and; c) Evaluation of PS for the digital fluency competence.

5.1 Participant Profile

The 3 questions asked to create the participant profile were: gender (multiple choice), age (fill-in-the-blank), and academic background (fill-in-the-blank). The majority of the subjects (n = 63) were female. Their ages varied between 24 and 74 years of age. The most common ages were 39, 41, and 50, with 6 participants each, as can be seen in Figure 3.

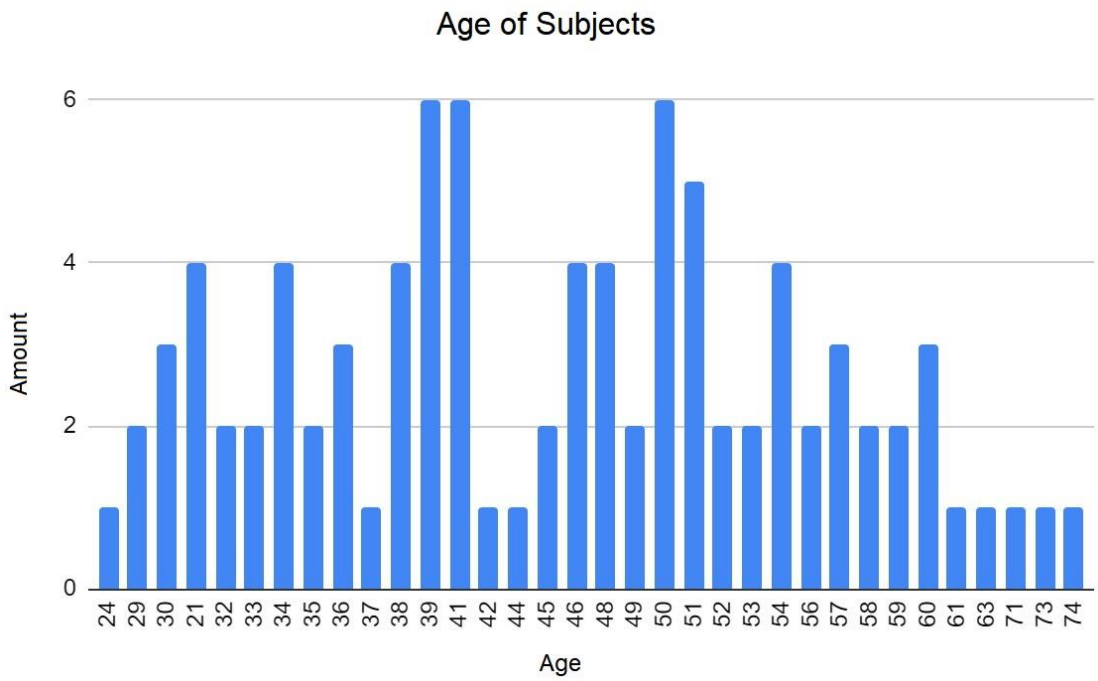

Figure 3. Participants' age. Source: The authors (2020).

Lastly was the level of academic study. The majority had their undergraduate degree (n=35), followed by those with Ph.D. and Master's degrees (n=27) and specialists (n=22), as illustrated in Figure 4.

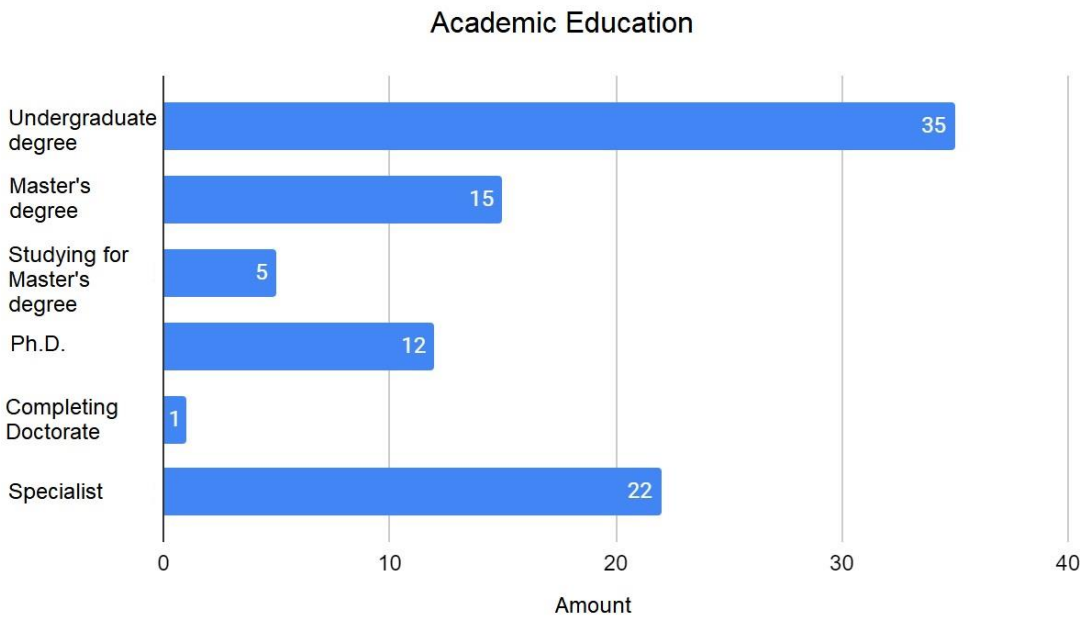

Figure 4. Academic Education. Source: The authors (2020).

The responses point to a more mature profile, the majority with graduate studies (n = 49) and primarily female (n = 63). Therefore, this public has a considerable theoretical foundation and also predominantly high teaching experience.

5.2 Evaluation of the Digital Fluency Competences

The second part of the questionnaire was related to the assessment of digital fluency competences. Respondents were asked to assign a number based on the 5 - point Likert scale, with the following values: "1 - not important", "2 - not very important", "3 - moderately important", "4 - important" and "5 - very important" for each of the 5 specific competences.

The 6 questions were: 1) In your opinion, what is the importance of the digital fluency competence and pedagogical strategies for distance learning?; 2) In your opinion, what is the importance of the specific competence of content production for distance learning?; 3) In your opinion, what is the importance of the specific competence of data protection for distance learning?; 4) In your opinion, what is the importance of the specific competence of networking for distance learning?; 5) In your opinion, what is the importance of the specific competence of virtual resilience for distance learning?; and 6) In your opinion, what is the importance of the specific competence of teamwork for distance learning?

When responding to the first question, the majority of participants (84.4%) considered the digital fluency competence and pedagogical strategies to be "very important", while 13.3% rated them as "important" and only 2.2% as "moderately important", as seen in Figure 5.

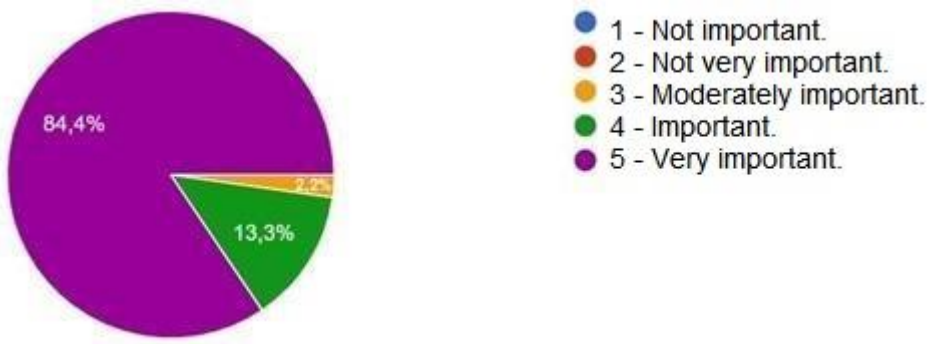

Figure 5. Importance of the digital fluency competence and pedagogical strategies. Source: The authors (2020).

Question 2 rated the importance of the specific competence of content production in distance learning. It was rated "very important" by 74.4% of people, "important" by 22.2%, "moderately important" by 2.2% and "not important" by 1.1%. In other words, only one subject considered this competence unimportant, as shown in Figure 6.

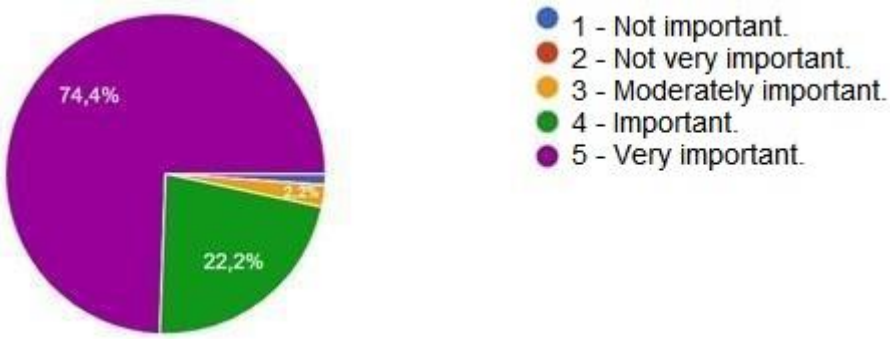

Figure 6. Importance of content production. Source: The authors (2020).

Most respondents (77.8%) rated the data protection competence "very important", whereas 12.2% responded "important", 7.8% "moderately important," and 2.2% "not important", as shown in Figure 7.

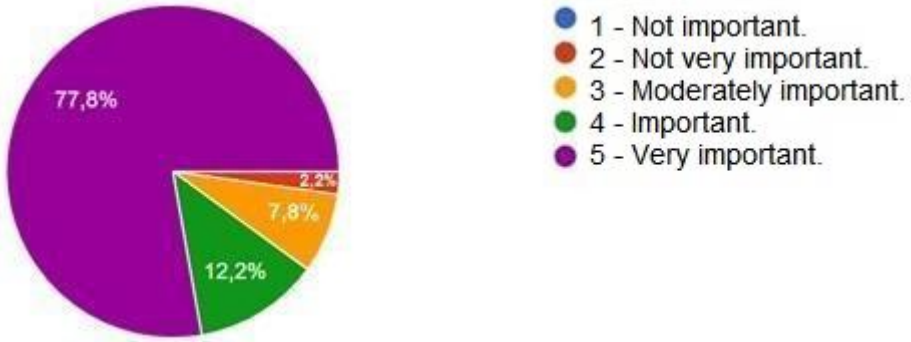

Figure 7. Importance of data protection. Source: The authors (2020).

Moreover, 67.8% of the participants rated networking as "very important", 17.8% as "important", 13.3% "moderately important," and 1.1% "not very important", as shown in Figure 8.

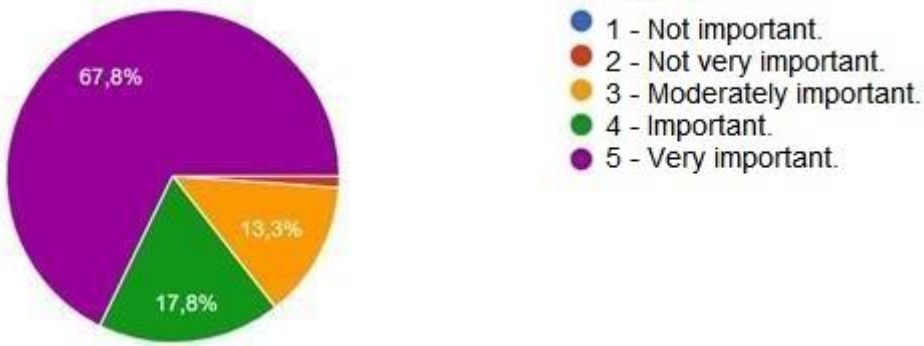

Figure 8. Importance of networking. Source: The authors (2020).

In terms of virtual resilience, 66.7% of people considered it "very important", 22.2% "important", 10% "moderately important," and 1.1% "not very important", illustrated in Figure 9.

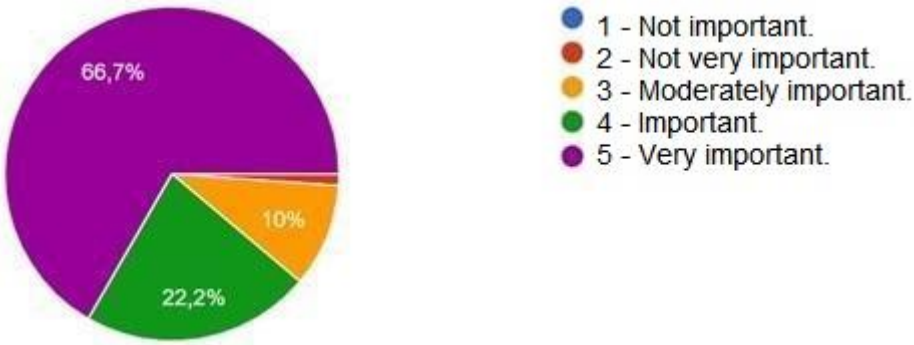

Figure 9. Importance of Virtual Resilience. Source: The authors (2020).

The last question in the second part of the questionnaire was about teamwork and 77.8% of the subjects

rated it as "very important." In addition, 15.6% rated it as "important", 4.4% "moderately important", 1.1% "not very important," and 1.1% "not important", as shown in Figure 10.

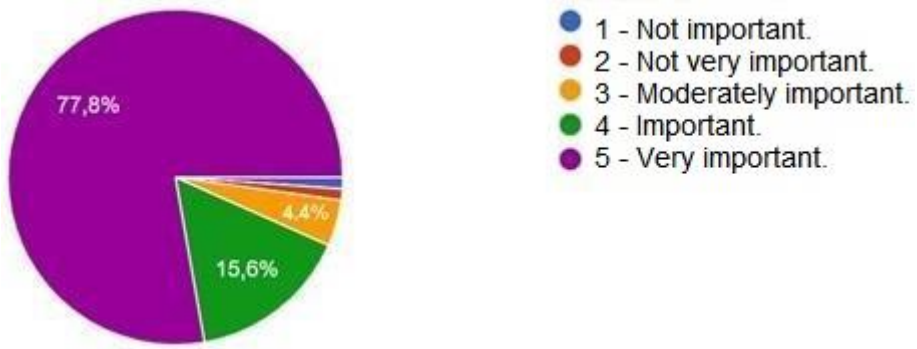

Figure 10. Importance of teamwork. Source: The authors (2020).

Therefore, the conclusion is that the 5 digital fluency competences were considered "very important" in all cases, with the lowest percentage obtained being 66.7% in virtual resilience, which is still a high value because it refers to the opinion of 60 participants. The results show that all the analyzed DC are relevant in the distance learning context, making it necessary to develop and apply PS that allow them to be constructed in the virtual environment, which will be discussed below.

5.3 Evaluation of the Pedagogical Strategies for the Digital Fluency Competences

The third and last part of the questionnaire evaluated and the adequacy of the pedagogical strategies created for each of the 5 digital fluency competences. It was composed of 10 questions, in which half were based on the Likert scale, using the same criteria as the evaluation of the DC to verify the importance of PS. The other half consisted of essay questions to give participants space to make suggestions for the strategies for each competence.

The pedagogical strategies created for content production were rated as "very important" by 76.7%, whereas 16.7% considered them "important", 4.4% "moderately important", and 2.2% "not very important". Participants' suggestions for this competence are presented in Chart 2.

Chart 2 - Participants' suggestions for the PS and content production.

"*Exclude the production of storyboard*" (P6).
"*Add ways to disseminate the production of digital content" (P9).*
"Add online debates with different people" (P11).
"Remove the production of storyboard" (P12).
"Include remote experiences" (P21).
"Adopt the principles of open education in the production of content. More open Creative Commons licenses" (P33).
"Insert self-assessment" (P38).
"Remove the request to produce a storyboard" (P39).

"Add gamification in Google form" (P43).
"Add user experience (UX) stage" (P46).
"Delete storyboard request" (P59).
"Eliminate the storyboard" (P70).
"Remove: Request to produce a storyboard for digital materials" (P73).
"Use diagnostic assessment questionnaires with the participants in the VLE about what they hope to learn and what they already know" (P76).
"Remove storyboard production" (P77).
"*I would add a podcast*" (P84).
"*Include hypertexts*" (P87).

Source: The authors (2020).

It is important to note that P6, P12, P39, P59, P70, P73, and P77 all suggested removing the storyboard from the PS. P9, on the other hand, suggested adding ways to disseminate content production. Other suggestions for additions included, P11 online debates, P21 remote experiences, P33 principles of open education in content production, P38 self-assessment, P43 gamification, P46 user experience, and P76 would perform diagnostic assessments. Finally, P84 suggested adding a podcast and P87 hypertexts. Based on the suggestion of seven participants, the storyboard was removed from content production to suit the evaluators' scores and five PS were added to the final table, as suggested by the participants.

The PS for data protection were also analyzed, in which 76.7% of the respondents considered them "very important", 14.4% "important", 7.8% "moderately important," and 1.1% "not very important". Chart 3 presents their suggestions.

Chart 3 - Participants' suggestions for the data protection PS.

"*Add how to make smart decisions about managing sensitive data" (P2).*
"Assessing fake news" (P3).
"Identity verification" (P11).
"More about protective laws" (P21).
"Learn the legislation on the topic" (P27).
"Remove ethics and netiquette" (P33).
"Address the types of licenses that exist" (P40).
"Emphasize the importance of respect in the virtual environment, not sharing links, spam, things that are out of context and that can harm others" (P41).
"Add a case related to the General Data Protection Law (LGPD)" (P46).
"The publication and punishment for those who plagiarize" (P60).
"I think that the issue of sites that are fake and have false links can be included" (P67).
"Remove presenting and discussing netiquette in the VLE" (P68).
"If it is not foreseen, it would be interesting to raise awareness of the identification of false content" (P69).
"Exclude netiquette" (P85).

Source: The authors (2020).

As Chart 3 reveals, P3, P41, P67, and P69 considered it important to make students aware of false content. P21, P27, P40, P46, and P60, on the other hand, emphasized the importance of including more information about data legislation. In fact, P46 called for "Adding a process related to the General Data Protection Law (LGPD)". P33, P68, and P85 all suggest removing the PS on the presentation and discussion of netiquette in the VLE. Also, P2 suggested adding how to make intelligent decisions about managing sensitive data and P11 would verify identity. Thus, there were various aspects to improve the PS that were suggested. Based on these, the PS linked to the netiquette was removed, as suggested by three participants, and four new strategies were also added.

Networking was evaluated as "very important" by 65.6% of the participants, "important" by 21.1%, and "moderately important" by 13.3%. Chart 4 presents the suggestions for the strategies created for this competence.

Chart 4 - Participants' suggestions for the networking PS.

"I would add coexistence and learning in virtual environments" (P2).
"I would remove group activities" (P6).
"I would create more direct communication between the students and teacher so that learning actually takes place" (P8).
"Include traceability" (P11).
"Create a Whatsapp group and meeting rooms, so that the participants can get to know each other better" (P23).
"Hold some real time meetings" (P27).
"I would add the construction of socioemotional skills for coexistence" (P35).
"Insert debate about the impact of technology" (P38).
"I would add a space for group work" (P46).
"Also address digital technologies; encourage exchange and coexistence through digital social networks" (P56).
"Encourage interaction with games in the classes" (P62).
"Address the rules of good coexistence, rights, and duties" (P66).
"Use collaborative tools in the process" (P67).
"Promote activities that enable sharing materials" (P68).
"Use video conferencing for better interaction" (P71).
"Share materials that help colleagues to understand the topic" (P76).
"Remove Netiquette" (P84).
"Create a collaborative Padlet" (P85).

Source: The authors (2020).

There were many suggestions for the networking PS. For example, P2 would add coexistence and learning in virtual environments, P11 would include traceability, P35 would add construction of socioemotional skills, P66 would address rules of good coexistence, and P84 would remove the netiquette. Both P68 and P76 argue that activities should be added that make it possible to share materials. On the other hand, P38

and P56 would address the use of technologies. The recommendation of using collaborative tools in the process was made by P62, P67, and P85. Yet, P6 would remove group activities, in contrast to P8, P23, P27, P46, and P71 who would add a more direct communication between the students as a strategy to bring them closer, as P23 suggested using complementary features such as "Whatsapp and classrooms meetings". Perhaps the ample amount of divergent suggestions made by the participants could justify the low value of 65.6% who considered the strategies "very important". Hence, five PS were added and the one referring to the netiquette was removed, making there a total of nine final pedagogical strategies.

Virtual resilience PS was considered "very important" by 71.1% of the participants, "important" for 18.9%, "moderately important" for 7.8%, and "not very important" for 2.2%. The suggestions for this competence are presented below.

Chart 5 - Participants' suggestions for the PS for virtual resilience.

"Work more on culture and virtual conduct" (P11).
"Add content to help students with this aspect" (P23).
"Provide students with knowledge about self-regulation and time management" (P33).
"Insert collaborative writing tools" (P38).
"Make more space for exchanges" (P46).
"Insert more debates" (P49).
"Include the exploration of interactive tools and construction of narratives" (P68).
"Encourage contact with colleagues and the DL team" (P71).
"Share strategies for better use of technological tools in the virtual environment" (P76).
"Encourage active listening" (P85).

Source: The authors (2020).

There were not many suggestions regarding virtual resilience. P11 would include working more on culture and virtual conduct, P23 would add content to help students, P33 would provide more information about self-regulation and time management, P46 would create more space for exchanges, P49 would create more debates, and P85 would encourage active listening. Moreover, P38, P68, P71, and P76 would encourage the use of technological tools for interaction and contact with colleagues. Due to the positive overall evaluation and few suggestions, the PS created can be considered pertinent. Therefore, three were added to the final table, making a total of seven strategies.

The last digital fluency competence was teamwork. It was rated "very important" by 78.8% of the participants, "important" by 20%, and "moderately important" by 1.1%. Chart 6 shows the suggestions made for the PS.

Chart 6 - Participants' suggestions for the teamwork PS.

"Add pedagogical interactions based on the collaborative teaching perspective" (P2).
"Include a group study to get to know the participants in the teamwork proposed" (P20).
"Intensify the gamification tools" (P21).
"Develop problem situations that enable interaction when searching for solutions" (P32).
"Include collaborative digital tools for teamwork" (P34).

"Do activities and dynamics that emphasize the importance of collaboration" (P56).
"Encourage collective authorship linked to the specific competence of teamwork" (P64).
"Use meeting platforms" (P83).
"Develop collective construction of materials that involve all students" (P85).

Source: The authors (2020).

Additions were suggested by various participants. In fact, P2 would add pedagogical interactions from the collaborative teaching perspective, P20 a group study, P21 would apply gamification, P32 would develop problem situations that would enable interaction, P34 would use digital tools, P56 would carry out activities and dynamics that emphasized the importance of collaboration, P64 would indicate collective authorship, P83 would employ the use of meeting platforms, and P85 would elaborate the collective construction of materials. Thus, four PS were added and none were removed, making a total of eleven strategies.
Hence, based on the participants' responses, the PS were modified as shown in Chart 7.

Chart 7 – Pedagogical Strategies for Digital Fluency Competences.

COMPETENCE/ DATA	PEDAGOGICAL STRATEGIES
Digital content production DC	• Present content production methodologies for digital materials. • Present the importance of copyrights in digital content production. • Use materials that encourage production such as podcasts, videos, animation, etc. • Present and teach how to use Creative Commons. • How to practically use digital content tools to produce materials and share them with colleagues and teachers in distance learning. • How to practically use tools within the VLE that enable the production of digital materials. • Share original materials produced with colleagues and teachers in the VLE. • Use evaluation and self-assessment questionnaires for production. • Use materials that allow for reflections on User Experience (UX). • Use steps from active methodologies such as gamification or design thinking for the production of materials. • Produce audiovisual content for web communication. • Share the materials developed and interact with others in social networks or virtual learning environments.
PS Data.	**Removed: 1 PS.** **Added: 5 PS.** **Final Total of PS: 12.**
Data Protection	• Present the possible ways to protect data in social networks and specifically

DC	in VLE. ● Learn and discuss Internet data protection legislation (https://brasilpaisdigital.com.br/saiba-mais/legislacao-sobre-dados-no-brasil/). ● Present Creative Commons and how it is used. ● Present the importance of copyrights in digital production. ● Develop an e-book to share the "Best Practices" for data protection and information security management. ● Present and discuss fake news and spam on social networks, groups, and VLE. ● Create self-assessment questionnaires on practices adopted to protect individual data in the network.
PS Data.	**Removed: 1 PS.** **Added: 4 PS.** **Final total of PS: 7.**
Networking CD	● Promote a debate on the impact of Information and Communication Technologies on education. ● Promote activities that enable sharing materials. ● Create spaces and develop group activities to enable collective coexistence. ● Include forums for discussing transversal themes on the topics covered. ● Use stages of active methodologies that allow for the creation of groups such as Think Pair Share, Project Based Learning, Gamification, and others. ● Develop an e-book to share the "best practices" for data protection and information security management. ● Discuss digital technologies that favor exchange and coexistence through digital social networks, as well as their impacts on society. ● Use collaborative and cooperative tools such as whiteboards (Padlet), Infographics (Canva), and others. ● Create virtual spaces for group communication such as videoconferencing (Google Meet, Zoom, MConf, and others), groups on WhatsApp, etc.
PS Data	**Removed: 1 PS.** **Added: 5 PS.** **Final total of PS: 9.**
Virtual Resilience CD	● Develop virtual resilience by using collaborative writing tools. ● Present virtual resilience and its impact on life. ● Create cases that bring situations of dissatisfaction or demotivation in the

	VLE so that students can discuss possible ways to overcome these virtual challenges. ● Request sharing materials in the VLE. ● Create social groups so that students can have a space to communicate and interact outside of the educational environment. ● Present problem situations so that students can collectively discuss and solve current problems. ● Include forums for discussing transversal themes on the topics covered.
PS Data	**Removed: 0 EP.** **Added: 3EP.** **Final total of PS: 7.**
Teamwork DC	● Develop activities that enable the "Digital Hackathon", the programming championship. ● Use stages of active methodologies that allow the creation of groups such as Think Pair Share, Project Based Learning, Gamification, and others. ● Present and discuss good etiquette practices (netiquette) in the VLE. ● Promote activities that enable sharing materials. ● Develop group activities for collective coexistence. ● Create social groups so that students can have a space for communication and interaction outside the educational environment. ● Collectively create a group work "contract" so that all participants can understand their duties and rights. ● Use collaborative and cooperative tools such as whiteboards (Padlet), Infographics (Canva), among others. ● Create virtual spaces for group communication such as videoconferencing (Google Meet, Zoom, MConf, and others), groups on WhatsApp, etc. ● Request sharing materials in the VLE. ● Present case studies that enable students to reflect on the importance of conflict management in group work.
PS Data	**Removed: 0 PS.** **Added: 4 PS.** **Final total of PS: 11.**

Source: The authors (2020).

It is worth mentioning that of the 5 digital fluency competences, only content production, data protection, and virtual resilience were considered to be "not important", receiving a maximum of 2.2% of the votes, corresponding to 2 people. New pedagogical strategies were also suggested. The digital fluency DCs for distance learning therefore totaled 46 strategies divided into specific competences. There are a variety of

elements that cover the use of VLE DT as well as specific methodologies that can contemplate the construction of each DC.

6. Conclusion

This article identified pedagogical strategies that can contribute to the construction of the digital fluency competence in the DL context. The study was carried out in three phases. In the first, 28 Pedagogical Strategies were elaborated by the postgraduate authors. In the second, the PS were evaluated by 90 DL professors who have experience in the use of digital technologies. In the third, the information from the questionnaires applied in the second phase, were analyzed in a qualitative way based on an interpretative approach. Thus, it was necessary to examine the data of the suggestions and observations made by the 90 participants when answering the questionnaire so that it was possible to carry out reflections and changes pointed out in the PS developed. Therefore, the responses were categorized into: a) Profile of the participants; b) Evaluation of digital fluency competences and; c) Evaluation of PS for digital fluency DC. Thus, there were a total of 46 pedagogical strategies for the digital fluency DC for distance learning that were divided into specific competences. It is possible to perceive a variety of elements that dialogue between the use of VLE DT, or beyond it, as well as specific methodologies that can contemplate the construction of each DC. Thus, this work is intended to contribute to improving the quality of the interactions between teachers and students, and also to strengthen these bonds in favor of the teaching and learning process.

7. Acknowledgement

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The pros and cons of working from home: Newspapers illustrators' views on remote work during the pandemic of Covid-19 in Brazil

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Abstract

In July 2020, a group of illustrators were contacted so we could hear if their views on remote work and professional collaboration had changed, in light of the covid-19 pandemic scenario. These illustrators participated in a previous research conducted with Brazilian newspaper illustrators between 2016-2018. The main research objective was to understand how illustrators were fitting in newspaper's routines and production, considering the multiplatform publishing trend led by the rise in mobile and digital readership. As it was observed then, illustrators were already used to working remotely. The investigation focused in assessing how these professionals viewed the pros and cons of face-to-face working way compared to working remotely. Also their views on the interaction with other fields' professionals, in projects involving Illustration & Design were considered. Illustrators of Brazilian newspapers answered a query and an interview with open questions. Although the original research had not been motivated by a pandemic scene, we believe that by renewing the subject with new data collected in 2020, the study can contribute to the ongoing broader discussions over reorganizing workflows for remote work, especially those involving designers and projects with multidisciplinary teams. This paper aims at presenting and discussing qualitative data regarding these issues.

Keywords: News illustration, remote work, multidisciplinary projects, work experience

1. Introduction

The study conducted with Brazilian newspaper illustrators between the years 2016-2018[1] had as main objective to understand how production for multiplatform environments was impacting newspaper

[1]MITCHELL, V.; NOVAES, L. (advisor). **A ilustração jornalística e os desafios para sua experiência em smartphones**,

illustration and the work of the illustrator. There were signs, at that time, that traditional illustration and cartooning were losing ground and waning from their usual editorial niches in the newspaper. Professionals and researchers from the field expressed this tendency in recent years such as Ary Moraes (2010, 2013), Orlando Pedroso (2016), Nannette Hoogslag (2013) and Jorge Pedro Sousa (2005). This motivated us to investigate the possible challenges for the insertion of illustrations in the mobile versions of newspapers, which had become the priority for many publications. Therefore, considering the reorganization that newsrooms underwent to adapt for multiplatform publishing, it was important to understand how the illustrators were fitting in the newspaper's new routines of production.

Since the 1990s, technological changes from desktop computing to digital culture led to a growing importance of graphics and visual journalism in newsrooms. The popularization of these resources supported the rise in importance of Design itself, with more credit given to News Design and a larger number of visual projects in which designers lead or participate with great involvement (Moraes, 2010, 2013). The need for different professional collaboration reflected on a more multidisciplinary composition of the Art Departments. To generate multimedia content for different platforms, Art teams were no longer structured around graphic design and illustration. They had increasingly hired staff able to design and code digital content with motion, animation, data visualization and interaction. Producing illustrated content for the new media required adaptations to incorporate the possibilities of digital technologies (Hoogslag & Sherman, 2019).

In the 2016-2018 research, professionals from "Art Departments" of 13 Brazilian newspapers were consulted through a survey. Traditional illustrators were found to be only 9,6% of those working "in office." By *traditional*, we meant the professionals not involved with cartooning, designing graphics or data visualization. When considering staff members who were able to produce illustrations in their routines, the number rose to 38.9%. Other data collected were with respect to the working way adopted. Traditional illustrators and cartoonists were mostly working from home: 63% as regular freelancers and 71% doing sporadic freelance work. Also of notice, 42.8% of respondents were Design graduates.

Later in the fieldwork, 31 Brazilian illustrators were interviewed, sharing their vision of the ongoing professional transformations. Two questions concerned organizational matters: how they viewed the pros and cons of working in person and, in comparison, to work from home. Also, how was their interaction with colleagues, designers, editors, journalists and professionals from other disciplines? We hoped the questions would shed light on related topics moving our speculations. If illustrators without design skills were being removed from the newsroom, how was their interaction when involved in multidisciplinary projects that demanded illustrations, such as digital and interactive content? Were they feeling isolated from editorial decision making? Did they actually prefer to work from home, not wanting larger involvement in such projects? What unseen possibilities may come from work-from-home arrangements for designers and artists? Their contribution provided some unpredicted observations and, we hope, valuable insight on this matter, two years before the Covid-19 pandemic emergency has forced most of us to learn how to work, study and interact from a distance. In July 2020, the same illustrators were contacted

Rio de Janeiro, 2018. 239p. Master's thesis – Departamento de Artes e Design, Pontifícia Universidade Católica do Rio de Janeiro – PUC-Rio, available at: https://www.maxwell.vrac.puc-rio.br/colecao.php?strSecao=resultado&nrSeq=35962@1

again to assess if their views on the matter had changed. This paper aims to discuss the qualitative results of these objectives.

2. Methodology for the interviews

The interviews were planned and conducted as described in the following sections.

2.1 Criteria for invitation

A professional under the designation of "Illustrator" may carry out different tasks in the newspaper business: illustrating, designing graphics and cartooning. Also, by reverse reasoning, many nomenclatures are used to refer to drawing specialists: cartoonists, comic artists, infographics specialist, visual journalists, designers and graphic artists. In his study on newspaper illustration, Gilmar Hermes (2005) observed that the designation "illustrator" had become broad and vague in journalism. Sometimes, the same professional performs more than one of these tasks in the work routine. For research purposes, our study invited Brazilian professionals if they fit two criteria: 1) Subject had a job as "Illustrator"; 2) Subject published work in daily news. The invitation was open to illustrators regardless of contract status and career experience.

2.2 Interview application method and theoretical support

Potential subjects were approached through the Internet. Upon agreement to participate, an email was sent with the interview, with 5 open questions, and a link to an online query. The *interview* provided for qualitative information. The *query* was structured with resources such as checkboxes and multiple-choice in 33 possible items, supporting quantitative investigation. The survey was held between 6/2/2017 and 11/5/2017. In total, 40 professionals responded to the query and 31 completed both interview and query.

For the purpose of discussing remote work and organizational issues in Design and Illustration work, this paper will focus on the answers to the following interview questions:

Question B: Let us consider two distinct working relationships: the illustrator who works in person at the newsroom's art department (daily with other illustrators, designers and journalists) and the illustrator who works remotely (with no duty to be in the newsroom), developing work from e-mail orders and conference calls, for example. How do you see the pros and cons of the illustrator's experience in each of these situations or environments, in your perception?

Question D: In your role as an illustrator, how is your relationship with editors, designers and journalists, in the process of designing and making projects involving illustrations?

During July 2020, the same group of illustrators was contacted. They were asked to consider the period in which Brazil has been through the Covid-19 pandemic and discuss, in two open questions, formulated as to resonate questions B and D from the 2016-2018 study. Seven professionals responded, whose visions inspired some reflections.

Question 1: Were there any changes in your view about the pros and cons of remote work in relation to face-to-face work?

Question 2: Were there changes in your work interaction with other professionals involved in the process of designing and carrying out projects with illustration (designers, journalists, programmers, editors, etc.)?

The "Underlying Discourse Unveiling Method (UDUM)", by Ana Maria Nicolaci-da-Costa (2007), or "MEDS", as it is abbreviated in Portuguese, provided the framework for the qualitative research. The method is interdisciplinary and exploratory, allowing for in-depth investigation in context, with flexibility of procedures and techniques. Our process of interviewing was informed by the MEDS methodology in the following procedures:

• Semi-structured interviews with open-ended questions;
• Natural or confortable settings for the interviews;
• Piloting interviews, exploratory, conducted with the purpose of "testing the adequacy of the interview outline to the research objectives" and "training the inexperienced interviewer" (Nicolaci-da-Costa, 2004, free translation by authors);
• Invitations in the most natural way possible;
• Avoidance of unnecessary interruptions, leaving interviewees free to express their thoughts;
• Recording of interviews, avoiding that technological apparatus interfere with subjects' posture.

The "MEDS" method favors the emergence of unexpected themes in qualitative responses. Theme labels were created based on recurrences and similarities identified in the discourses of interviewees. The full qualitative material was reread and reworked to the point of "saturation", when the appearance of new relevant themes became scarce. Transcriptions were codified and analyzed with the use of spreadsheets. As suggested by the MEDS method, themes were extracted in two directions, intersubject and intrasubject: 1) in the total set of responses of various subjects, to a specific question; and 2) In all the responses to various questions from one specific subject, the same Illustrator. This was useful in mapping themes that brought points of interest to a specific objective that was supposed to have been explored in a different question from the one it appeared in. Considering that the objective was to understand the vision of the interviewees on certain topics and elaborate reflections, in addition to the fact that the identification of each illustrator contacted wasn't really necessary for our mental exercise, we decided to assume the answers as representative of the group, keeping the illustrators anonymous.

3. Collected data

The findings showed in the collected data were as follows. The interviews were held in Portuguese. Fragments presented were freely translated by authors.

3.1. Remote work, favorable opinions, 2016-2018

Autonomy

Greater autonomy was seen as the best advantage of remote work, with the possibility of working for more clients and increase earnings. One illustrator reported working for "dozens of newspapers at the same time." Another illustrator's home state had "very few publications that hire illustrators". Working remotely allows her to work "from anywhere in the country". Another mentioned that the transition to working remotely opened new career opportunities, allowing him to start illustrating books of children's literature.

Work interaction viable

Interaction from a distance was seen as viable, with "no loss" in communication. Some believed interactions are better, more "concise" and "objective." One illustrator described negotiating via e-mail and video calls as "simple and efficient", working both for Brazilian and international newspapers. Another observed that this dynamics favors "editorial" illustrations jobs, as "what matters most is the delimitation of space for the illustration and the text."

Immersion

Isolation as immersion was perceived positively and associated with a more "comfortable", "peaceful" and "quiet" environment at home or at a studio. This "solitude", without the "madness" of the newsroom around them, is seen as beneficial for concentration, deep thinking and research.

3.2. Remote work, unfavorable opinions, 2016-2018

Worse work coordination

Interaction was impaired in arguments concerning trust and non-verbal communication. As one illustrator said, "knowing people and perceiving the tone of voice and their reactions" helps to understand the level of trust and "equality" in the professional relationship. Another believed meeting personally could attenuate communication troubles that commonly arise. In his view, ideally, illustration and text should "work almost like a third discourse, joining forces as if they were conceived together from the first draft". Remote work, for him, "has an impersonal character because it is not a process of exchange but a delivery".

Loneliness and isolation

Isolation was associated with loss of focus, lack of self-discipline and alienation from decision-making. The lack of incidental conversations and peer review that may help advance work and solve problems was observed. At home, one illustrator expressed concern about straying from the news mindset and information awareness of the newsroom, which is important in the newspaper work. Another was emphatic: "This isolation and loneliness – typical of *draftsman* and *designers* – is *counterproductive* and something we must fight against."

Devaluation of occupation

Remote work was associated with a devaluation of the profession and economic vulnerability. In contrast, a regular job represented expectations of a salary, health insurance, vacation and other indirect advantages. There was the belief that these opportunities were supported by the business model of the print era, with illustrators expressing skepticism as to the viability of supporting a career, in Brazil, exclusively as a freelancing illustrator. Others observed that illustration might become a "secondary activity", done by designers in the newspaper staff, improvising on press deadlines.

Other themes

Also observed were the ideas that remote work demands **"Higher self-discipline"** and professional maturity; that **"Office work is good for beginners"**, with the newsroom seen as the ideal workplace for young, developing professionals, and the **"Constant availability"** experienced when working online, remotely, which may create professional stress.

3.3. In Office work, 2016-2018

Shared knowledge and richness of interactions

Many illustrators recalled beginning their careers inexperienced and learning skills by working together with experts of their time. For them, the collaborative environment of the Art Departments favors the passing of knowledge from one generation of professionals to the other. One illustrator recalled this aspect from his early days at work: "A wonderful thing was the exchange of experiences, ideas and techniques that we illustrators shared". Others recalled guidance they received from older or more experienced colleagues in their staff. For an experienced illustrator, the ideal work environment should "bring together a mix of young and veteran professionals".

Chaotic and stressful environment

The newsroom was associated negatively with "stress", "pressure", "chaos", and "madness". A "heavy and claustrophobic" environment, perceived as tumultuous and demanding. This wears the professionals physically and mentally, impairing concentration and the work process. Dealing with daily deadlines and last minute requests isn't uncommon, and may "create a repetitive and tiring routine, daily or frequent closings tend to be stressful". Limited space to draw was also mentioned.

Other themes

Also observed in the answers were: **"Better work coordination",** representing the belief that participation and feedbacks are better in office; **"Infrastructure and stimulating work environment"**, where the office atmosphere is perceived as work-inducing; "**More control, less autonomy"** and a **"Higher economic security"** associated with a steady job.

3.4. Remote and freelance arrangements as trending or inevitable

Regular jobs for illustrators were perceived as rare or inexistent. One illustrator thought the position "practically does not exist anymore." Another believed "Illustration has lost space," regardless of the sector. A cartoonist thought the "collapse of the press" and its business model prompted cuts of things considered "superfluous."

3.5. Remote work, favorable opinions, 2020

Better quality of life

Working from home was associated with a gain in quality of life. One illustrator said he felt "more focused and relaxed to develop the most creative parts of the projects." Time factor was also mentioned: "Time can be better spent (...) without commuting time, which in my case varies between three to four hours a day." The same illustrator remarked feeling more safe, since security and city violence in Rio de Janeiro are critical matters: "I think there is a significant gain in quality of life." Another observed that it allows for "flexibility of schedules", and "autonomy over productivity", by "freeing work progress from corporate protocols."

Remote work unchanged or more efficient

Three illustrators believed their routine was unchanged and the production of traditional illustration unaffected. One observed: "I don't think there were any significant changes in the creative process itself. It

consists of reading the text and trying to create a visual narrative to it." Another believes "remote work has proven to be as efficient as face-to-face", adding that productivity may actually rise.

Illustrating is naturally a lonely job

"The illustrator works alone whether digitally or on the drawing board," said one respondent. Another said, "The illustrator's creation is already very lonely in its nature." Being alone was not viewed as good or bad, but part of the job.

Good for artists' unique development

One cartoonist believes working remotely favors the development of an "intimate atmosphere and idiosyncratic vocabulary."

3.6. Remote work, adverse opinions, 2020

Worse infrastructure

Having worse "infrastructure" at home is viewed as a disadvantage: "computer, chair, table". An illustrator remarked that the "implementation of remote work was done on an emergency basis due to the pandemic," which was a new experience: "I ended up having to improvise and set up a workstation that would be used for months on a daily basis. The company's computers and chairs are more suitable than my personal ones." Another made similar observations about his home equipment being inferior technologically and ergonomically: "I had to adjust my space to make it more comfortable and not suffer from neck pain". His computer being of an older generation was incompatible with the installation of applications needed to access the company's network remotely. Also, there are more general concerns: "There can't be a power shortage."

Uncertainty about future impact on work

One illustrator expressed missing the "ambience" of the Newsroom, having worked in office for 20 years and fears that it will eventually impact his work: "I don't know what psychological effect this will have on the final process, in the short or long term. I'm not an expert in the field to answer. My impression is that some change will happen." Another, considering the Covid-19 pandemic, reported having lost opportunities due to uncertainties: "I was going to share a studio with another artist in a collective and everything is adjourned." He was also unable to release a publication in a comic fair: "Everything was canceled, with no plans to reschedule."

Slower response time

Difficulties using The Virtual Private Networks ("VPN to access files and digital publishers on the company's computers") were mentioned. An illustrator observed: "Access is usually much slower." Another said that Internet service at home is not enough for the whole family, especially in the evenings, when "everybody is locked inside, using streaming applications." This becomes a concern for delivering on time: "There are days I have trouble sending a 2 megabyte file." To solve this, the illustrator reported sharing files from computer to phone through Bluetooth, and then sending it through the smartphone's data plan.

Time management

A professional observed: "The biggest challenge is in managing one's own time, but since personal progress depends on it, I believe that remote work is also a stimulus for own organization and work optimization."

Loneliness

One illustrator believes working remotely "has the setback of extreme loneliness."

3.7. Illustrators' views on interactions with other professionals, 2016-2018

Creative freedom concerns

Many responses were concerned about creative freedom. It is considered normal for the illustrator to receive general guidance, but the illustrator shouldn't feel forced to make the drawing exactly as suggested. One illustrator exemplified: “The best relationships between editors and designers are those when they present you with a project, guiding you what they expect but not tying up a pre-conceived and completed idea, allowing freedom for your creation.” This relationship may mature in long-term collaborations, with responses mentioning the importance of "knowing" what the editor expects. This reliance works the other way around, when editors trust the illustrator's "talent and knowledge" to take a different path. One illustrator, for example, explained his work process as listening to suggestions on briefing but not necessarily executing them, saying he should have the "final word" if he is signing the work. Another supported a similar stance: "There is always a 'suggestion', which is no longer made by art directors, but by the columnist who thinks of images as if they were text. Everything is always very explanatory and obvious. I steer away from it and present what I think is best, but there are youngsters being formed under this workflow, and they won't draw without a briefing".

When a preconceived idea is imposed on the illustrator, trouble arises. One illustrator referred to experiencing the problem as a "tug of war". Some suggestions are viewed as "bad" or "cliché." An illustrator saw this situation as a "dangerous distortion" of the craft and occupation, "an exercise of power and subjugation.”

Partnership and mutual trust

The idea of "listening to" and being "heard" was important. One illustrator emphasized "mutual agreement" as both editors and designers can give constructive feedback to illustrators and vice versa. Notions of "integration", "dialogue" and "collective effort" were also identified. One interviewee remarked that, in his work experience, "editors and designers always admired teamwork" and that "selfish professionals were rare." Another observed: "The best jobs invariably came out of a relationship of mutual trust."

Few interactions as freelancer

Freelancer working remotely have less interaction. Most dialogue takes place through e-mail. Voice conversation and face-to-face meetings are rare. One illustrator believed there is a higher risk of misunderstandings in Internet communications. Others believed less interaction is good, when there's mutual knowledge and trust between the illustrator and the clients. An illustrator described it as a "buy and sell relationship." Another exemplified: "The best customers are those who come to you because they know your job well, know what to expect, interfere little, pay on time. The worst are those who do exactly the opposite."

Creative freedom is contextual

Some illustrators correlated creative control with conflict with the newspaper's editorial guidelines. Most find this understandable, since the company's position is known in advance, making its reactions to certain topics predictable. Notions of journalism are helpful in understanding and negotiating such context. A comic strip artist explained that he knew "how far" he could go and avoided "minefields" like "politics, football and religion." A cartoonist believed collaborations were "increasingly guided and monitored." Another recalled having a cartoon not published for "its political content" and thought that a newspaper's "commitment to political forces" was "depressing".

Good relationship, pragmatic

A "good relationship" between professionals was mentioned, though in a more generic and dismissive, viewing collaboration simply as "positive", "easy", or "effective, no frills".

Special projects demand more involvement

"Special" projects are believed to demand higher involvement and "longer conversations". This would be the case when the illustration was "an intrinsic part of the content" such as having "the function of interactive menus, for example."

3.8. Illustrators' views on interactions with other professionals, 2020

Traditional illustration unaffected

Illustrators observed no meaningful changes in the process of producing a traditional illustration remotely.

Work experience as facilitator

It was observed that the experience of the professionals involved attenuated the effects of adaptation to remote work. In an illustrator's words: "Luckily, most of the people I work with are very experienced in their tasks and can see the project as a whole. In this case, the individual effort of each professional made it possible to carry out projects without any major trauma." Another interviewee mentioned that, when facing unexpected technical problems, the support and shared knowledge of colleagues allowed him to continue working, improvising a collaborative network to send illustrations. Another said: "We've been adapted to the so-called remote work for a long time."

Worse interactions

One illustrator reported that the workflow of "setting up, making and editing work" has become more "costly" as communication takes place in multiple channels: "Each step "requires" a different tool. *Teams* for meetings, phone calls to arrange deliveries for those who were not at the meeting, messages on *WhatsApp*, email to send references and receive the work, *Slack* to communicate with the rest of the team." In his view "Comments, guidelines, expectations alignment end up being harmed." Another interviewee also believes that personal interaction is "greatly impaired". In his view "Feedback from other professionals, the exchange of ideas about the job, although it can also happen online, I think it loses a lot." A third illustrator also prefers networking in person: "I am not very fond of lives, nothing against it, but I still prefer to wait and see how the face-to-face meetings will be rearranged."

Better interactions

Interactions were perceived as more "direct", "objective" and "no frills." The way "everything is registered in the chat by the applications" was seen as positive, inducing more "attention" at collaborations.

Experience could encourage mindset change

One illustrator believed that the emergency change in working environments was felt mainly by those who hire Design & Illustration works, as professionals providing these services were already used to working remotely. In his words: "Communication and advertising professionals such as Art Buyers, creative directors and planning managers, as well as direct customers (traders, business owners, and other professionals), who have now been forced to work from home, have been able to review their routines. They've realized the time wasted with urban commuting, especially in large cities, the inefficiency of meetings that could be summarized in an email, or if necessary, videoconference as an important work tool. It was like unmasking corporate, mechanized and counterproductive behaviors that have always been criticized by freelancers and creative professionals, but the situation has made it obvious to those who have never rethought their own lifestyle."

Specific illustrated projects may have process impacted

The illustrator remarked that he believes that for specific illustrated projects, that demand more involvement with other professionals, communication may be "more difficult", such as getting "feedback from editors, designers and reporters about the theme addressed and the content design, its relation to the text."

4. Conclusions and afterthoughts

When comparing results, some topics addressed in the answers from the query and interviews conducted in 2016-2018 resonated in the answers of professionals that recently went into a remote work situation. They expressed similar feelings and views as their colleagues who already were experiencing the daily routine of working from a distance, back then. In this sense, regarding the organization of remote work, the similar themes observed were: "worse interactions" in workflow and collaborations; questions of "infrastructure", as home equipment was not up to par; "better quality of life" with time and safety gains, and the importance of "work experience and previous training as a facilitator" to adapt teamwork to a remote scenario. Also, the idea that isolation is "natural" or even beneficial for the illustrator came up, as it allows for "immersion" and higher focus on the job.

As far as the collaboration of Design & Illustration on projects, it was mentioned that while "editorial" and "traditional" illustration was unaffected, "specific" or "special" illustrated projects might have a harder time in adjusting communications. This corroborates with the general data findings collected during the 2016-2018 study, in which illustrators believed the job of producing a traditional illustration was perfectly viable from a distance and, given creative freedom and mutual trust, matured in working relationships with art directors, journalists and designers. On the other hand, it appears that for "special" projects demanding greater involvement and interdisciplinary interactions between a team of professionals from different fields, collaboration is seen as harder or uncertain. Unfortunately, the few responses received until now addressing this issue – five mentions in 2016-2018 and one in 2020 – make us unable to arrive at conclusions on this topic, indicating that it needs further studies.

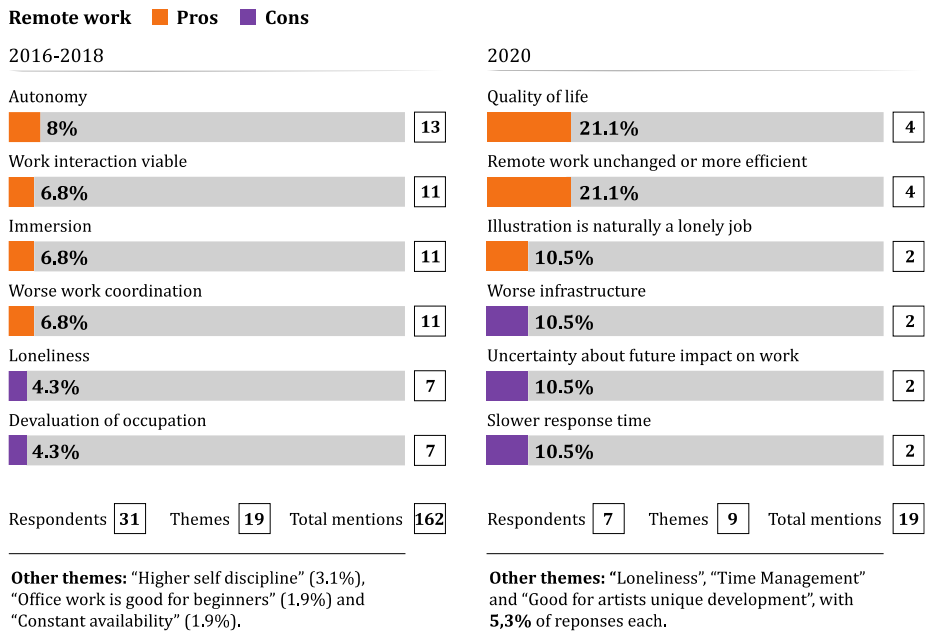

Figure 1 – Summary of results.

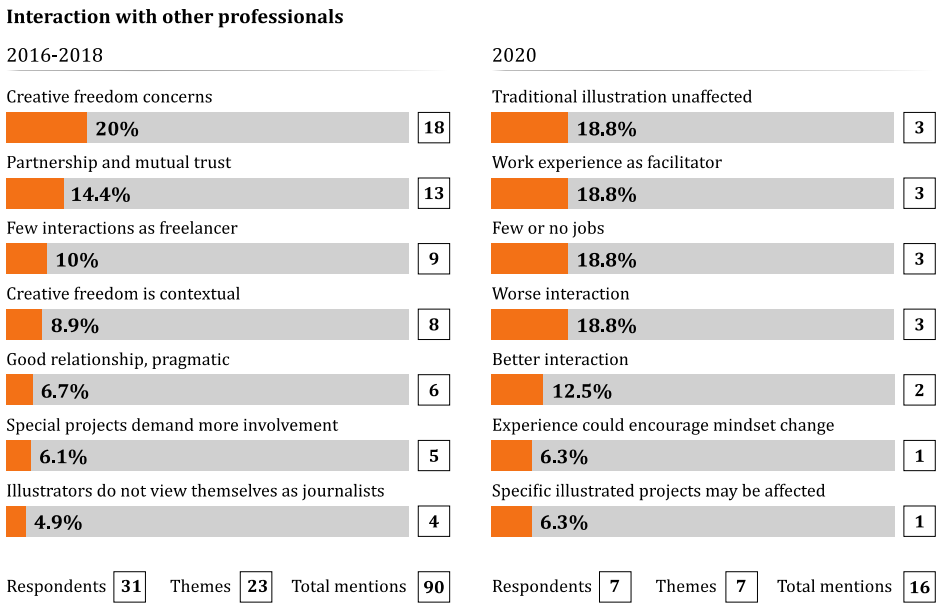

Figure 2 – Summary of results.

New themes found in 2020 should interest other pursuits. One concern expressed in the collected data is about the use of virtual private networks for sharing and sending work. This may be of importance to designers and illustrators working in editorial and news projects, as deadlines are tight and last minute changes aren't uncommon. As tools and resources become more complex, so are the sizes of project files, making the management of digital archives harder. How will this tendency of higher complexity and pace in projects adjust to worse equipment and slower networks as professionals are working from the infrastructure of their homes?

One respondent observed that, while designers and illustrators were used to working remotely, "art buyers" and managerial professionals that hire Design & Illustration work are experiencing it now, due to the pandemic emergency. This illustrator believed that the experience would promote awareness of the benefits of remote working, specially considering time gains through the avoidance of unnecessary in-person meetings and commuting. According to this view, distrust of virtual tools for remote management and job discussion should lower in corporate environments that still resisted changes, something valuable for creative professionals. To corroborate this, some illustrators who believe interaction is better on remote jobs described it as more objective, direct and straight to the point. Could this really lead to a permanent change in the mindset of professional relationships?

Three of seven subjects perceived the field as uncertain, mentioning either few or no jobs, or many acquaintances unemployed. "Dark times," as a professional called it. We can't conclude that this is specifically due to neither the remote working situation nor the Covid-19.

Considering qualitative research and the analysis of interview material, we believe there should be an effort to reach a balance between presenting qualitative and quantitative data. Although theme prevalence was summarized in graphics for presentation purposes in the conclusion, relevant questions that were voiced in the illustrator's answers were considered even if they were rare and had less statistical presence in the total pool of themes. The qualitative possibilities and its relevance in relation to research objectives and discussion were considered.

Lastly, as seen in the 2016-2018 research, being in contact with expert professionals was very important for sharing knowledge in the field of work. Also, interactions at the office were remarked as being beneficial to work development, such as gathering information and feedback incidentally on informal conversations. It was also observed that in person office work was viewed as good for the development of beginners. In 2020, one interviewee, reasoning over the transition to remote work, attributed the well-succeeded adaptation of the Design & Illustration team to the vast work experience among its members, who knew their jobs but, also, were able to see the "project as a whole". These remarks may provide inspiration for future investigations about education and training, considering new professionals that will enter the career in a situation of remote work and physical isolation.

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Effect of School Environmental Factors on Academic Development of Secondary School Students in Boripe Local Government Area of Osun State.

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Abstract

This study is designed to investigate the effect of school environmental factors, particularly the serenity of school environment and adequacy of school facilities on academic development of secondary school students in Boripe Local Government, Osun State. The study made use of descriptive survey research design. Structured questionnaire was used to collect primary data from the sample size of 41 respondents selected from ten selected secondary schools in Boripe Local Government. relevant works of authorities in related fields were reviewed. Data were presented in tabular form and analyzed, using mean rating and standard deviation as descriptive statistics. Chi square test statistics was used to test the hypotheses at 0.05 level of significance. The study found that the serenity of school environment influences academic development of secondary school students, and that adequate school facilities enhances academic development of secondary school student as wells. It was recommended that government should set standard for serenity of secondary school environment and enforce same to ensure compliance always. Further to this, upgrade, renovation and provision of adequate secondary school facilities should be ensured to enhance students' academic development at both state and federal level.

Keywords: Academic Development, School Environment, School Facility, Secondary School Students, Serene Environment

1. Introduction

Over the last two decades, there has been a growing appreciation that the school environment, the quality and character of school life nurture or undermine children's academic development, learning and academic

achievements. Anecdotal surveys confirm that a safe and supportive school environment, in which students have positive social relationships and are respected assist students to learn better (James 2018). Further to the above, a growing number of reports, studies and legislation emphasize the importance of positive school climate in reducing inequities in students' achievement, enhancing healthy development and promoting the skills, knowledge and dispositions that provide the foundation for 21st century school and life success (Carol 2019).

Cambell (2019) explained that school environment is the quality and attribute of school life. It is based on patterns of school life experiences and reflects norms, goals, values, inter personal relationships, teaching learning and leadership practice, and organizational structures. A sustainable, positive school environment fosters youth development and learning necessary for a productive and satisfying life in a democratic society. This environment includes norms, values and expectations that support people's feeling socially, emotionally and physically safe, which government, educators, consultants, students, families and other stakeholders work together to develop, live and contribute to a share school vision.

Educators model and nurture attitudes that emphasize the benefits and satisfaction gained from learning, therefore, they contribute to the operations of the school and the care of the physical environment. The terms ''school environment,'' school culture'' and '' school climate'' have been used interchangeably, but sometimes, quite different ways in the educational literature (Kathleen 2010).

The school environment, includes facilities like classrooms, libraries, technical workshops, laboratories, teachers' quality, school management, teaching methods, peers, school's topography, environmental serenity, etc they are referred to as variables that affect or influence students' academic achievements. They remain an important area that should be evaluated and well managed to enhance students' academic performance.

The issues of poor academic performance of students in Nigeria has been much of concern to the government, parents, teachers and even the students themselves. The quality of education not only depend on the teachers as reflected in the performance of their duties, but also in the effective coordination of the school environment (Ajao 2008).

Teachers as well as students themselves are essential in teaching-learning process. The extent to which students learning could be enhanced depends on their location within the school compound, the structure of their classroom, availability of instructional facilities and accessories are observed to enhance their concentration and propel them to achieve academic desires. Kathleen (2010) opined that well planned school will gear up expected outcomes of education that will facilitate good social, political and economic emancipation, effective teaching and learning process and academic performance of the students.

Williams, et al. (2018) reported that safe and orderly classroom environment (aspect of instructional space), School facilities (accessories) are significantly related to students' academic performance in schools. Similarly, Glassman (2010) assert that a comfortable and caring environment among other treatments helped to contribute to students' academic performance. The physical characteristic of school has variety of effect on teachers, students, and the learning process. Poor lighting, noise, high levels of carbon-dioxide in classrooms and inconsistent temperatures makes teaching and learning difficult (Williams et al, 2018). Poor maintenance and ineffective ventilation system lead to poor health among students as well as teachers, which lead to poor performance and higher absentee rates (Frazier, 2020 and

Ostendorf, et al. 2008). These factors can adversely affect students' behavior and lead to higher levels of frustration among teachers, and poor learning attitude among students.

The above are the reasons why school plant needs to be well organized and planned for. School plant organization in the view of Atolagbe (2019) encompasses the prearrangement of the school location and how classroom blocks, dining hall, hostel blocks, technology workshop, kitchen, administrative block, science laboratories agricultural science block, arts studio, typing rooms, assembly hall, students' common room, conveniences, teachers and other staff offices, water supply, power supply , adequate supply of furniture and equipment are arranged for easy access and identification and obeying the smooth work flow in the secondary school with respect to topography and beautification of the environment. He found that proper school plant planning has a role to play in the ultimate academic development of students in secondary school.

Beyond the direct effects that poor environment has on students' ability to learn, it creates an uncomfortable and uninviting workplace for teachers, breeds frustrating behavior from students, creates a stressful set working conditions for teachers. Because stress and job dissatisfaction are common precursors to lowered teacher enthusiasm (Animasahun, & Aremo, 2019). Previous studies have investigated the relationship of poor school environment to include problems with students-teacher ratio, school location, school population, classroom ventilation, poor lighting, and inconsistent temperatures in the classroom, as significant to student's health problems, student's behavior and student achievement (Crandell, et al. 2020; Moore, 2018; Tanner, 2018). To complement these studies, the present research will examine some of the aforementioned areas of school environment as they affect students' performance in Nigeria schools.

In the opinion of the researcher, the poor performance of students in secondary school today is rampant due to the unavailable infrastructural facilities, teaching and learning materials, libraries, laboratories, classroom as well as qualified teachers to the extent that students are not capable to solve normal academic problems such as good communication skills, creativity, health fitness etc.

Statistics reveals that the percentage of Osun State public school students that bagged five credit pass including English and mathematics in 2018 WAEC was approximately 41% (WAEC, 2018). This in researchers' view is below average and not commendable considering the huge expenditure and investments of both parents and government on education. It is for this reasons that the researcher intends to investigate various environmental factors that affect students' academic performance such as school plant planning, school facilities, class size and school location in Boripe Local Government Area of Osun State being the area earlier specifically surveyed by the researchers.

1.1.Statement of the Problem

Students' academic performance in Osun State has been one of the major areas of concern to all education stakeholders in the State. The generally observable submission of the masses is that the academic development of students is low, while government believed that the trend of students' academic development is increasing. The researchers observed that the increment of academic development as claimed by government is only increasing at a decreasing rate, and that most of the celebrated development are characterized by irregularities and malpractices especially from the parents in collaboration with some of the teachers. The reading and assimilation habits of students are gone unlike those days when school

environments are serene and constitute positive factors that motivate students to study and come out in flying colors. Inadequate funding of school is observed to have negative effect on environmental factors, therefore not propelling students to academic excellence, this is why most of the students inputted into our higher institutions are unfit for study, most of them later constitute academic nuisance to the system. They resulted to lobbying and buying their ways to have academic success they cannot defend after graduation. This may be one of the reasons why in Nigeria of today, most of our professionals fall below expectation in their performances. Hence, reason for this study.

1.2.Purpose of the study

The purpose of this study is to examine the effect of environmental factors on academic performance of secondary school students in Boripe Local Government, Osun State. Specifically, the study seeks to:

i. Examine the effect of serenity of school environments on secondary school students' academic development in Boripe LGA
ii. Examine the effect of adequate school facilities on the academic development of students in the secondary school in Boripe LGA

1.3.Research Questions

This study is guided by the following research questions:

i. Is there any significant relationship between serenity of school environment and students' academic development of secondary school students in Boripe LGA?
ii. Is there any significant relationship between adequate school facilities and students' development of secondary school students in Boripe LGA?

1.4.Research Hypotheses

The study has the following hypotheses:

Ho_1: There is no significant relationship between serenity of school environment and academic development of secondary school students in Boripe Local Government.

Ho_2: There is no significant relationship between adequate school facilities and academic development of secondary school students in Boripe Local Government.

2. Methodology

This study used descriptive survey research design and collected its data from both primary and secondary sources. Primary data was collected through questionnaire, this instrument was administered on 50 respondents (This comprised five best SSS 3 students from each of ten selected public secondary schools in Boripe Local Government) using stratified random sampling. The researcher was able to retrieve 41 questionnaires and this pegged the sample size at 41. The questionnaire contains 14 items. The instrument was structured based on 4-point rating scale as: Strongly Agreed (4), Agreed (3), Disagreed (2) and Strongly Disagreed (1). Face and content validity of instrument of data collection was done by two experts from Department of General Education, University of Ilorin, Nigeria. The reliability of the instrument was

determined, using statistical analysis of the data collected from the pilot study conducted at Akinorun Grammar School, in Ifelodun Local Government, Ikirun, Osun State. The correlation between data of test-retest was calculated using Pearson Product Moment Correlation (PPMC). The reliability index is 0.82. This shows that the instrument is reliable, according to Shuttleworth (2009), a test re-test correlation of +0.75 or greater is considered to indicate good reliability. Mean rating and standard deviation were used as descriptive statistics to analyze the primary data. Mean score of 3.50 and above is taken to be strongly agreed, between 2.50 and 3.49 is agreed, 2.0 to 2.49 is disagreed, while below 2.0 is strongly disagreed. Secondary data were sourced from the works of relevant authorities in related fields. Chi-Square Test Statistics was used to test the hypotheses at 0.05 level of significance. If the P value is less than the alpha significance of 0.05, the hypothesis is rejected, but if the P value is higher that the alpha significance of 0.05, the hypothesis is accepted.

3. Results

Research Question 1: Is there any significant relationship between school environment and students' academic development of secondary school students in Boripe LGA?

Table 1: School Environment and Student's Academic Development

Items	Mean	Std. Deviation	Decision
Your academic success will be influenced by good school environment	3.83	.381	Agree
You prefer beautiful environment now, compare to what you have before	3.78	.419	Agree
The way your school is organized and easy access to other facilities like library, workshop, laboratory, connivences, etc will motivate you to learn	3.61	.494	Agree
Better arrangement of school environment will enhance your learning process	3.59	.547	Agree
New school buildings and other facilities will propel your good grades	3.56	.550	Agree
A serene school environment will motivate you to use your skill and knowledge to perform well	3.44	.673	Agree
The serenity of your school environment will contributes to your academic development	3.37	.662	Agree
You like the location of your school compare to other schools	2.66	.480	Agree
Average Mean and Std Deviation	**3.48**	**.526**	**Agree**

Table 1 shows that majority of respondents agreed to all the questionnaire items on the Table. This is evident as all the mean scores are above the fixed decision value of 2.50. The standard deviation on the Table ranged from 0.381 to 0.673, this indicates that there is low variability in the respondents' responses. The aggregate mean and standard deviation of 3.48 and 0.526 respectively are pointers to this fact. The indication of this is that serenity of school environment has influence on academic development of secondary school students in Boripe Local Government.

Research Question 2: Is there any significant relationship between adequate school facilities and students' development of secondary school students in Boripe LGA?

Table 2: Adequate School Facilities and Students' Academic Development

Items	Mean	Std. Deviation	Decision
You will love to study in your school garden (if any)	3.68	.471	Agree
The presence of recreational facilities in your school make your more committed to school	3.28	.452	Agree
Well-equipped laboratories will cater for your brilliant performance in practical	2.78	.690	Agree
Good looking classroom arrangement will draw you to class always	2.68	.471	Agree
Neat and satisfactory conveniences in your school will make you comfortable for studies	2.63	.488	Agree
You always like to study in your school library to enhance your performance	2.46	.505	Disagree
Average Mean and Std Deviation	**2.92**	**.513**	**Agree**

Table 2 shows that majority of respondents agreed to items one to five. This is obvious as the mean scores of items one to five are above the fixed decision value of 2.50. Majority of respondent disagreed to item six which its mean score of 2.46 is below the fixed decision value of 2.50. However, the standard deviation on the Table ranged from 0.452 to 0.690, this indicates that there is low disparity in the respondents' responses from the mean. The aggregate mean and standard deviation of 2.92 and 0.513 respectively are pointers to this fact. This shows that adequate school facilities have influence on academic development of secondary school students of Boripe Local Government, except for the fact that the respondents lack library culture as a result of the fact that most schools under observation have no a befitting and well-equipped library for students.

3.1.Testing of Hypotheses

Ho_1: There is no significant relationship between school environment and academic development of secondary school students in Boripe Local Government.

Table 3: Chi-Square Test Statistics for Hypothesis one.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.707[a]	2	.035
Likelihood Ratio	9.280	2	.010
Linear-by-Linear Association	2.341	1	.126
N of Valid Cases	41		

From Table 3, the p-value 0.035 is less than the significance level of 0.05, as a result of this, null hypothesis is rejected. Therefore, there is significant relationship between school environment and academic development of secondary school students in Boripe Local Government. The study therefore, infers that school environment influence the academic development of secondary school students.

Ho_2: There is no significant relationship between adequate school facilities and academic development of secondary school students in Boripe Local Government.

Table 4: Chi-Square Test Statistics for Hypothesis two.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.570[a]	2	.037
Likelihood Ratio	6.089	2	.048
Linear-by-Linear Association	5.759	1	.016
N of Valid Cases	41		

From Table 4, the p-value of 0.037 is less than the significance level of 0.05, as a result of this, null hypothesis is rejected. Therefore, there is significant relationship between adequate school facilities and academic development of secondary school students in Boripe Local Government. The study therefore, infers that adequate school facilities enhance academic development of secondary school student

4. Discussion

Findings on research question one shows that academic success of students od secondary schools will be influenced by good school environment as students compare the aesthetic value of schools. Further to these, the way school is organized and easy of access to facilities like library, workshop, laboratory, connivences, etc will motivate students to learn, and that good school environment will allow students to use their skills and knowledge to perform well in their endeavors. The serenity of school environment will contribute to students' academic performance. Finding on hypothesis one also shows that serenity of school environment influences the academic development of secondary school students. All these findings are in line with the finding of Atolagbe (2019) who found that proper school plant planning which includes

how school facilities and supplies are arranged for easy access and obeying the smooth work flow in the secondary schools with respect to topography and beautification of the environment has a positive role to play in the ultimate academic development of students in secondary school.

Findings on research question two shows that students will love to study in school garden (if any), and that recreational facilities in school will make students more committed to the school activities. Moreover, a well-equipped laboratory will cater for students' success in practical, while good looking classroom arrangement, neat and satisfactory conveniences will draw students to school always. Conversely, students in secondary school do not usually study in library to enhance performance, this may be as a result of inadequacies surrounding provision of libraries in schools under observation. Finding on hypothesis two also shows that adequate school facilities enhance academic development of secondary school student. These findings are in line with the result of study conducted by Amanckwu and Olulube (2015), they observed a close relationship between school physical environment and academic performance of students, they were of the opinion that the education received by children bears direct relevance to the availability or lack, thereof of physical facilities and the overall atmosphere in which learning takes place.

5. Conclusion

The purpose of this study is to investigate the effect of serenity of school environment on academic development of secondary school students. Specifically, the study specifically sought to examine the effect of serenity of school environments and adequacy of school facilities on secondary school students' academic development in Boripe LGA. The study used descriptive survey research design, primary data were described using mean ratings and standard deviation and hypotheses were tested using chi-square. The study found that serenity of school environment influences the academic development of secondary school students, and that adequate school facilities enhance academic development of secondary school student. Therefore, school serenity and provision of adequate facilities will go a long way in contributing to secondary school students' academic development and enhance their scholastic achievement on the long-run.

6. Recommendation

The following were recommended based on the findings of this work:

The serenity of school environment has been established by this study to have positive influence on students' academic development, therefore, it is recommended that government should establish a unique standard for serenity of secondary school for both private and public schools and ensure compliance as this will assist students' academic development.

Adequate facilities have been adjudged to enhance or contribute to students academic development, it is therefore recommended that government should ensure upgrade, renovation and provision of adequate facilities in secondary school so as to reinforce students' commitment to academic development.

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Elaboration of a flowchart for healthcare quality improvement of patients with diabetic foot ulcer

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Abstract

Objective*: The aim of this study is to map the work process of a Municipal Centre for the care of diabetic foot ulcer, in order to elaborate a multi-professional flowchart for the management of these patients.* ***Methods****: Qualitative study, developed by means of Bizagi software version 3.7.0.107, for the purpose to map the flow of activities encompassing the first attendance for people with diabetic foot ulcer, through observational record, elaborating a multi-professional flowchart for improving quality of care.* ***Results****: The investigation, mapping and comparison between two flowcharts, current and future directions, highlighted the need to offer multi-professional care for patients, besides of implementing improvements in the quality of care, emphasizing the importance of holistic approach over the chronic wound carrier, avoiding, consequently, futures complications.* ***Conclusion****: Finally, it was elaborated a new map of work process to consolidating the presence of multi-professional team for treatment of people with diabetic foot ulcer.*

Keywords: Diabetes Mellitus; Diabetic foot; Workflow; Patient Care Team;

1. Introduction

The wound is a pathological process that occurs when the anatomical or physiological structures of the skin

are affected by internal or external agents, such as physical, mechanical, or chemical trauma, requiring evaluation and appropriate treatment (1). The wounds are classified according to the healing time in acute or chronic. The chronic wounds affect more than 2 million patients, depending on the aetiology, and involve costs that exceed 1 billion U.S. dollars (2).

Among the chronic wounds, the diabetic foot ulcer prevails, considering the high number of diabetic adults in Brazil, achieving 12.5 million, in addition to affecting a total of 425 million people in the world (3).

The main complications associated with diabetic foot ulcer are infections and amputations that require complex procedures and cause expenditures of around 96.8 billion dollars per year, what represents in Brazilian currency, 510.55 billion of reals (4).

Thus, the diabetic foot ulcer is conceptualised by the International Working Group on the Diabetic Foot (IWFGD) as infection, ulceration, and/or soft tissue destruction associated with neurological changes and varying degrees of peripheral artery disease (PAD) in the lower limbs, what consequently requires a multi-professional evaluation, and especially, from the Nurse in the nursing consultation (5).

The multi-professional team's care for patients with diabetic foot ulcers requires several actions such as the elaboration of the care plan more efficiently (6).

It is possible to identify, through a previous study, that the multi-professional evaluation with attention encompassing holistic view avoids amputations and diminishes the reulcerations, since that the teams will work for glycaemic control, treatment of wound bed, venous insufficiency management and secondary infections prevention (7).

However, it is common some difficulties for achieving goals as avoiding amputations and reucerations in patients with diabetic foot ulcers due to the lack of multi-professionals teams acting in municipal and state reference centres for assisting this group (6).

Therefore, this study aims to map the work process at Municipal Centre for Diabetic Care, in order to elaborate a multi-professional flowchart for the treatment of these wounds.

2. Materials and Methods

It is a qualitative observational study performed through a case study at Municipal Centre for Diabetic Care (MCDC) of Uberlandia, with the purpose to proposing the improvement of quality of healthcare by means of mapping of the workflow related to the first attendance of people with diabetic foot ulcer showing the current status and future directions, including a proposal for multi-professional assistance.

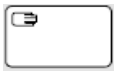
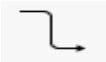
The data collection occurred from 1 February to 2 March, through 7 visits at Municipal Centre for Diabetic Care. Moreover, the data were collected by means of participant observation and requesting professionals to describing the activities of the first care for the patient with diabetic foot ulcer.

These data served as subsidium for elaboration of the maps of workflow, that described the current routine and the future proposal, outlined under a multi-professional care in accordance with previous studies which addressed such subject (8-6).

The flowcharts, current state and future directions, for attendance of people with diabetic foot ulcers were elaborated via Bizagi Modeler, a platform used for Business Process Model Notation (BPMN), version 3.7.0.107 open source.

The Business Process Model Notation refers to a world language to showing graphically the mapping work process associated with a particular company, such as hospitals. Its basic symbology consists to using elements to indicating specific activities, such as: events, activities, gateways, among others. The main elements utilised in this study are represented in the Box 1:

Box 1 – Elements and symbols of Business Process Model Notation

Elements	Subtypes	Symbology	Concepts
Events	Start event		It indicates the start of process;
	End event		It represents the end of process;
Activities	Abstract task		It points out a task to being realised by person;
	User task		It represents a task realised by users or clients of company;
	Manual task		It consists of tasks performed by people through the hands;
Flow	Sequence flow		It shows the sequence of activities performed by participants in workflow;
	Message flow		It represents messages from one process participant to another;
Gateways	Exclusive Gateways		It divides and/or unifies the flow, allowing only one path/decision can be taken;
	Inclusive Gateways		It divides and/or unifies the flow, allowing 2 or more alternatives flows where all paths are evaluated;
Links	Link Symbol		It connects two activities in the same process

2.1. Ethical considerations

This current study is a complementary proposal associated with a research project approved by Research Ethics Committee at Federal University of Uberlandia, underpinned by opinion number: 3.937.483 e C.A.A.E number 29441020.0.0000.5152, related to chronic wound and elaboration of assistance protocols.

3. Results

This study proposed the investigation and mapping of two flowcharts entitled, current state and future directions, in order to recommend the improvement of the work process, besides to provide multi-professional care in the treatment of diabetic foot ulcers at a municipal reference centre, emphasizing the

importance of a holistic view on those carriers of wounds.

3.1. Flowcharts of the current state and future directions

With regard to the flowchart of the first attendance for diabetic foot ulcers, the **figure 1** refers to the current state, based on the existing and real routine of care at Municipal Centre for Diabetic Care, obtained during the data collection phase of the survey.

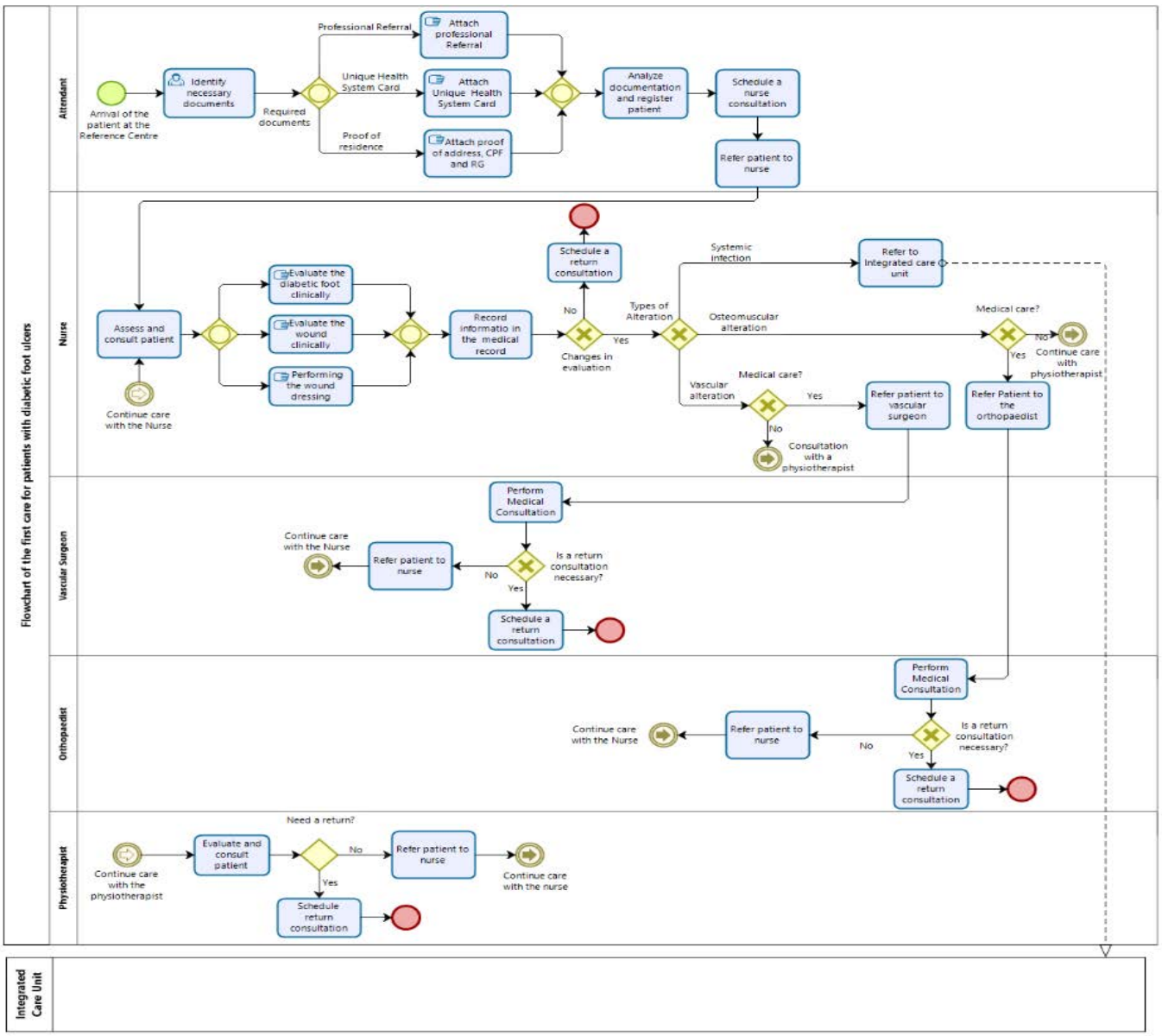


Figure 1 - Flowchart of the first care for patient with diabetic foot ulcer - Current Status.

In the **figure 2**, aiming at quality multi-professional service for attendance the diabetic foot ulcer carrier, the flowchart of the work process (Future directions), was elaborated with the purpose of approaching the emphasis in the holistic vision to these users of the health system and to avoid gaps during the execution of the activities.

When the future directions flowchart was compared with the current state, it was not noted differences concerning the activities performed by the attendant in the reception of the patient, considering that these administrative activities do not directly interfere in the treatment of the diabetic foot ulcer carrier.

After that, following the sequence flow, the attendant will analyse the documentation, registering the patient information and scheduling him with the Nurse (**Figure 2**). The patient in future directions will be attended by the nursing technician who will check vital signs and will collect blood samples for hemogram and biochemical tests according to protocols. In the next step, in accordance with the flow, the patient will be referred to the Nurse with a systematised nursing consultation directed to the clinical assessment of the feet; wound bed evaluation, and the first wound dressing, besides the control of complications (**Figure 2**).

The flow will continue with the patient being referred to the nutritionist. At this stage, a nutritional consultation is performed with the goal to implement pertinent conduits for improving the nutritional condition of the individual, what will contribute to wound healing (**Figure 2**).

Thereafter, the patient will be referred to psychological care, where he is evaluated and if necessary, the patient will receive psychological intervention and mental health care plant to controlling the factors that affect the healing process. After psychological evaluation, the patient will be referred to the social assistant, and this moment constitutes an important stage, in which it involves control of social and economic factors, which directly and/or indirectly interfere in the wound healing (**Figure 2**).

Hereafter, the flowchart continues with the patient being attended by the physiotherapist, receiving care focused on exercises, prescription of insoles and shoes adapted through baropodometer and referral by this professional to the orthopaedic technician, the professional who produces insoles and orthopaedic shoes.

In terms of medical consultation, the last stage of the future directions flowchart, blood tests will be interpreted and alterations pointed out by multi-professional team will be analysed and treated (**Figure 2**).

Finally, there is a possibility of the patient to be scheduled for returning to the Reference Centre with any professional, and whether he needs a medical specialty, he will proceed to a multi-professional ambulatory, in which its alterations will be discussed and new conduits will be taken with the purpose to treat the patient, according to the evaluation of all professionals (**Figure 2**).

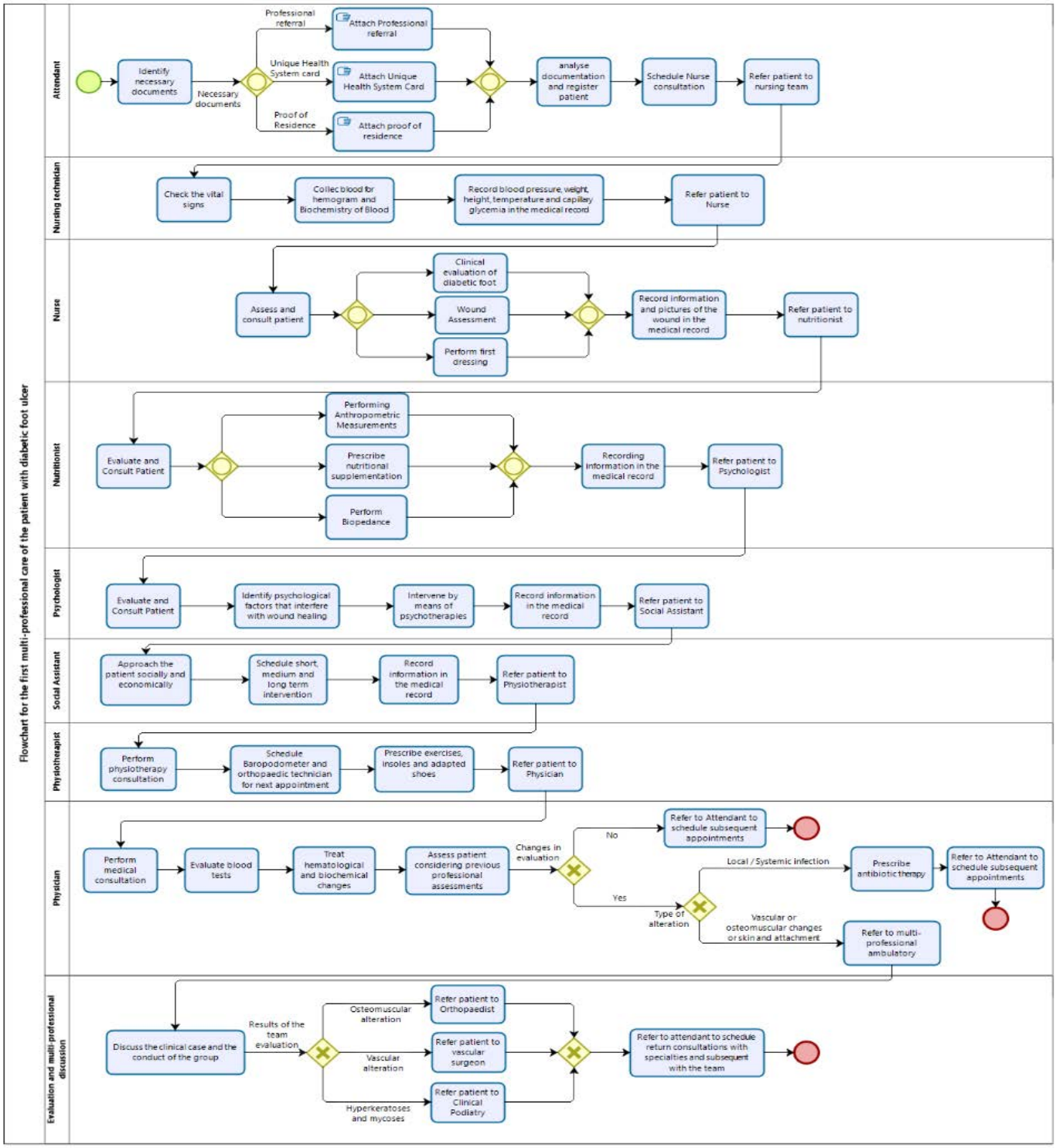


Figure 2 - Flowchart of the first multi-professional care of the patient with diabetic foot ulcer - Future Directions

4. Discussion

4.1. Multi-professional flowchart for the care of diabetic ulcer carriers

For the mapping of workflow, it was elaborated the flowchart, future directions, aiming to provide multi-professional healthcare to diabetic foot ulcers carriers.

The attendance performed by different professional categories, allows to patient fast diagnostic and

accurate range of the therapeutic goals controlling all factors that may interfere in wound healing, such as psychological, social, nutritional and physiological. Therefore, the patients should be referenced and assessed by psychologists; social assistants; nutritionists; physiotherapists; physician and nurses (8).

A Previous finding suggests a relation between depression and diabetes, that is, depression is associated with a higher risk to developing type 2 diabetes, what consequently, may result in depression (9). The consultation carried out by psychologists have the purpose of handling depression, the mental stress and anguish, commons in this group of diabetic foot ulcer carriers. The changes imposed by chronic stress promotes high levels of cortisol hormone, that consequently, delays the healing process due to the interference in inflammatory phase associated with anti-inflammatory effect of this hormone (10). We highlighted that the importance of this professional in attendance of patients with diabetic foot ulcers, since that, depression was associated with high risk of mortality in those individuals that developed diabetes foot ulcer in the earliest 5 years (11).

The diabetic foot ulcers, besides the numberless complications, have their clinical improvement influenced by the social and economic environmental around the patient. We emphasize, thereby, the relevance of healthcare that the social assistance provides to diabetic foot ulcer carrier because this professional is directly involved with social support systems and financial resources that assure care to these patients (12).

Most of patients with diabetic foot ulcer have a micronutrients imbalance, what may cause malnutrition and damage to the wound healing. The minerals and vitamins such as zinc, vitamin A and C are associated with collagen synthesis and immunomodulation accelerating the wound healing process (13-14).

The nutrients prescribed by nutritionists as arginine, glutamine and beta-hydroxy-beta-methylbutyrate (HMB), a leucine metabolite that presents an anti-catabolic effect, have been reported in a study while nutrients that favours the healing of diabetic foot ulcers (15).

The nutritional assessment and dietary supplements offer are strategies that also interfere in wound healing, showing the notorious work of nutritionists who contribute to the health of the diabetic foot ulcer carrier (15).

The physiotherapist is a professional who assist the population emphasizing the maintaining of body movement, preventing, treating and recovering dysfunctions and skeletal muscle diseases, being, therefore, its main working medium (16). It was demonstrated implications of physical exercises using lower limbs on wound healing, with the goal to promote muscle strengthening, balanced posture, and weight control among other factors (17).

The physical assessment of the physician is necessary for evaluating the patient and keep the continuous workflow. The addressing of the wound by physician team should include essential action as clinical diagnosis, detection of comorbidities associated with peripheral vascular disease; neuropathies; necessity of surgical debridement and treatment of wound infection, requesting tissue culture of wound for prescribing the correct antibiotic promoting the rational use of the medicine (18).

Although the endocrinologist was not predicted in the flowchart entitled future directions, this specialist is in charge to deal with the control of endocrinopathies whose its main functions are to educate and empower the patient, besides to handle risk factors that affect the wound healing (19). The orthopaedist, while member of multi-professional team, should act preventing and treating diseases that affect tendons, ligaments, muscles, joints and bones in theses DFU patients. The relation between diabetic foot ulcer and

this specialist is due to the need for orthopaedic surgeries, which there is a paramount role in the management of this pathology. Furthermore, the orthopaedist is responsible some activities, such as the treatment of the foot deformities utilising surgery; to determine the patients eligibles for the surgical debridement, to indicate the correct antibiotics and treatment for Charcot neuropathy (20).

Regarding the vascular surgeon, this professional is relevant for the treatment of diabetic foot ulcers since that is need to correct vascular insufficiencies. It is important to mention that this professional should never indicate amputation without an accurate evaluation of veins and arteries of the lower limbs, employing Doppler and transcutaneous oximetry (TcPO2), in order to indicate revascularization, which in turn, is essential in wound healing (21).

It is understandable a range of activities performed by nurses in relation to diabetic foot ulcer management, because this professional acts promoting health, preventing wounds, detecting peripheral neuropathies and vascular insufficiency, besides of realising the wound curatives and prescribing primary dressings (22).

According to the Federal Board of Nursing of Brazil, it is the responsibility of nurses the assessment, prescription, and execution of dressings, including mechanical, biological, enzymatic and autolytic debridement's. Even though there are doubts about the wide range of actions performed by nurses in wound treatment, this professional is authorised to treat wounds using Low-level laser therapy (LLLT), since this professional has obtained the title of specialist such as stomatotherapy and dermatological nursing (22). Moreover, the nurse is authorised to use the Light-Emitting Diode (LED), an adjuvant therapeutic modality that promotes the tissue repair of acute and chronic wounds, once fulfilled the previous requirements associated with a professional specialisation (23).

We highlight still, the autonomy regarding negative pressure to treat diabetic foot ulcers. This therapy provides a non-invasive, local and controlled sub-spherical pressure what allows the healing of wound. It is important to remember that, the nurses have autonomy to prescribe this new technology either stomatotherapist or dermatological nursing (24).

5. Conclusion

Therefore, the flowchart future directions, elaborated in the present study, represents quality improvement in healthcare provided to patients with diabetic foot ulcers, since this flowchart contemplates a multi-professional assessment, aiming continuously the prevention, recovery and rehabilitation of these patients under holistic view.

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Functional characterization of biofortified sweet potato flour dried at different temperatures

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Abstract

Sweet potato (Ipomoea batatas (L.) Lam.) is an abundant source of carotenoids, and the processing of its tubers as flour is an alternative to add value and expand its use. The objective was to characterize flour from the pulp of biofortified sweet potato dried at different drying temperatures. Biofortified sweet potatoes (accession CNPH1210) were dried in a forced air ventilation oven, under four temperature conditions: 45, 55, 65 and 75 °C. Drying continued until the sliced roots reached moisture content of 14 % (d.b.). Fibers, phenolic compounds, carotenoids, β-carotene, antioxidant capacity by ABT and DPPH, scanning electron microscopy, high-field magnetic resonance imaging, infrared absorption spectrometry were evaluated. Flours obtained from sliced roots dried at 45, 55, 65 and 75 ºC showed stability in their morphological characteristics. The temperature of 45 °C was the most indicated for the production of biofortified sweet potato flours, as the produced flours had higher contents of bioactive compounds, being a significant source of carotenoids.

Keywords: Dehydration; Phenolic Compounds; β-carotene; Antioxidant Capacity; Magnetic Resonance.

1. Introduction

Sweet potato (*Ipomoea batatas*) is a rustic tuberous vegetable of wide adaptability, cultivated in virtually the entire Brazilian territory (Silva et al., 2004). It is a crop of great economic and social importance, with the advantages of low production cost, easy cultivation, prolonged harvesting and resistance to pests and diseases (Silva et al., 2008).

The roots of orange-fleshed sweet potatoes have stood out due to their nutritional and functional value, especially due to the high concentration of β -carotene, provitamin A (Van Jaarsvel et al., 2005; Bovell-Benjamin, 2007; Donado-Pestana et al., 2012), as well as antioxidants (Islam et al., 2016), carbohydrates (Zhu & Wang, 2014), fibers (Mullin, 1994), minerals and vitamins (Suarez et al., 2016).

In Brazil, sweet potatoes is commercialized almost entirely in the form of raw roots. The access to this vegetable by consumers and its acquisition are still limited, either by the low production (IBGE, 2020), by the prices offered, which vary greatly over the years (CEAGES, 2020), or by eating habits.

In this context, sweet potato flour can be an alternative to increase consumption and marketing, because this vegetable in the form of flour, besides having an increased shelf life, can be introduced as food in regions with less access to the fresh root or that do not have the habit to consume it. Flour can be incorporated into several other products and can even partially replace wheat flour in manufacture of breads (Nzamwita et al., 2017), cakes, biscuits and other products (Rodrigues-Amaya et al., 2011).

Studies have demonstrated that sweet potato flour can add nutritional value to processed products due to its high content of carotenoids. When quantifying bioactive compounds in biofortified sweet potato flour, Trancoso-Reyes et al. (2016) observed carotenoid content of 137.49 μg g^{-1}, as well as Rodrigues et al. (2016), who obtained carotenoid content of 196.6 μg g^{-1} in biofortified sweet potato flour.

Nunes et al. (2016) reported that breads enriched with biofortified sweet potato showed good sensory acceptance. Infante et al. (2017) demonstrated an increase in the nutritional and sensory quality of sorghum biscuit formulations enriched with biofortified sweet potato flour. Studies conducted by Pereira et al. (2019)

demonstrated positive effects replacing wheat flour with biofortified sweet potato flour in panettone doughs, including the reduction of fermentation time, predominance of yellow color and presence of new volatile compounds. Gomes et al. (2017), studying the sorghum extrusion process associated with biofortified sweet potatoes, found that the addition of biofortified sweet potatoes led to an increase in iron bioavailability due to the presence of β-carotene.

However, the drying conditions of sweet potato in oven, such as temperature and exposure time, can affect the quality of the flour produced. Some studies have already been conducted evaluating the impact of temperature and drying time on food composition. Miranda et al. (2010) evaluated the effect of drying temperature (40, 50, 60, 70 and 80 °C) on phenolic content and antioxidant capacity of quinoa seeds, Multari et al. (2018) studied the influence of drying temperature (60 and 70 ºC) on the contents of phenolic compounds and carotenoids in quinoa seeds, and Liu et al. (2019) assessed heat treatment (65, 80 and 95 °C) on the physicochemical composition of potato.

Thus, the objective of the present study was to determine the best drying condition of biofortified sweet potato pulp for the maintenance of its nutrients.

2. Material and Methods

2.1. Preparation of sweet potato flours

The roots of biofortified sweet potato (genotype CNPH1210) were developed by Embrapa Vegetables (Brasília, DF, Brazil) and cultivated in experimental field of the Federal Institute of Goiás (Rio Verde, GO, Brazil). The sweet potato used for the experiment had moisture of 74% (d.b.). The roots were washed and peeled manually, and then the pulp was sliced into chips with approximate dimensions of 4.6 x 4.0 x 0.3 cm (length, width and thickness) (Borges et al., 2008), using a domestic grater. The slices were dried in an oven with air circulation, with velocity of 1.0 m s^{-1} and four different temperatures: T1: 45 °C for 7 h, T2: 55 °C for 6 h, T3: 65 °C for 5 h and T4: 75 °C for 3 h, and the moisture content was standardized by the breakage percentage calculation to 14%. Each sample, composed of 0.3 kg of roots, was evenly distributed in rectangular aluminum trays (25 x 10 cm), without perforation. After drying, the samples were ground in a mill (Tecnal TE-650, Piracicaba, SP, Brazil) and placed in polypropylene plastic bags, sealed and stored at 4 ºC in B.O.D. type chambers in the absence of light until the analyses.

2.2. Dietary fiber

The total, soluble and insoluble dietary fiber contents of the biofortified sweet potato flours were determined by the gravimetric-enzymatic method described by AOAC (1995), adapted by Freitas et al. (2008). Due to the low lipid content of the flours, it was not necessary to degrease them. The samples were hydrolyzed by thermoresistant α-amylase (A-3306 Sigma), protease (P-3910 Sigma) and amyloglucosidase (A-9913 Sigma) to remove protein and starch. After enzymatic hydrolysis, insoluble fiber was filtered and separated, and soluble fiber was precipitated using four volumes of ethanol (95%). The alcoholic solution was then filtered and the precipitated residues were washed with ethanol (95%) and acetone, dried and weighed. The total dietary fiber was calculated from the sum of insoluble dietary fiber and soluble dietary fiber.

2.3. Total phenolic compounds

The spectrophotometric determination of phenolic compounds was performed according to the methodology described by Singleton (1965), using the Folin-Ciocalteu reagent. Extracts of sweet potato flour were prepared using 1 g of flour and 20 mL of 70% ethanol. The solution was homogenized for 15 min and then filtered through Whatman filter paper nº 4. Absorbance was read at 765 nm in spectrophotometer (Biospectro SP-220, São Paulo, SP, Brazil).

2.4. Antioxidant activity: tests with DPPH and ABTS

The antioxidant capacity by the stable radical 2,2-diphenyl-1-picryl-hydrazyl (DPPH) was evaluated following the procedure adapted from Brand-Williams et al. (1995). A volume of 100 µL of extracts previously prepared for phenolic compound analysis and 3.9 mL of DPPH solution were added. Then, the solution was homogenized in a tube shaker (Merse M81, Taquara, RJ, Brazil). Readings were performed in a spectrophotometer (Biospectro SP-220, São Paulo, SP, Brazil) at 517 nm, 30 min after the beginning of the reaction.

To determine the antioxidant capacity by ABTS (2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid), a 30-µL aliquot of the extract was transferred to test tubes with 3.0 mL of the ABTS radical and homogenized. The samples were read in a spectrophotometer at 734 nm, after 6 min of the mixture. The ability to scavenge the radical ABTS and DPPH was determined using a standard curve obtained with Trolox (0 to 300 µmol L^{-1}) and ABTS·+ and DPPH. The results were expressed in Trolox (µmol 100 g^{-1}).

2.5. Total carotenoids

Total carotenoids were determined using 1 g of biofortified sweet potato flour and 50 mL of acetone and, after that, the mixture was homogenized (Marconi MA102, Piracicaba, SP, Brazil) for 1 min. This extract was vacuum-filtered in Büchner funnel with Whatman filter paper nº 4 and the filtrate was collected in Kitasato flask. The extraction was repeated until the residue was white. Then, 40 mL of oil ether were added; then, 250 mL of distilled water were added and, after separation of the lower aqueous phase, the washing was repeated three more times to remove all acetone. The ethereal phase was collected in a 50-mL volumetric flask and the readings were performed in a spectrophotometer at 450 nm (Rodrigues-Amaya, 2001). The results were expressed in µg g^{-1}.

2.6. β-carotene

β-carotene determination was performed according to Rodrigues-Amaya (2001), using the extracts previously prepared for the analysis of total carotenoids. A 5-mL aliquot of extract dried in liquid nitrogen was collected and resuspended in 5 mL of acetone. β-carotene was quantified in a high-performance liquid chromatograph (HPLC), SPD-M20A (Shimadzu Co., Kyoto, Japan), with C18 column (ODS Hypersil 150 × 4.6 mm, 5 µm), mobile phase with acetonitrile, methanol and ethyl acetate (ratio ranging from 10 to 80% in 22.5 min), flow rate of 0.8 mL min^{-1}, photodiode array detector (PDA) with scanning from 300 to 550 nm, column temperature of 22 °C and external standardization. The identification of β-carotene was performed by comparing the retention time of the peaks found for the samples with those obtained from a commercial standard (Sigma-Aldrich, São Paulo, SP, Brazil). The results were expressed in µg g^{-1}. Data

were collected using *Labsolution* software (version 5.57).

2.7. Scanning electron microscopy

Microstructural analysis was used to evaluate the morphology of flour particles, mainly starch granules, under scanning electron microscope (JSM-6610 Jeol®), equipped with EDS, ThermoScientific NSS Spectral Imaging. The samples were previously degreased using the Soxhlet method (AOAC, 2000), placed in aluminum stubs with double-sided tape, covered by an ultra-thin gold film (electrically conductive material), allowing the principle of operation of the SEM, i.e. emission of electron beams with 5 kV acceleration voltage by a tungsten filament. The micrographs were performed with magnifications of 500x and 1000x.

2.8. High-field high-resolution solid-state NMR

The high-resolution nuclear magnetic resonance (NMR) analysis of carbon 13 (^{13}C) of starch (solid samples) was performed using the cross-polarization pulse sequence with magic angle spinning (spinning of 10 KHz) and high-power decoupling known as CP-MAS. Hexamethylbenzene, the methyl line referenced at 17.3 ppm, was used to reference the chemical displacement. The instrument used was an Avance III HD 400 MHz spectrometer (Bruker, Berlin, Germany). The acquisition parameters used for the analyses were waiting time of 5 sec, scan number 1024 and contact time 1 ms. Samples (approximately 200 mg) were placed in 4-mm-diameter cylindrical zirconium oxide rotors (Schiller et al., 2001).

2.9. Infrared absorption spectrometry (FTIR)

Fourier transform infrared absorption spectroscopy (FTIR) analyses were performed on Vertex 70 spectrometer (Bruker, Berlin, Germany). The samples were analyzed by attenuated reflectance (ATR) using a diamond crystal as support. The spectra were acquired with 32 scans and with a resolution of 4 cm^{-1}.

2.10. Statistical analysis

A completely randomized design (CRD) was used, with one sweet potato genotype, four drying temperatures and five replicates. The data were assessed by analysis of variance - ANOVA (GLM-ANOVA) of the SAS® Statistical Analysis System v. 8.0 (SAS Institute Inc., 1999). The means were compared by Tukey test at 5% significance level.

3. Results and discussion

The contents of total, soluble and insoluble fibers (Figure 1) of the samples dried at 75 ºC were lower than those found in samples dried at 45 ºC. Thermal processing reduces fiber content due to solubilization and subsequent degradation of dietary fiber components (Arrigoni et al., 1986). Similar values were reported in a study on biofortified sweet potatoes, 4.47 g 100 g^{-1} for soluble fibers and 4.60 g 100 g^{-1} for insoluble fibers (Mullin, 1994).

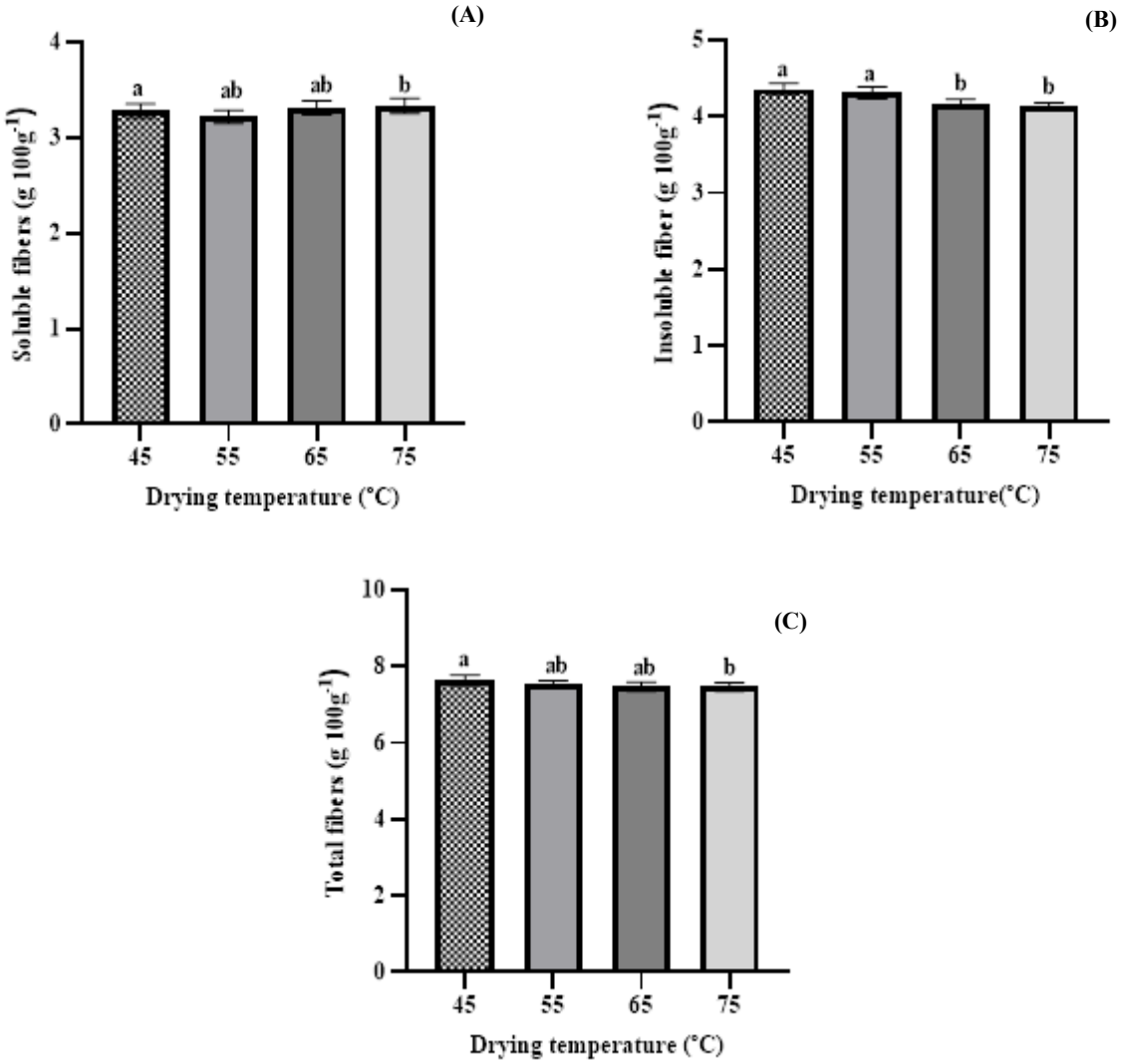

Figure 1. (A) soluble fibers, (B) insoluble fibers and (C) total fibers (g 100 g^{-1}) of biofortified sweet potato flours, dried at 45, 55, 65 and 75 °C.

Degradation of bioactive compounds was higher with the increase in drying temperature (Figure 2). The higher the drying air temperature and relative humidity, the faster the chemical reactions inside the food (Lajolo and Mercadante, 2018).

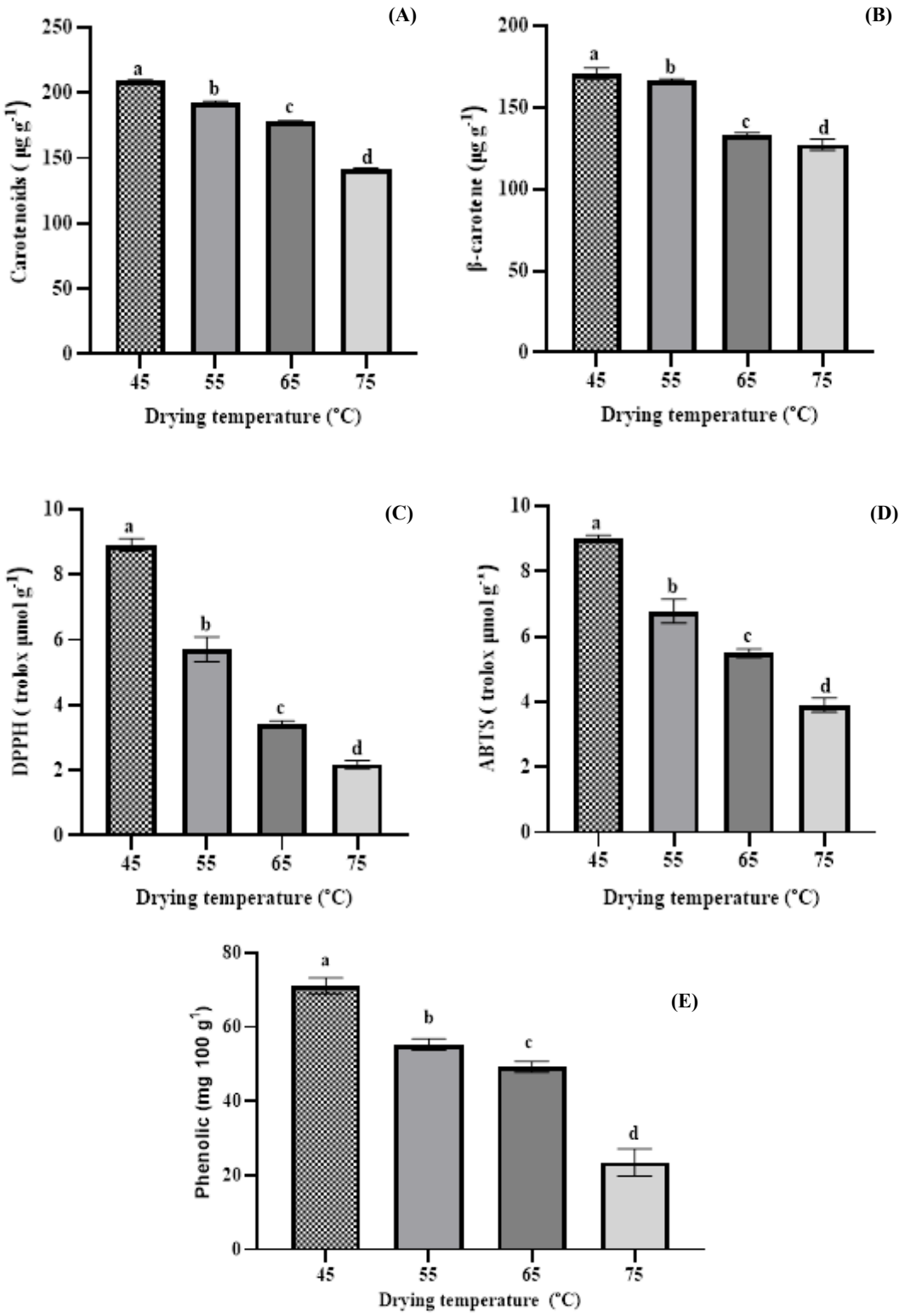

Figure 2. (A) total carotenoids (µg g^{-1}), (B) β-carotene (µg g^{-1}), antioxidant activity by (C) DPPH (trolox µmol g^{-1}), (D) ABTS (trolox µmol g^{-1}) and (E) phenolic compounds (mg 100 g^{-1}) of biofortified sweet potato flours, dried at 45, 55, 65 and 75 °C.

Increase in drying temperature caused greater losses of carotenoids (Figure 2A). Higher temperature and the presence of oxygen in the drying process in the oven provided a more favorable environment for the

occurrence of oxidative reactions. Carotenoid degradation comprises several simultaneous transformations: isomerization with the formation of oxidative products and volatile compounds (Zepka et al., 2009; Zepka & Mercadante, 2009; Zepka et al., 2014).

Hagenimana et al. (1999) observed that the drying of sweet potato slices in an oven at 6 ºC for 12 h reduced the total content of carotenoids by 30%. Bechoff et al. (2009) reported that β-carotene losses, after sweet potato drying, ranged between 16 and 34%.

It was observed that the increment in the drying temperatures led to the greatest losses of these phenolic compounds. Similarly, Donado-Pestana et al. (2012) reported that thermal processing reduced the contents of phenolic compounds in biofortified sweet potato flour. Other authors have also reported losses of these compounds due to thermal degradation (Miranda et al., 2009; Pedreschi et al., 2011).

Thermal processing negatively affects the contents of phenolic compounds, causing the softening and rupture of cells and consequently facilitating their hydrolysis (Arruda et al., 2005).

The antioxidant capacity of sweet potato flour samples decreased significantly with the increase in drying temperature (Table 3C). This may have occurred due to the reduction of bioactive compounds in the samples caused by thermal degradation (Tang et al., 2015). Studies have reported lower antioxidant capacity with increased temperature during drying (Roy et al., 2007; Negri et al., 2009; Garcia-Perez et al., 2010; Djendobi et al., 2012).

Figure 3 presents the microstructures of the samples of biofortified sweet potato flour. Protein bodies (P) usually have spherical shapes, starch granules (S) may show oval shapes with lipids (L) adhered to their surface (Damodaran et al., 2010), and fibers (F) are porous and irregular structures (Santana and Gasparetto, 2009). These characteristics can be identified in the images obtained from sweet potato flours (Figure 3).

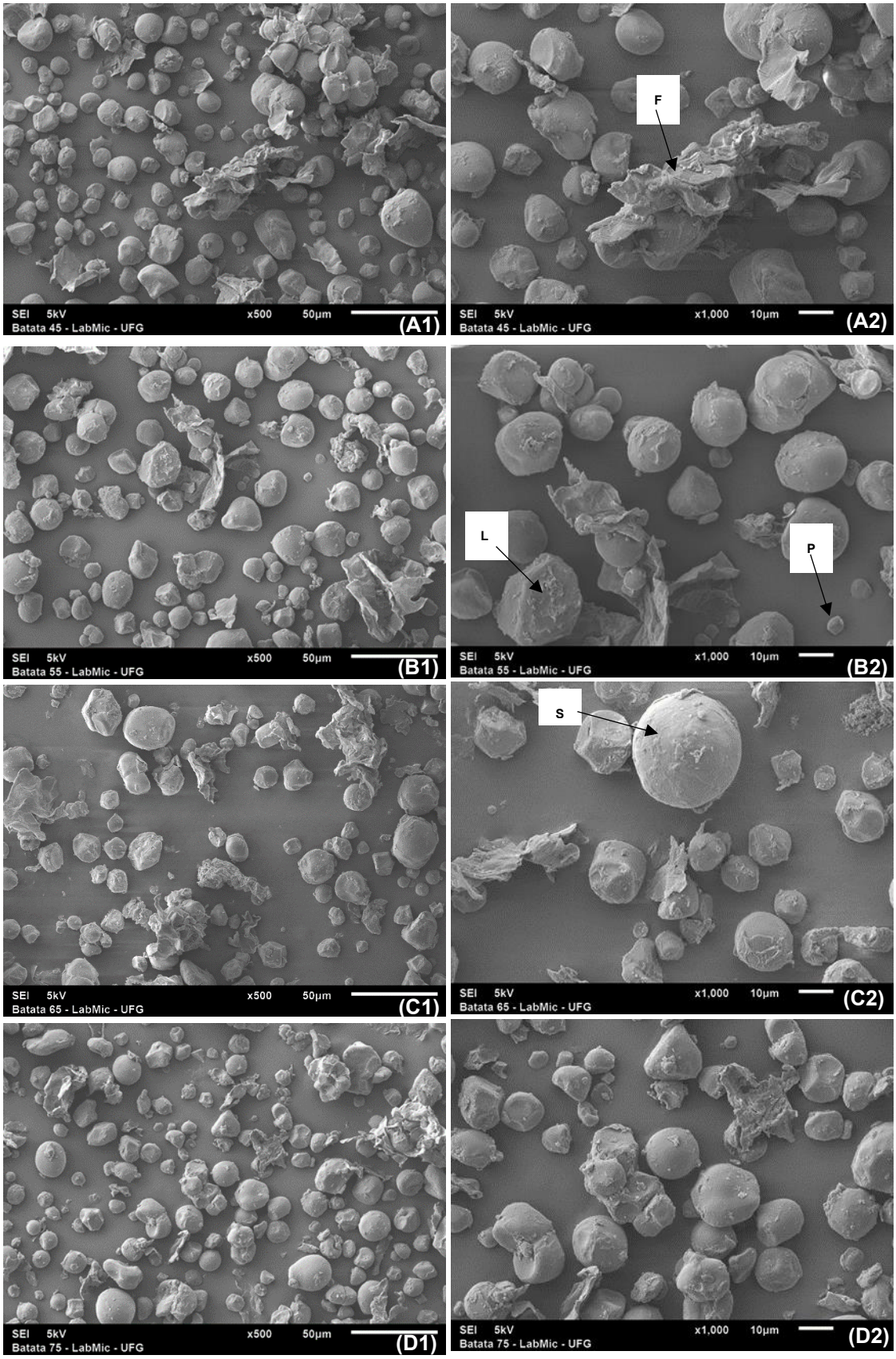

Figure 3. Scanning electron microstructure of biofortified sweet potato flours, dried at (A1) 45 °C magnified 500X, (A2) 45 °C magnified 1000X; (B1) 55 °C magnified 500X, (B2) 55 °C magnified 1000X; (C1) 65 °C magnified 500X, (C2) 65 °C magnified 1000X; (D1) 75 °C magnified 500X, (D2) 75 °C 1000X increase. In the images, the highlighted letters refer to the following structures: S - starch; F

- fiber; L - lipids; and P - protein.

There was no morphological change in the material with the temperature variation between 45 and 75 °C. It can be noted that the shape, apparent size distribution and types of structures found were similar. Gonçalves et al. (2009), when analyzing the effect of heat treatment on sweet potato starch, observed that there were no changes in starch structures. The authors report that the granules showed oval and polygonal shapes, with smooth surfaces, with no evidence of ruptures or cracks after heat treatment at 90 ºC in an oven for 16 h and microwave for 1 h.

Figure 4 shows the Fourier-transform infrared (FTIR) absorption spectra of the samples of biofortified sweet potato flour, which are characteristic of starch (Craig et al., 2015).

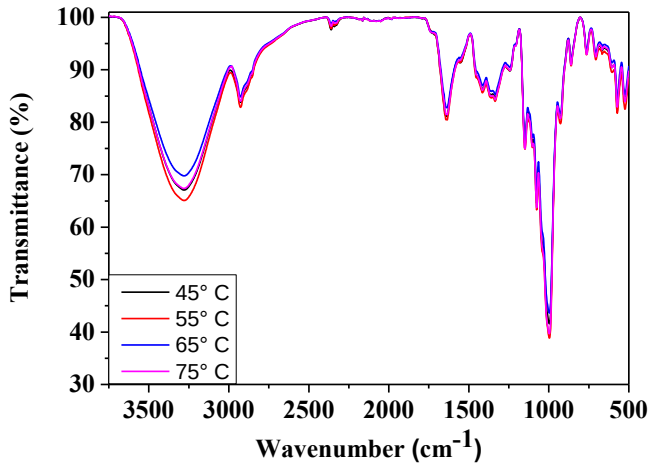

Figure 4. Fourier-transform infrared (FTIR) absorption spectra of samples of biofortified sweet potato flour dried at 45, 55, 65 and 75 °C.

The wide signal between 3000 and 3500 cm^{-1} is due to the symmetrical stretches of O-H bonds, the signal between 2960 and 2860 cm^{-1} is due to the symmetrical and asymmetric stretches of C-H bonds, the signal between 1680 and 1600 cm^{-1} is due to the asymmetric stretch of O-H groups, and the intense signal between 1160 and 900 cm^{-1} is related to the symmetrical stretch of C-O bonds.

Since all spectra were virtually identical, there were no changes between the samples dried at different temperatures, as verified in the electron scanning microscopy analyses.

Figure 5A shows the NMR signals of ^{13}C obtained with the CP-MAS method for the different samples of biofortified sweet potato flours, Figure 6b presents the expansion of the spectra between 55 and 90 ppm. In Figure 6A, the signal at about 102 ppm is the signal of carbon 1 of the glucose molecules, the signal at about 82.5 ppm is of carbon 4, the signal between 77 and 67 ppm is related to carbons 2, 3 and 5, and the signal at about 63 ppm is due to carbon 6.

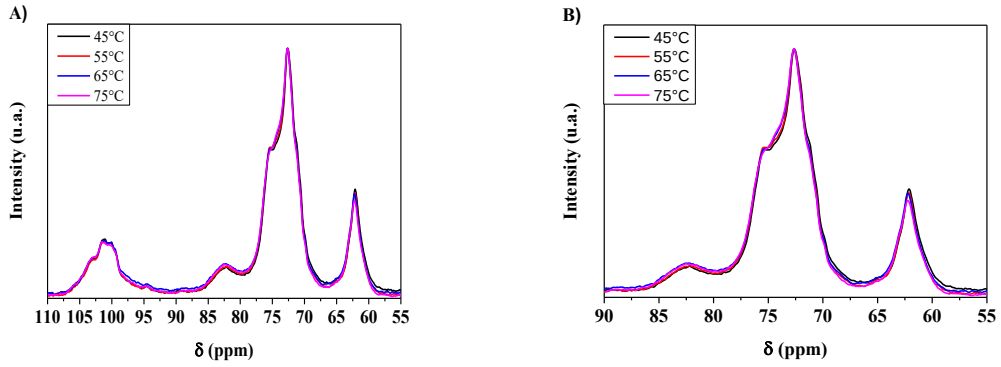

Figure 5. Signals obtained by the CP-MAS method of biofortified sweet potato flours dried at 45, 55, 65 and 75 °C.

In Figure 5B it is possible to observe that there is a small difference in the most intense signal at about 75 ppm, which is an indication that at temperatures of 65 and 75 °C there may have been changes in the crystalline/amorphous ratio of the material, compared to samples dehydrated at temperatures of 45 and 55 °C, in which the material absorbs more water, which in turn has greater mobility.

When starch molecules are heated, part of the structure loses crystallinity, and water molecules form hydrogen bridges between amylose and amylopectin, originating the amorphous regions (Singh et al., 2003).

In samples dried at 65 and 75 °C, there may have been starch retrogradation with formation of more crystalline zones. In the process of starch retrogradation, molecules that have been heated form a gel and, when it is cooled, hydrogen bonds are formed, originating the crystalline structure (Yu et al., 2009; Jiamjariyatam et al., 2015).

4. Conclusion

Drying temperatures did not alter the morphological structures and infrared spectra of the samples dried at 45, 55, 65 and 75 °C. Phenolic compounds, antioxidant capacity, carotenoids, β-carotene decreased with the increase in drying temperature, and in nuclear magnetic resonance signals there was a small change in the crystalline/amorphous ratio of the samples dried at 65 and 75 °C. The temperature of 45 °C was the most indicated for the production of flours, since the produced flours had higher contents of bioactive compounds, being an important source of carotenoids.

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UV Spectrophotometry Applied to the Quantification of Omega-3, -6 and -9 in Fresh Tissues of Wild and Farmed Tambaqui

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Abstract

The demand for healthy foods has also increased the demand for wild and farmed tambaqui since it is a fish rich in omega-3, -6 and -9. To determine which of the two types of fish has the best nutritional quality and thus test the hypothesis that there are no nutritional differences between the groups of fish evaluated, the method of ultraviolet absorption spectrophotometry was used. For this, tambaqui from different environments (wild and farmed) were obtained in the states of Amazonas and Rondonia, Brazil. The fish groups showed differences in the concentrations of omega-3, -6 and -9 (ANOVA, $F(8.30) = 16.213$, and $p < 0.01$), both between states and between environments. The wild fish of the Amazonas state presented the best quality meat, and exhibited the highest concentrations of omega-3 (0.223 g ± 0.05 g) and omega-9 (0.208 g ± 0.04 g), which also implies the presence of omega-6, while the other group of fish exhibited the lowest values of omega in their composition.

Keywords: Fatty acids; alpha-linolenic acid; linoleic acid; oleic acid; absorption spectrophotometry; unsaturated fatty acid.

1. Introduction

The human body needs the intake of certain nutrients for proper functioning (Vidal et al., 2012), among these stand out lipids, which are organic chemical compounds that act as an energy source for the cellular maintenance of living beings, mainly in the form of fatty acids (Suárez-Mahecha et al., 2002).

Fatty acids at room temperature are classified into saturated (solid state) and unsaturated (liquid state), and these can be used for energy by the cells of animals and plants, where they are found, respectively (Bolzan, 2013). They belong to the group of carboxylic acids (COOH) of the aliphatic chain, to which belong omega-3 (alpha-linolenic acid, ω-3) (Figure 1A), -6 (linoleic acid, ω-6) (Figure 1B) and -9 (oleic acid, ω-9) (Figure 1C) (Pubchem, 2020).

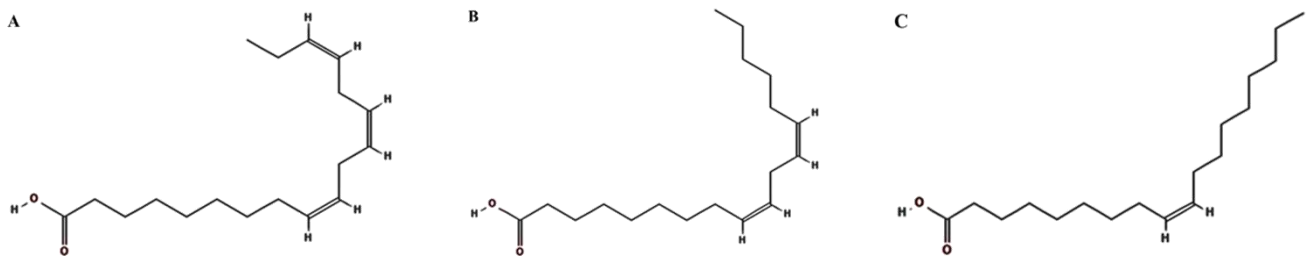


Figure 1. Two-dimensional images of the respective omegas, A = ω-3; B = ω-6; C = ω-9 (PUBCHEM, 2020).

The fatty acids ω-3 and ω-6 are considered essential because they are not synthesized by the human body and for this reason they must be ingested through food (Souza et al., 2007; Kus and Mancini-Filho, 2010). In addition, they have distinct physiological functions,though act together for the regulation of biological processes (Suárez-Mahecha et al., 2002; Kromhout and Goede, 2014). On the other hand, ω - 9 is produced through endogenous processes, but, for this to occur, it is necessary that the omega-3 and 6 have been previously ingested (Suárez-Mahecha et al., 2002; Asif, 2011).

Studies have pointed out that omega fatty acids are able to help in the control and prevention of diseases (Saravanan et al., 2010; Weiser et al., 2016), such as postnatal depression (Kaviani et al., 2014) and cardiovascular diseases (Saravanan et al., 2010). They can also act as anti-inflammatories in neurodegenerative diseases, among other health benefits (Hu et al., 1999; Skulas-Ray, 2015). For these and other reasons, the demand for "healthy" foods, containing omegas -3, -6 and -9, has increased.

The foods most sought out for having high concentrations of omega-3 and -6 are fish oils (Vilarta, 2007; Bentes et al., 2009) and vegetables (Gebauer et al., 2006). Among the freshwater fish, the tambaqui (Colossoma macropomum) is rich in ω-3, especially because it is a plankton filter, which is one of the primary sources that are rich in fatty acids (Kus and Mancini-Filho, 2010). It is also one of the most consumed fish in the northern region of Brazil, where it leads production, whether farmed or wild (Instituto Brasileiro de Geografia e Estatistica, 2019).

With the increasing supply and demand for fish for human consumption, a question has arisen between commercial fishermen and fish farmers, in which it is alleged that, due to it coming from a natural environment, the meat of wild fish has better quality than that of captive fish in relation to nutritional characteristics (Oliveira et al., 2020). However, determining which is the best meat in a nutritional sense

requires complex and in-depth analysis, since there are few methods used for this.

There are a number of techniques that can be used to determine the occurrence and concentrations of omegas present in food, including gas chromatography (Bentes et al., 2009; Reis, 2015), infrared spectroscopy (Pantoja, 2013) and ultraviolet absorption spectrometry (Pavia et al., 2010). The latter is widely used since it is low cost and since it can detect the presence of certain functional groups in small samples (Pavia et al., 2010; Pantoja, 2013).

Thus, in this study, we applied the spectrophotometry technique allied to the method of extraction of fatty acids in order to evaluate whether rearing in the wild or the farming of tambaqui influences the levels of omega-3, -6 and -9, in other words, if the meat of wild fish or farmed fish differ in their fatty acid content. For this, the following hypotheses were tested: i) there are no differences between the absorption values for omegas-3, -6 and -9 between the meats of the groups of wild and farmed tambaqui; ii) the previous parameters do not differ for the fish groups between the states of the northern region (Rondonia and Amazonas states).

2. Materials and Methods

2.1 Fish samples

The specimens of tambaqui used in this research were acquired in wild and farmed environments, in the states of Amazonas and Rondonia, since these two are the largest producers of this species in Brazil (Brazilian Institute of geography and Statistics, 2019).

A total of 28 slaughtered tambaqui were obtained, seven were wild and obtained in the Lago do Cacau (03º09’22’’S 60º06’42’’W) and seven were from fish farms (03º17’06’’S 60º11’09’’W), both in the municipality of Iranduba (Amazonas). In the state of Rondônia, the same quantities were acquired in the Madeira River, near the city of Porto Velho (08º42’56’’S 63º55’23’’W) (wild fish) and from a fish farm in the municipality of Presidente Medici (11º09’37’’S 61º54’22’’W).

All fish, when obtained, were stored in isothermal boxes, in alternating layers of ice and fish, in a ratio of 1:1 (kg of ice:kg of fish), labelled and transported to a laboratory facility, where they were eviscerated, descaled, boned, packaged, labeled and frozen. From each fish, three samples of meat with skin were randomly collected for further procedures and analysis in the Nanomaterials Laboratory-Nanobiomagnetism, Federal University of Rondonia. The methodological procedures for the collection and processing of the data of this research were approved by the Ethics Committee of the Federal University of Rondonia under the registration number: 82882817.5.0000.5300.

2.2 Chemical Reagents

Chloroform compounds (P.A. 99.8% Alphatec), methanol (P.A. 99.8% Alphatec), oleic acid (P.A. 99.5% Synth), linoleic acid (P.A. 99% Sigma) and linolenic acid (P.A. 99% Sigma) were used for the solubility of the samples.

2.3 Preparation procedures

Initially, a sample of tambaqui meat was randomly selected and subjected to milling with the aid of an

ultrasonic sonicator (homogenizer disperser), using 200 mg of fish meat sample for each of the respective chemical compounds: chloroform (3 ml), formaldehyde (2 ml), methanol (1 ml), hydrochloric acid (1 ml) and ethylene glycol (0.5 ml), in order to verify in which solution the sample presented the best solubility. At the end of the tests, the solutions of chloroform and methanol showed better solubility in the dilution of the samples.

After homogenization, the resulting mixtures of the samples were used for two-hour incubation in the standard extraction solution of chloroform: methanol (2: 1). The preparation of the samples were in the following proportions: 300 µl (30%), 150 µl (15%), 50 µl (5%), 10 µl (1%) and 5 µl (0.5%) of sample dissolved in a total volume of 3 ml for each sample generated. The standard solution was also used to prepare the fatty acids ω -3, ω-6 and ω-9, in their respective percentages.

The sample solutions were submitted to spectrophotometery (NOVA, 2102 UVPC), with the aid of Win-sp5 UV work station software, in the region of 190 to 1100 nanometers (nm). For spectrophotometry measurements, chloroform solvent solution (CHCL3) was used in the proportion of 1% of the sample, which was observed as being the best resolution of the spectra (Figure 2). For the analyses, 3 ml of each sample was used. This was added to a quartz cuvette with an optical path of 5 mm and an optical dispersion width of 0.2 mm. Between each measurement, the cuvette was cleaned with distilled water to avoid contamination.

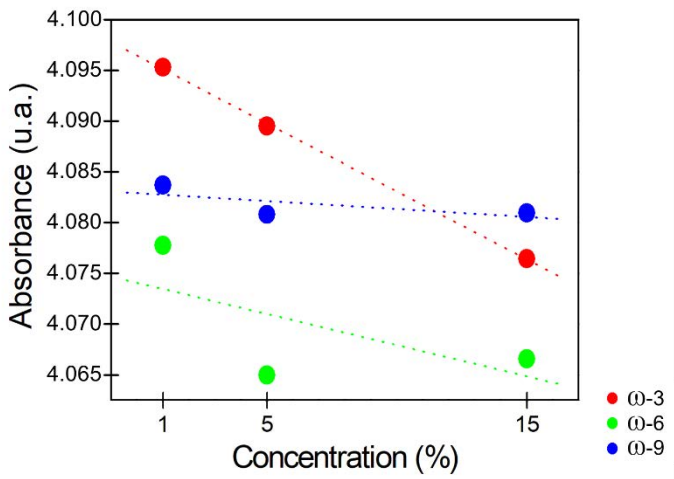


Figure 2: Calibration of UV/VIS absorbance spectroscopy in arbitrary units (a.u.) as a result of the concentration of omegas, which was dispersed in standard solution medium of omegas in chloroform/methanol. Dotted lines are the linear regressions for the experimental data of the maximum absorbance value of each UV/VIS spectrum. (ω = Omega)

2.4 Statistical analyses

The data treatment for the analyses was based on the range of the electromagnetic spectrum of the ultraviolet light that extended from 190 to 400 nm, displayed with the aid of Origin Microcal (TM) software (Version: 6.0, serial number: G73S5-9478-7063326), where the absorption peaks were identified in regards to the wavelength of each sample, resulting in a dimensional graph that showed these variables (Pavia et al., 2010; Pantoja, 2013). The standard value of each omega, ω-3 = 278.43 g/mol, ω-6 = 280.45 g/mol and

ω-9 = 282.47 g/mol, was used in the quantification of omegas present in each fish group, determined from the number of pi transitions present in each sample. For this, the Lorentz distribution (Equation 1) was applied to both fish samples and omegas, in order to find out the value of the area under the peak absorption (A). Then, the A values of the samples were used to quantify the Omegas -3, -6 and -9 present in each individual (Equation 2).

Equation 1

$$y = y_0 \frac{2Aw}{\pi(x - xc)^2 + w^2}$$

Where:

y = Spectrum intensity;
y_0 = Initial spectrum intensity constant;
x = Independent variable. Fixed wavelength;
π = 3.14;
A = Area under peak absorption;
w = Line width at half height; and
xc = Floating wave length.

Equation 2

A=A(mean) ± ΔA(error)

The total sum of A multiplied by the standard of each omega (g/mol) results in the total amount of omega present in each fish (Equation 3).

Equation 3

ai = m(ΣA)pi

ai = Total amount of omega per individual
m = Standard of each omega
pi = Weight of each individual

The omega values obtained for each group of fish were submitted to the Levene and Shapiro-Wilk test, in order to verify the assumptions of homocedasticity required by the analysis of variance (ANOVA), then the Tukey test was used to verify the significant difference (honestly significant difference - HSD) between the different groups. A correspondence analysis (CA) along with the Tukey test showed the differences between fish groups in relation to the amount of omegas. These tests were performed using the Statistica 9.0 program (Statsoft 2009), where $p < 0.01$ was considered statistically significant.

3. Results

The values of absorption spectra in the ultraviolet region, obtained from triplicates and omegas, exhibited

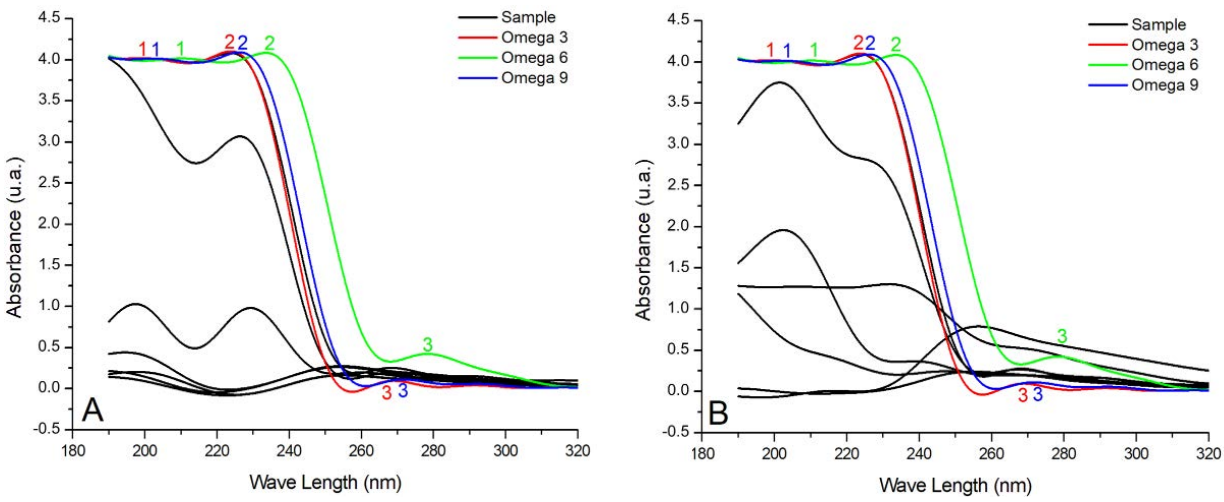
maximum absorbances in wavelengths ranging from 190 to 320 nm. The spectra of the omegas showed up to three characteristic bands of absorption. Omega-3 showed maximum absorption at wavelengths 201, 224 and 268 nm, omega-6 at 211, 234 and 278 nm, and omega-9 at wavelengths 203, 227 and 271 nm (Figure 3). However, band 2 showed higher absorbance intensity when compared to bands 1 and 3, this behavior is due to the transitions of N → π* and π → π*,because of the carbonyl group and the polyenes present in the omegas (Valeur, 2005), and was therefore considered for the quantitative calculations of the omegas.

The samples of the tambaqui presented different behavior in the absorption spectra for each individual and respective environments. A wild specimen from the Amazonas state showed predominance of omega-3 and -9 in its spectrum. When the highest intensity absorption bands were observed in the samples, omega-3 band 1 was present in four individuals, while band 2 was identified in 3 individuals. Omega-6 band 2 was present in the 7 fish of the wild group of the Amazonas state, but with greater absorbance in only 3 specimens. Omega-9 band 1 was present in all individuals, while band 2 was present in only 3. The band 3 of the omegas was not found in any of the samples tested (Figure 3A).

On the behavior of the absorption spectra of the wild fish from Rondonia state, five specimens presented the bands 1 and 2 of omega-3, -6 and -9, and only one individual exhibited greater intensity in wavelength. Two individuals presented band 3 of omega-6 and five fish were present in band 3 of omega-3 and -6 (Figure 3B).

The fish from the Amazonas state farms presented the bands 1 and 2 of the omegas in practically all individuals, and only 2 exhibited different intensities in the absorption bands, one fish presented band 2 greater than band 1, while the other showed the reverse (Figure 3C). Omega-6 showed a low incidence in all animals. Omega-3 bands 1 and 2 were present in 6 individuals, except for one fish that did not present band 2. As for omega-6, band 1 was evident in four individuals and band 2 in six. For omega-9, bands 1 and 2 were present in 6 of the 7 individuals tested. All animals showed jumps to the smaller wavelengths and did not show band 3 in their spectra (Figure 3C).

As for the intensity of the absorption bands of farmed fish from Rondonia state, one of the specimens presented the bands 1, 2 and 3 of the omega-3, -6 and -9 in its entire spectrum, the other samples exhibited the lower absorbance intensity (Figure 3D). In four fish, band 1 and 2 of omega-3, -6 and -9 were present with the exception of 2 fish that did not present band 3 of omega-6 (Figure 3D).



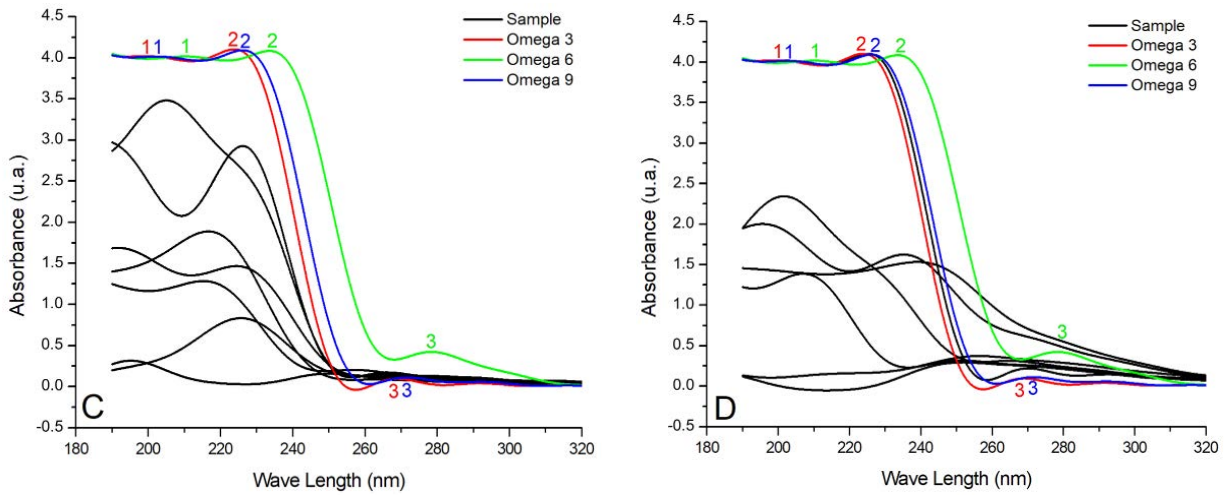


Figure 3. Representation of absorption spectra in the ultraviolet region of tambaqui samples together with the spectra of omega-3, -6 and -9. Where: A = wild Amazonas fish, B = Wild Rondonia fish, C = farmed Amazonas state fish, and D = farmed Rondonia state fish.

The quantification of omegas -3, -6 and -9 in relation to meat mass of fish was obtained using the Lorentz distribution function for the spectra of Figure 3, and we performed the sum of the derivatives of the acquired absorption areas. In this case, the distribution function was applied to the identity spectrum of each individual and determined the areas under the spectra. The areas are equivalent to the amount of omega that responded to a given wavelength. This amount was correlated with the standard molar weight of each omega, along with the percentage of the material dissolved in the medium in which the spectrophotometry measurement was performed (Folch et al., 1956; Bligh and Dyer, 1959; Rodríguez et al., 2010).

The analysis of variance showed significant differences between the quantitative omega by groups of tambaqui ($F(8.30) = 16.213$, and $p < 0.01$) and also varied with the Tukey post hoc test (Table 1). The tambaqui that presented the highest amounts of omega-3 and -9 in their meat were the wild fish of the Amazonas state, with an average of 0.223 g and 0.208 g per fish, respectively. The individuals that exhibited the lowest amount of omega-3 were from the farmed group of the Amazonas state (0.045 g), and the lowest values of omega-9 was equal to tambaqui farmed in Rondonia state (0.051 g). The wild tambaqui of Rondonia (0.075 g) had a higher concentration of omega-6 when compared to the wild tambaqui of the Amazonas, and the specimens from farms in Rondonia (0.028 g) presented lower amounts of omega-6 compared to those of cultivation from the Amazonas state (Table 1).

Table 1. Mean and standard deviation values of the amount of omega extracted from each tambaqui individual per group, in different environments and states, followed by the Tukey test ($p > 0.01$). Identical letters in the same column do not show significant differences between the means of the variables presented. PM = mean weight of individuals per group.

Sample location	PM (g)	ω-3 (g)	ω-6 (g)	ω-9 (g)
Amazonas (wild)	1381.4 ± 294.2	0.223 ± 0.047 a	0.059 ± 0.012 a	0.208 ± 0.044 a
Rondonia (wild)	1803.5 ± 721.3	0.075 ± 0.030 b	0.075 ± 0.030 a	0.071 ± 0.028 b
Amazonas (farmed)	1490.6 ± 581.8	0.045 ± 0.008 c	0.058 ± 0.010 b	0.060 ± 0.008 c
Rondonia (farmed)	2351.1 ± 623.6	0.098 ± 0.025 d	0.028 ± 0.007 c	0.051 ± 0.013 d

The correspondence analysis explained the distribution of the values of the omegas within the coordinate matrix with 86.91% inertia. There is an evident separation between the groups of tambaqui and their concentrations of fatty acids, in which in dimension 1 the omegas 3 and 9 were grouped on the left side of the x axis for the wild fish of the Amazonas and Rondonia farms, while the wild fish of the Amazonas state and farmed fish from Rondonia were grouped on the right side with the highest values of omega-6. In dimension 2, the separation of fish groups by state was noted, in which the groups of the Amazonas were in the upper part and the groups of Rondonia in the lower part of the Y axis (Figure 4). This demonstrates that the wild tambaqui of the Amazonas presented the highest amounts of ω-3 and ω-9, followed by the farmed individuals holding equal place for ω-6. The group of Rondonia tambaqui remained in the lower part of the y-axis, where they exhibited the lowest concentrations of ω-3 and ω-6, for farmed and wild fish, respectively (Figure 4).

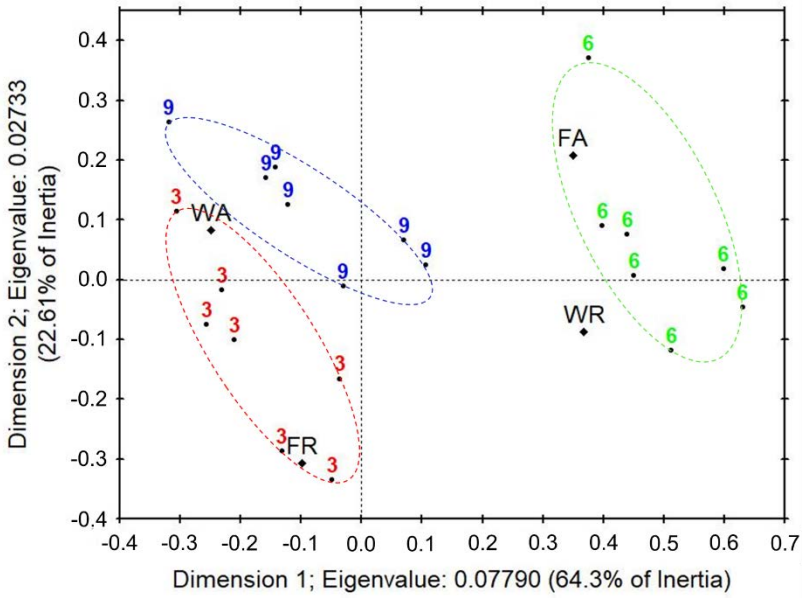


Figure 4. Analysis of correspondence with the distribution of the groups of tambaqui, according to the concentrations of the groups of omega-3, -6 and -9 and their respective capture sites. Where: FA = Amazonas farmed fish; FR = Rondonia farmed fish; WA = wild Amazonas fish; and WR = wild Rondonia fish.

4. Discussion

Spectrophotometry is a technique used to measure the presence of functional chromophore groups of a sample (Gonçalves, 2001; Pantoja, 2013). When the statistical equations are added, these results can efficiently report the exact amount of the investigated substance (Waite, 1976), as well as provide information on compounds that have double bonds in their structure (Gonçalves, 2001; Pantoja, 2013; Pavia et al., 2010).

Unsaturated fatty acids have these double bonds in their molecules, and physico-chemical characteristics, such as boiling points and melting points that are different from saturated fatty acids (Assif, 2011; Bolzan, 2013), as is the case of omega-3, -6 and -9, which showed absorption in wavelengths of between 200 to 300 nm, and which occurs due to the diene system present in their structures. (Instituto Adolf Lutz, 2008).

These acids can be found in oily seeds, such as flaxseed and Brazil nuts, in corn and sunflower vegetable oils, olive oils and almonds, and fish oils, such as salmon (*Salmo salar*) and trout (*Oncorhynchus mykiss*). In addition, fish are also considered as the main source of omega (Sugano and Hirahara, 2000; Kus and Mancini-FILHO, 2010).

Omega-3 and -6 are usually found in greater quantities (up to seven times more) in fish that inhabit cold regions, when compared to fish from warmer environments (Visentainer et al., 2000; Souza et al., 2007; Torres et al., 2012), and the main source of these compounds are plankton and algae (Souza et al., 2007; Asif, 2011). However, in the Amazon basin (Fishbase, 2020), well known for being a tropical region, with temperatures ranging from 20 °C to 35 °C (Ruffino and Roubach, 2009), there is the tambaqui, a native fish species, considered rich in ω-3 (Kus and Mancini-Filho, 2010). These individuals also have as their food base the phyto and zooplanktons (Oliveira and Sousa, 2017), which have large concentrations of fatty acids in their structure.

Thus, it is noted that fish in general have distinct behaviors and characteristics, which may be linked to the environmental conditions in which they live and consequently the feeding in these different places (Sugano and Hirahara, 2000; Bentes et al., 2009), and therefore, the amounts of omegas present in the meat of these individuals may vary (Sugano and Hirahara, 2000; Moreira et al., 2003; Bentes et al., 2009). This pattern was observed in the results presented here, where the groups of fish from different environments (wild and farmed) showed differences between themselves.

However, studies point out that both the human organism and the fish do not have the ability to produce the double bonds existing in the fatty acids ω-3 and ω-6. However, they can be lengthened and desaturated by the enzyme system (Martin et al., 2006; Assif, 2011), although this conversion is performed in low percentages, since there is a physiological competition between these omegas, which in turn, are only able to be altered one at a time (Suárez-Mahecha et al., 2002; Bentes et al., 2009). This factor may explain the fact that the wild tambaqui of the Amazonas presented high values of ω-3 and ω-9 and low amounts of ω-6.

Therefore, it is necessary that the intake of omega-3 and -6 through food occurs in a balanced way, since the excess of one induces the deficiency of the other (Suárez-Mahecha et al., 2002) and this may promote disease pathogenesis or suppressive effects (Renaud, 2002; Suárez-Mahecha et al., 2002; REIS, 2015). On the other hand, ω-9 is beneficial to humans and also to fish, as it is naturally produced by the organisms of these individuals in the optimal amount (Martin et al., 2006). There are recommendations regarding the amount of omega-3 and -6 that should be ingested, however there is no exact amount proven and pre-established for consumption (Almeida and Franco, 2006). The balance between the omegas is essential to promote a good functioning of the body, however omega-3 is the most important among the studied omegas (Assif, 2011), since this fatty acid, among other benefits, is also responsible for the reduction in the formation of clots that occur in the bloodstream (Connor, 2000; Suárez-Mahecha et al., 2002; Almeida and Franco, 2006).

The results of this study showed that the wild tambaqui of the state of Amazonas stood out in relation to the wild tambaqui of Rondonia, with individuals rich in ω-3 and ω-9. As for farmed fish, Rondonia individuals had more ω-3 than Amazonas fish, which in turn exhibited the highest rates of ω-6 and ω-9. Some studies have indicated that farmed fish have higher omega-3 and -6 levels than wild fish (Suarez-

Mahecha et al., 2002), while other studies report the reverse (Moreira et al., 2001). In the case of farmed carp (*Cyprinus carpio*), the omega-6 values (16.1%) were higher than those of wild individuals (13.5%) and for omega-3 the reverse occurred, farmed fish presented 9.6% and wild fish 15.8% of these fatty acids in their meat (Suarez-Mahecha et al., 2002). In the Amazonas basin, wild specimens of piramutaba (*Brachyplastystoma vaillantii*) did not present ω-6 values in their flesh, while farmed piraputanga (*Brycon microlepis*) exhibited a higher rate of omega-6 (11.86%) when compared to wild specimens (5.27%) (Moreira et al., 2003; Bentes et al., 2009). For the wild tambaqui of the state of Amazonas, the highest concentrations of ω-3 and ω-6 were found compared to farmed fish. While wild tambaqui from Rondonia exhibited the highest values of ω-6 and lowest rates of ω-3 in relation to farmed fish.

The distribution of different levels of omegas in the tissues of the fish studied may be related to the different environments and types of food to which they were subjected (Almeida and Franco, 2006). The states of Amazonas and Rondônia have distinct geographical and environmental characteristics, where the former still contains large areas of floodplains and well preserved forests (Bittencourt and Amadio , 2007; Pacheco, 2009), thus providing favorable conditions for the healthy development of the existing tambaqui.

The state of Rondonia, however, presents a history of economic growth based on the production of cattle with large areas of pasture and bean production (coffee and soy) (Melo Filho et al., 2005; Silva, 2014), which, added to the large areas of deforestation, lead to the anthropization of river beds, causing siltation and environmental modification (Fearnside, 2006). These factors may have influenced the low values of ω-3 and ω-9 found in wild tambaqui of this region, and this may be a consequence of food shortages.

Therefore, the maintenance and preservation of the natural flooded areas in which the tambaqui live is necessary, since they are still the most suitable spaces for the acquisition of healthy food and rich in nutrients for these individuals, which act as a source of protein indispensable for human diets. On the other hand, the proper management of fish in confined environments can also be achieved, but for this to occur a diet with higher amounts of omega-3 and -6 must be offered to the animals being reared.

5. Conclusion

The groups of tambaqui evaluated showed differences in the concentrations of omegas-3, -6 and -9, both between the states (Amazonas and Rondôinia), and between the environments in which they were obtained (wild and farmed). However, the wild fish of the Amazonas were the ones that presented the best nutritional quality in their meat, since they exhibited the highest concentrations of omega-3 and -9, which also implies the presence of omega-6.

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The senior manager as a strategy manager in change scenarios: practice in the brazilian public sector

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Abstract

How does the senior manager of a public organization practice the strategy and mobilize his team to enable continuously, in the organization where it is located: meeting its mission, stakeholder needs and the dynamics of the internal and external environment? This question guides the research of this article which also presents the structuring of a framework that brings together four academic approaches - Carlos Matus' Situational Strategic Planning (1991; 1997; 2005), as a central element; Whittington's Strategy as a Social Practice (1997; 2002; 2004; 2006); Freeman's Stakeholder Theory (2010); and Burns' Transformational Leadership (1978; 2003). Data were collected in semi-structured interviews and treated qualitatively by Thomas's inductive analysis (2006), the Gibbs coding and categorization method (2009) and the matching presented by Trochim (1989). The framework should serve as a reference for the action of the manager regarding the mentioned issue.

Keywords: Management and Strategy; Strategic Situational Planning; Transformational Leadership.

1. Introduction

From the second half of the twentieth century, due to the strong hostility environment in competitions by market, the strategy area started to get great relevance, both in the business and academic fields. In addition, the increase in the structural complexity of organizations associated with the fast pace of environmental changes required bigger capacity to design and implement strategies, in order to overcome noticeable organizational challenges (Camargos & Dias, 2003; Vasconcelos, 2001).

Scenario changes resulting from internal changes in organizations - such as admission, dismissal and retirement - and external changes - such as crises, financial plans and political changes - make planning activities more difficult in terms of projecting a set of actions that aim to achieve an specific result in the future, especially in public organizations (Alday, 2000; Iida, 1993). We also realized some difficulties in the strategic management environment in the public area, especially in the process of updating and reforming management, from the bureaucratic model to the subsequent forms, in which public governance issues and efficiency in service to society's demands are highlighted (Secchi, 2009; Bresser-Pereira, 2017; Abrucio, 2007; De Paula, 2005).

It is also necessary to verify how strategic planning is suitable in public organizations in the face of constant and unpredictable reality changes in the plan. Likewise, analyze the formulated proposal by the Situational Strategic Planning (SSP) which owns a non-deterministic approach, making constant adjustments to the

plan, according to scenarios changing (Matus, 1991; 1997), since the plan is surrounded by "uncertainties, inaccuracies, surprises and other actors' rejections and support" (Matus, 1991, p. 28).

In the case of rejections and support for the practice of the strategy in which Matus (1991) refers to, another issue is directly related to the success of this practice in an organization and finds reference in the approach of Strategy as Social Practice (SASP): personal interests, sometimes contradictory, immersed in organizations, articulate a number of favorable (or contrary) practices to the everyday practice of strategy making (Da Silva et al., 2011). Addressing these contradictions and their respective interactions with the subject practice involved in the strategy execution is also the aim of this work.

Another element that can interfere in the strategy's practice is the manager's team involvement and commitment and its technical staff that make up the organization, especially concerning to the way in which these managers and directors lead their teams. The concept of Transformational Leadership also makes a contribution to the practice of strategy by establishing a connection between leaders and followers, in search of the common ideal, such as the strategic organizational objectives (Burns, 2003).

The articulation between the four elements - Situational Strategic Planning, Stakeholders' Theory, Strategic as Practice and Transformational Leadership - observing the aspects of the Weberian bureaucratic model evolution, for the proposed reforms by the new public administration models (Secchi, 2009; Bresser-Pereira, 2017; Abrucio, 2007; De Paula, 2005), is the aim of this study, which is guided by the following question: how the high leader of a public organization practices the strategy and mobilizes his team, in order to continuously make feasible, in the organization where he is located, meeting his mission, the needs of stakeholders and the dynamics of the internal and external environment?

That said, this article is divided into nine sections: "1. Introduction"; "2. Public environment and strategic management", in which public sector issues that impact on the strategy's practice and management are addressed, and which are based on the evolution of public management models; the four concepts that articulate in the answer to the research problem ("3. Situational Strategic Planning", "4. Strategy as Practice", "5. Stakeholders' Theory" and "6. Transformational Leadership"), thus constituting the development; a section called "7. Methodological Procedures", in which the type of research, the interviewed subjects, and the characterization of data collection are presented; in section "8. Results and Analysis", the entire structure of the proposed framework and its interrelation with the four approaches studied are described; finally, there is section "9. Conclusion ", containing the final considerations, their results and a proposal for future research for the topic in question.

2. Public Environment And Strategic Management

Mintzberg et al. (2009) identify flaws in the planning of companies and organizations, because, in addition to the problems related to the emergence of changes in external scenarios that impact the intended strategy, making it different from the one that was actually carried out, there were also difficulties generated for its compliance, as a consequence of the separation between thought and action, since different groups think, elaborate and practice this strategy. For this reason, it is assumed that the strategy, to be effective in the organizational environment, cannot be developed by senior management and implemented by subjects who do not participate in this conception (Mintzberg et al., 2009).

The difficulties and failures in the strategic management environment are not exclusive to private organizations. In the public area, they demanded reform in the Brazilian public administration, over the years, seeking to modernize the national management process (Secchi, 2009; Bresser-Pereira, 2017; Abrucio, 2007). This process of reforming or updating the state machine, also called *aggiornamento*, required considerable updating in the practices of administration and management of the public machine, looking for improvement services to the population (Abrucio, 2007).

In more detail, *aggiornamento* means a public management update to try to make it more efficient than that existing in the old Weberian bureaucratic model which, despite having been effective in the past, is now unable to meet the growing demand of the population for quality public services (Secchi, 2009; Bresser-Pereira, 2017; Abrucio, 2007; De Paula, 2005).

Analyzing the history of the evolution from the bureaucratic model to the models of public administration, Secchi (2009) carried out a research about the evolution of public administration in Europe and the United States.

From the observation that the bureaucratic model is outdated and inappropriate, given the presumption of inefficiency, slowness, self-referential style and departure from the contemporary needs of citizens, the new organizational models emerge as alternatives: Public Management Administration (PMA); Entrepreneurial Government (EG) and Public Governance (PG). The first two are classified as organizational models and the last as a relational paradigm (Secchi, 2009), thus presenting the potential to influence the change in the management of public organizations and the way they relate in the long run. Strategic planning is present in all these organizational patterns, however, it is especially emphasized in the models of Public Management and Entrepreneurial Government (also called *Managerialism*) (Secchi, 2009).

Bringing the analysis back to the specific Brazilian reality, it is clear that the search for greater efficiency and quality in public administration has not achieved the expected success in Brazil, due to the difficulty of translating the proposed changes in the emerging models of administrative reform in the world reality for the peculiarity of the Brazilian political one (Abrucio, 2007).

De Paula (2005) makes an important comparative analysis between the managerial and societal models, which emphasizes greater social participation in the development project of the Brazilian State, although it is less prominent than the managerial model in the organization of the nation apparatus and the public administrative machine. Insufficient social participation in the management model, in comparison to the societal model, leads to a centralism in the decision-making process and the consequent difficulty in the political relationship and governance of the management model. This scenario creates excessive centralization in government decisions, leading to personalist and centralizing practices, restricting public policy debate to the environment of parliament and with little participation by society (De Paula, 2005, p. 43).

Differently the managerialist model, the societal model is based on the conception of the public institutions opening to popular participation, sharing with society the central and discretionary power of the elaboration and execution of public policy, in order to reduce the centralism of the decision-making process and the personalism characteristic of traditional public management (De Paula, 2005).

With regard to the conditioning and impeding elements to an administrative reform in Brazil, three groups of problems stand out in the Brazilian cultural and socio-political context: “patrimonialism, personalism

and the weaknesses of democracy, manifested by authoritarianism, costumerism and local orderism ”(Da Costa, 2006, p. 2).

There are also strong political obstacles that prevent the reform of the Brazilian State as a result of the lack of governance due to the absence of “political conditions to implement the democratization and modernization declared objectives” (Da Costa, 2006, p. 12). All of these questions find an alternative solution in the contributions that have existed, for some time, of Matus' Situational Strategic Planning (SSP) (1991).

3. Situational Strategic Planning

The constant change of scenarios in Brazil and in the world is an element that requires, for itself, improvement in the process of strategy construction (Alday, 2000). In addition, as issues that lead to frequent problems in strategic planning, according to Mintzberg et al. (2009), there is, for example, the separation between thought and action in the construction of the strategy - one of the major reasons for the failure of the construction and execution of the strategy in organizations.

Situational Strategic Planning (SSP) presents an approach capable of adapting to recurring variations in the dynamics of the real situation. In addition, the SSP approach (Matus, 1991) not only proposes to present a solution to the problem of changing the scenario, but also indicates an alternative to the complications generated by the separation of planning and execution functions in the strategy, as pointed out by Mintzberg et al. (2009).

The diagnosis of failure of the traditional strategic model in organizations, due to their inability to deal with changing scenarios, was not observed only by Mintzberg et al. (2009). The traditional plan uncertainties, inaccuracies and surprises that lead to its modification, making it unpredictable, had already been identified by Matus (1991) and dealt with by the SSP.

There are two important SSP concepts in order to address and solve the problem of scenarios variance: governance and uncertainties. Governability is the space where the rules are located and where the actor - or player, as explained before - has control (Iida, 1993). Uncertainties, on the other hand, present themselves as a counterpoint to the deterministic character of the traditional strategy model. The external elements that influence the plan, causing changes in the scenario, are dealt with at the exact moment they occur.

Matus (1991, p. 34) presents “the plan as an open bet [...] because knowing how to draw in the face of uncertainty consists of knowing how to draw under strong doubt and this is the opposite of drawing the plan determinedly”. This statement has a non-deterministic character for complex problems that arise during the execution of the plan and due to variables that are out of the player's control. Thus, "player" is considered to be the individual who interacts in the plan and from different perspectives, including when that individual is against the full success of the plan.

The social game constitutes the environment in which the plan is carried out. This, on the other hand, is covered with uncertainties in which the variables that are under the control of a given player and the variables that are out of control can be observed, and even some of them may be unknown to him (Matus, 1991).

The domain of the social game is synthesized, therefore, through the control and solution of three major problems, which are: the player's ability to explain the reality of the game, how much he can play and act on strong uncertainties and finally know the moment exactly what is done in the plane.

Controlled variables, in the social game environment, are called "those which are the object of options and choice for a player and, at the same time, are relevant to the achievement of the objective of their plan" (Matus, 1991, p. 35). The variables that are out of the control of a player can be known to him, even knowing his law of future change, with conditions to predict them - called invariants. On the other hand, variants are variables whose change law the player does not know, and it is not possible to predict them (Matus, 1997).

The concept of Government Triangle, another important element in the design of the SSP, consists of the articulation of three variables that are positioned at the vertex of a triangle and that "constitute a triangular system in which each variable depends on the others" (Matus, 1997 , p. 51).

The first vertex of the Government Triangle deals with the project or plan of the organization that configures the content of what one intends to do and where one wants to go; the second vertex of the Government Triangle is the system's governability capacity, which depends on the level of control the player has over the variables present in the game; and the third vertex of the Government Triangle defines the technical capacity of the player and his team to conduct or direct the plan.

According to Matus (1991; 1997), the interaction between the three vertices and their respective mutual conditioning are elements identified by the plan's practice through its players or actors. In this sense, the Government Triangle allows a better understanding of the relationship between the plan and its effective implementation or practice.

Migliato and Escrivão Filho (2003), as well as Duarte et al. (2017), also state that Situational Strategic Planning emerges as a result of a criticism of traditional planning. However, although SSP and traditional planning consider the importance of the large number of actors during their process, the primary difference between the two models is the way these actors analyze and interact with the process by practicing the plan.

Matus (1991), Mintzberg et al. (2009) and Migliato and Escrivão Filho (2003) put the practice of the plan and the interaction between its actors as decisive elements for the success of the strategy. Duarte et al. (2017) also point out that SSP, unlike traditional planning, is able to involve easier different actors with different interests and motivations, in addition to having in this involvement the essential element for the implementation and practice of the strategy.

Based on the content learned here, the importance and protagonism of SSP are explained, which is why we chose to use this theme as an anchor of the research.

4. Strategy as Practice

Matus (1991) points out that it is at the moment of doing that everything is decided. Still in conjunction with the issue of "making strategy" as a decisive element for Situational Strategic Planning, the present author highlights another important point: the conflict of interests between actors who reject and actors who support the practice.

Whittington (2004, p. 45) states that "strategy is something that people do (...) can be perceived as a social

practice like any other, be it domestic, political or educational. (...) the people involved in this activity can be helped to understand it and improve their practice".

The vision of strategy as an incremental process and combined with the action of several actors was, according to Da Silva et al. (2011, p. 123), a precursor that "paved the way for the emphasis on everyday social practices". In this perspective, "the approach of strategy as a practice emerged, focused on the micro level, which focuses on practices in their relations with the macro level of analysis" (Da Silva et al., 2011, p. 123). In this sense, Strategy as Practice has a more sociological view with a focus on what strategy practitioners do in the social field, including with regard to social relations - their interactions and negotiations as actors involved (Villar et al., 2017).

In addition to the social vision present in the Strategy as a Practice and put forward by Da Silva et al. (2011) and Villar et al. (2017), there is the important meeting between the strategy, the organization and the subject who performs it, in fact, that practices the strategy (Duarte et al., 2017).

For Whittington (1997; 2002; 2006), the theoretical model of Strategy as Practice can be articulated in three interrelated concepts that are placed as fundamental elements: the practices, that is, the set of technologies and tools to think and act and that strategists use to "make strategy"; praxis, which is the work effectively and in fact done to "make strategy" and practitioners who can be conceptualized as those who "make strategy" in the sense of implementing and conceiving it. "Making strategy" in the daily organizational life is using, adapting and manipulating the resources employed to engage in the execution of the strategy activity over time (Da Silva et al., 2011), while observing the relationship between the personal interests, and sometimes conflicting ones, of the subjects who practice the strategy and its influence in their daily practice, considering the social contexts that interfere in their actions (Matus, 1991; Duarte et al., 2017).

It worth scoring that the external social contexts that influence the practice of the strategy also have a dialogue with the interest of Freeman's stakeholders (2010).

5. Stakeholder Theory

Matus (1991), Mintzberg et al. (2009), Duarte et al. (2017) and Migliato and Escrivão Filho (2003) reinforce the importance of the relationship between the actors that interact in the plan as a decisive element for the success of the strategy. Matus (1991) highlights the importance of these actors for the success or failure of their practice, highlighting the conflict of interests between them as a device of great influence on the success of the strategy.

Thus, the maneuvers between those in the position of power - own - and those in the position of the "other", that is, in a subordinate position to themselves and how this subject uses "tactics" to subvert the strategy, stand out. These subjects who end up interacting with the plan and practice are called stakeholders and have interests and relationships with the organization that impact the elaboration of the mission or plan and its consequent practice, according to Freeman (2010), Matus (1991) and Da Silva et al. (2011).

Regarding the public environment, Freeman's Stakeholder Theory (2010) is similar to Secchi's public management models (2009) - Public Governance (PG) and Managerial Public Administration (MPA) - which also have a greater focus on the issue of strategy (Secchi, 2009, p. 358).

There is also the need to propose a solution to the obstacles brought by Matus (1991) and Mintzberg et al.

(2009) about the interests of stakeholders (Freeman, 2010), especially when these interests are opposed, as pointed out by Whittington (2006).

In this sense, the importance of mediation between these subjects - internal and external - and their followers in the organization, within the environment of construction and practice of the plan, finds reference in the concept of Burns' Transformational Leadership (1978).

6. Transformational Leadership

The concept of Transformational Leadership establishes a mediation between leaders and followers in search of the common ideal, without any polarization in the relationship between both. For Burns (2003, p. 27), “Transformational Leadership arises when one or more people relate to each other, in such a way that leaders and followers motivate each other at higher levels of motivation and morality”. On the other hand, the author adds that “purely charismatic leadership also distorts the relationships of constructive and mutually empowering leaders”.

Likewise, Da Silva (2015, p. 18) finds that "the leader needs to develop actions that will satisfy those desires and needs of his employees, inducing them to act in the desired way and that they may be motivated". Therefore, remuneration is an external motivating factor that, despite being intense, lasts for a short time. Thus, even with extra or higher remuneration, if the subject does not have the pleasure and satisfaction in what he does, even with excellent remuneration, motivation tends to decrease.

Similarly, Burns (1978) is concerned with moving away from Weber's concept of charismatic leadership, clarifying that it is not a magical attribute or a special quality that resides in the leader. Said author places Transformational Leadership as a form or method of relationship between leader and follower. The common ideal, as an agglutinating and facilitating element to achieve the organization's objective, is very important in its definition of leadership (Burns, 1978; Calaça; Vizeu, 2015). A central concept about moral leadership is presented, recognizing values and attributes necessary for the mediation of leadership relationships that are always in conflict.

In the concept of moral leadership by Burns (1978), the question arises from the public over the private, that is, the individual interests of a certain subject cannot prevail over the collective interests of the society to which he belongs.

The leader has the ability to motivate and transform his followers using his influence, intellectual stimulation and individual consideration as a tool. Intellectual stimulation is one of the elements that motivates the creation of new leaders within the team, something fundamental to the concept of Transformational Leadership (Burns, 1978).

Transactional Leadership, on the other hand, would not be built on the pillars of moral content in the relationship between leader and followers, being characterized as the moment when the leader bases his capacity in handling resources to meet the individual interests involved, through his influence among followers (bargain or submission) (Burns, 1978).

It is also worth mentioning the bibliographic research by Calaça and Vizeu (2015) on what influenced Burns' (1978) seminal work on Transformational Leadership. The crisis of political leadership that the United States experienced in the 1960s and 1970s caused this theory to emerge from this social and political

context. In this way, there was "interest in the ability of certain US political leaders to sensitize the population around a common ideal" (Calaça & Vizeu, 2015, p. 127).

Therefore, Transformational Leadership is an alternative to raise awareness and involve practitioners of the strategy who have the conflicts of interest raised by Da Silva et al. (2011) and by Matus (1991), using subversive tactics to implement the Strategy as Social Practice (Calaça & Vizeu, 2015; Whittington, 2004).

7. Methodological Procedures

7.1. Research Type

The research model adopted was qualitative research, which "is of particular relevance to the study of social relations due to the pluralization of spheres of life" (Flick, 2008, p. 20).

The theoretical foundation was elaborated from the analysis in books, specialized journals and other scientific works on the theme. The field study, on the other hand, was carried out through empirical investigation, with information collected about the phenomenon in the field where the research subjects worked (Vergara, 2013).

7.2. Research Subjects and Selection Criteria

As a source of primary data, a sample was selected among managers of the public area, containing nine interviewed, from different political-ideological spectra, who held the positions of ministers of state, state governors, mayors, state secretaries at the federal, state and municipal level, and state officials.

The selection was based on the importance of these agents for the implementation of the organization's strategy. In addition, the selection criteria followed the concepts of accessibility on the part of the researcher and typicality, that is, people with notorious knowledge and mastery of the researched subject (Vergara, 2013).

7.3. Data Collection Characterization

Semi-structured interviews were used as a data collection technique that, according to Roesch (2000), follow a script with open questions that enable the researcher, in the role of interviewer, to understand and capture the perspective of the research participants. In this script, the concepts covered in the sections related to the theoretical foundation of the article were taken as a base, aiming to answer the research question, as the data collected in scientific research need a correlation with the study aims (Vergara, 2013).

The interview script was composed of 20 open and semi-structured questions, organized in three blocks, referring to the themes presented in the theoretical foundations, considering the choice of Situational Strategic Planning as thematic basis:

- Block A - Strategy as Practice and Situational Strategic Planning.
- Block B - Transformational Leadership and Situational Strategic Planning.
- Block C - Stakeholder Theory and Situational Strategic Planning.

The nine interviews, carried out over three months, lasted about 60 min each.

7.4. Data Processing and Analysis

The data analysis process takes place immediately after the end of data collection, meaning this is, when the researcher accumulates a significant amount of notes and testimonials (in text format) organized for due interpretation (Roesch, 2000).

After the analysis of each interview, a comparative criticism and matching process of the findings related to the approach presented in the theoretical basis of the article were elaborated (Trochim, 1989).

Therefore, series of systematized actions were used that aim to categorize the collected data, making easier the subsequent comparison and study of their relationships. The systematic and inductive approach is guided by specific assessment objectives. Thus, we sought to summarize the raw data and identify the conclusions that came from it. Since then, a framework of evident processes has been developed (Thomas, 2006).

The stage of preparation and treatment of the data, according to the methodological proposal of Thomas (2006), was carried out obeying the chronological order: 1) Preparation of the raw data files, seeking a structure in common format; 2) Detailed reading of the text, to understand the studied subjects; 3) Creation of categories, according to research objectives, developed from real phrases or relative meaning of the specific text. For that, a compilation was made from categorization codes, in order to establish a structure of thematic ideas (Gibbs, 2009); 4) Descriptive categorization, elaborated from the excerpts marked in the text of the interviews; 5) New revision, seeking to refine the categories, in order to find subcategories, selecting citations permeated by the central idea of the category; and 6) Reduction of categories and subcategories, by grouping or discarding, aiming at reaching the maximum number of eight categories and 32 subcategories, as advised by Thomas (2006).

8. Results and Analysis

The data analysis process, based on its own definition and systematization, reinforced what was already indicated by the present studies in the theoretical foundation of this work: the centrality of Situational Strategic Planning (SSP) as a capable element of structuring the three other approaches - Strategy as Practice, Stakeholder Theory and Transformational Leadership - used to answer the research question (Figure 1). Besides that, it was possible to build a framework from the data analysis, able to present the relation between the subcategories - and consequently between their respective categories - that emerged in the analysis process.

The following are the eight analytical categories, and their respective 32 subcategories (Table 1), organized based on the methodological analysis of Thomas (2006) and the structuring of thematic ideas by Gibbs (2009).

Table 1 - Research categories and subcategories

Block A - Strategy as Practice and Situational Strategic Planning	
Category	**Subcategory**
1 - Strategy: define how and where you want to go	1.1 - The intended and accomplished strategies coincide
	1.2 - It is practically impossible for the intended strategy to coincide with the one
	1.3 - Meetings as an instrument to verify the fulfillment of the strategy
	1.4 - The strategy carried out did not coincide with the one intended
	1.5 - The strategy is being adjusted as the practice progresses
2 - Management of conflicts of interest diffused by the practice of strategy in the social field	2.1 - Monitoring of the practice of the strategy by the manager as an element influencing the strategy
	2.2 - Identification of the change of scenery due to the relationship built with the team that practices the strategy
	2.3 - The "own" of Strategy as Practice is the great articulator of strategy
	2.4 - Leadership and credibility as elements that impact the strategy
3 - Transforming factors of the strategy	3.1 - External transforming factors of the strategy: emergence of variables outside the management of the manager and the team that practices the strategy
	3.2 - External factors transforming the strategy: governance with parliament
	3.3 - Internal factors transforming the strategy: budget
	3.4 - Internal factors transforming the strategy: team competence
	3.5 - Lack of importance to the quality of the plan, contributing to the failure of the strategy practice
Block B - Transformational Leadership and Situational Strategic Planning	
Category	**Subcategory**
4 - Governance of the practice of the plan	4.1 - Governance by societal support
	4.2 - Governability for the validation of the plan in relation to the one executed with the practitioners of the strategy
	4.3 - Governance combined with the compensatory balance between the plan, the team's execution capacity and the manager's trust in the team
5 - Detection of changes by societal control	5.1 - Identification of the change in the daily monitoring of the strategy practice by the manager

	5.2 - Assimilation of the plan change through periodic meetings with the team: check-list
	5.3 - Detection of change by technical indicators periodically measured in the management process
6 - Leadership as recognition of the team, regarding the leader according to his practice	6.1 - Leadership that involves and motivates the team by the result of the strategy as a result of the collective work
	6.2 - Motivation of the team for involvement with the importance of the strategy and its previous realization
	6.3 - Capacity of the team strengthened with the replacement of better qualified subjects to practice the strategy
	6.4 - Extra remuneration and events for result, as motivation to achieve the objective of strategic planning
Block C - Stakeholder Theory and Situational Strategic Planning	
Category	**Subcategory**
7 - Dialogue to mediate the influence of stakeholders in the practice of the plan	7.1 - Techniques for reducing the capacity of the interested party contrary to the strategy of influencing the plan
	7.2 - Meeting the interests of stakeholders based on the forces involved with an impact on the strategy's practice
8 - Communication of the plan through the daily participation of the team in the practice of the plan since its elaboration	8.1 - Maintenance of the team that prepares and practices the strategy, in order to facilitate management
	8.2 - Change of team hinders management
	8.3 - Communication of the plan aiming to adapt the goals of the areas to the macro goals of the government plan
	8.4 - Relay over time (between those who make the strategy and those who practice the strategy) as a facilitator of the fulfillment of the plan

Source: Own elaboration.

As can be seen in Table 1, the categories were grouped separately in each of the three blocks that guided the structuring of the interview script - Strategy as Practice and Situational Strategic Planning; Transformational Leadership and Situational Strategic Planning and Stakeholder Theory and Situational Strategic Planning.

8.1. Proposed Framework

From the results obtained in the data analysis, a frame of reference is proposed with the mapping of the relations subdivided into categories and blocks. These relationships dialogued directly with the four approaches present in the sections that cover the theoretical foundation, emerging in the analysis process, according to the pairing of Trochim (1989). The mapping of this relation enabled the framework to serve as an instrument capable of assisting the top management of a public organization, in the practice and execution of the formulated strategy, to continuously enable the achievement of its mission, the needs of the interested parties and the dynamics of the internal and external environment, mobilizing your team for this purpose. The framework was developed based on the result of grouping the categories within the data blocks, which, in the other hands were structured in the questionnaires and had their categories and subcategories grouped and analyzed. The relationship detected between these categories and subcategories, extracted from the analysis process, forms the frame of reference (Figure 2) that makes up the framework.

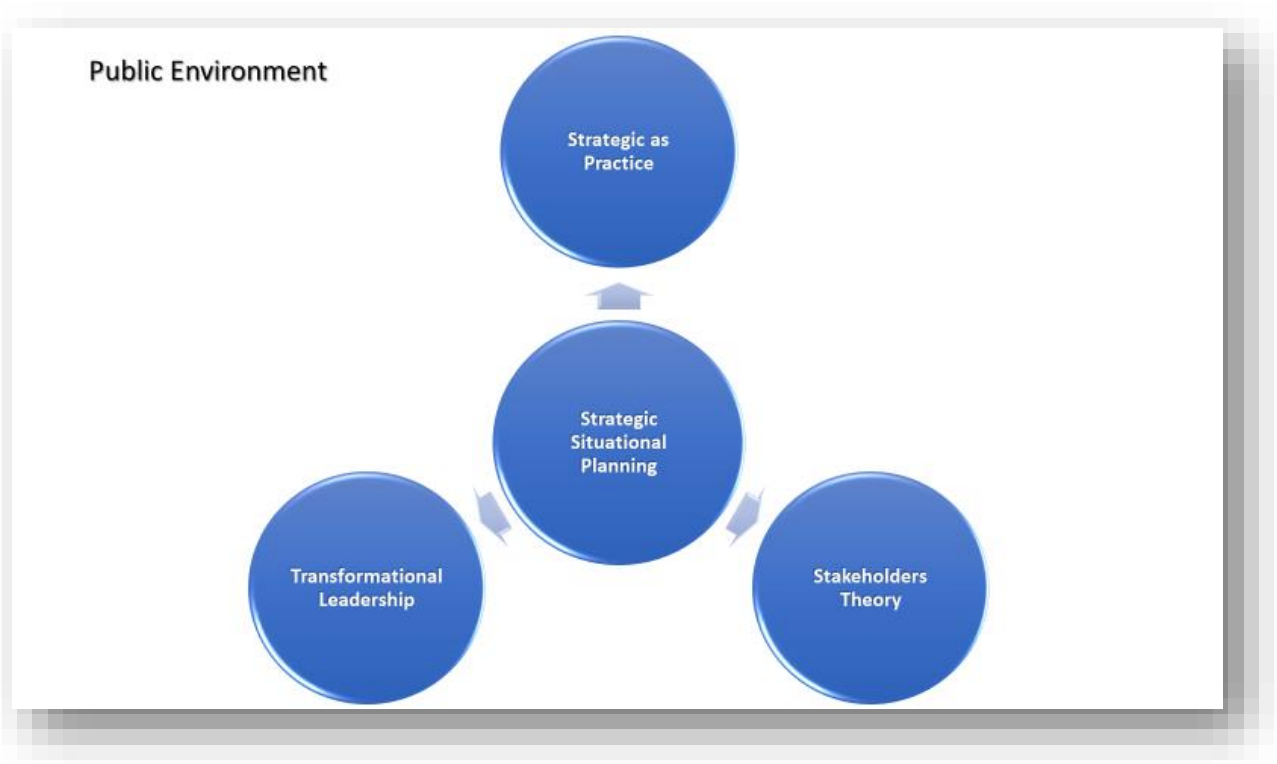

Figura 1 – Framework's proposal.
Source: Own Elaboration.

The relationships between the subcategories, the categories and their blocks expressed a common point between the four approaches of this research: the centrality of Situational Strategic Planning (PES) by Carlos Matus (1991, 1997, 2005) in complementing the role of the other three - Whittington's Social Practice Strategy (1997, 2002, 2004, 2006), Freeman's Stakeholder Theory (2010) and Burns' Transformational Leadership concepts (1978, 2003) - in the practice of strategy within the public organizational environment , as shown in Figure 2 and detailed in Figures 3, 8, 11, 16 and 20. These five figures - which show the relation between the categories - had, in turn, the mapping of the relation between their respective subcategories, demonstrated in Figures 4, 5, 6 and 7 for the relation between the categories

in Figure 3; in Figures 9 and 10 for the relation between the categories in Figure 8; in Figures 12, 13, 14 and 15 for the relation between the categories in Figure 11; in Figures 17, 18 and 19 for the relation between the categories in Figure 16; and, finally, in Figures 21 and 22 for the relation between the categories in Figure 20.

To demonstrate the macro relation between blocks of categories "A", "B" and "C", figures 3, 8, 11, 16 and 20 were completed with tables containing excerpts from the field interviews, without identifying the nine interviewed public figures, but with an identifier to facilitate the comparison and crossing of contents (E01, E02, E03, E04, E05, E06, E07, E08 and E09), to present the cause and effect relation contained in the interview , for the development of data analysis, being properly mapped in the framework.

8.2. Framework Structuring

In the proposed framework, a set of relation is presented between the subcategories, present in the same block or in different blocks, which generate positive impacts, which must be explored and intensified, or negative, which must, in turn, be avoided or mitigated, both in strategy and in practice.

In Figure 2, the relationships between categories of distinct blocks at the macro level are specified, since the scope of this figure is restricted, in a synthetic way and without the respective internal details related to the relationships between categories within the same blocks, as shown in the Figures 3 to 21.

Therefore, all the presented relations were based on the data analysis carried out in this research.

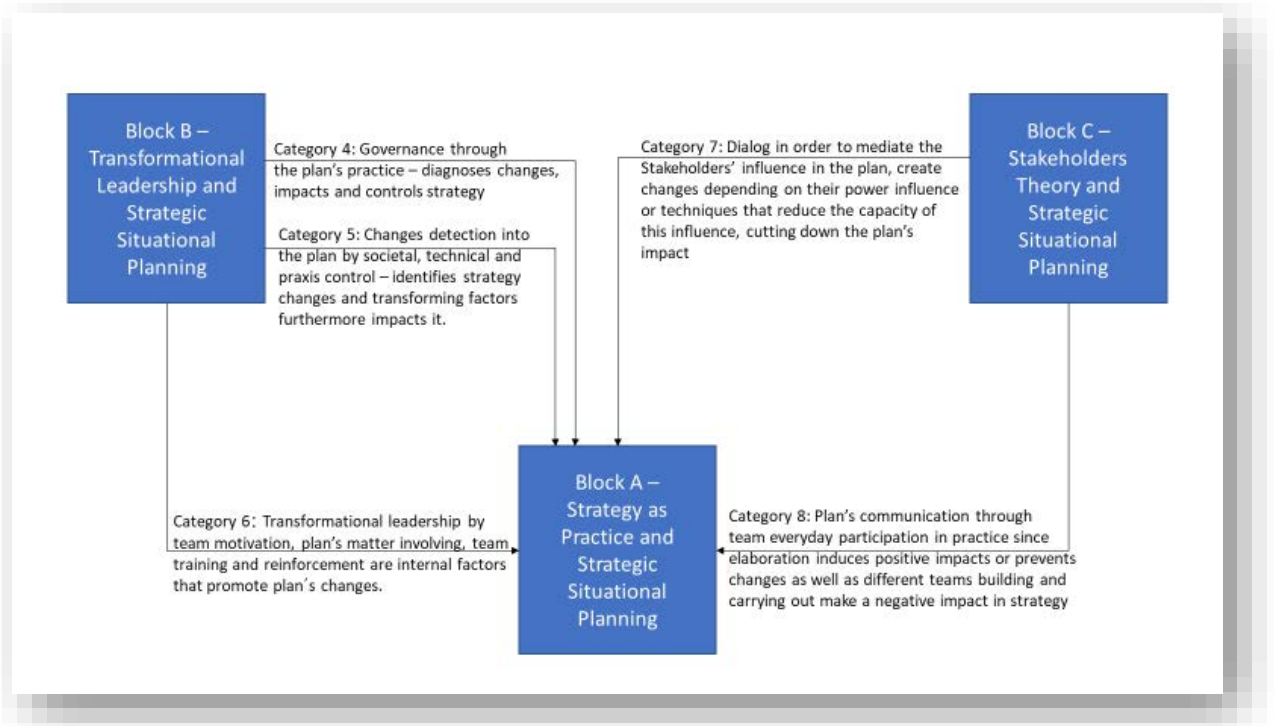

Figure 2 - Blocks Relation Framework Macro View.
Source: Own Elaboration.

The list of categories between the blocks is shown in Figures 3, 8, 11, 16 and 20, which detail the reference table in Figure 2.

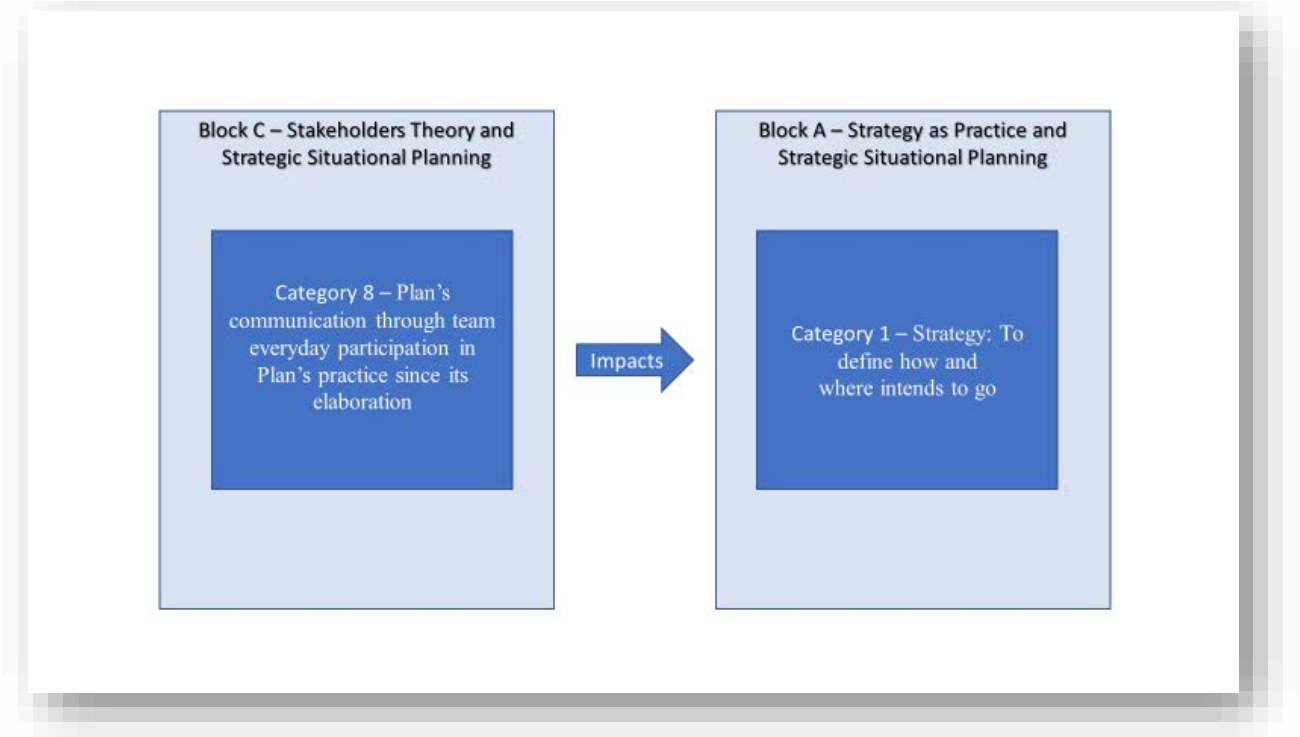

Figure 3 - Relation between categories 8 and 1 from blocks "C" and "A".
Source: Own Elaboration.

The cause and effect relations between blocks "C" and "A" are first presented in a synthetic way in Figure 3, and category 8 - "Communication of the plan through the team's daily participation in the plan's practice since its inception" preparation "has an impact on category 1 - "Strategy: to define how and where one wants to go". Table 2 shows some excerpts from interviews that demonstrate these cause and effect relations, according to the three subcategories of category 8 (Figures 4, 5, 6 and 7).

Table 2 - Summary of the analysis category Communication of the plan by the daily participation of the team in the practice of the plan since its elaboration

Category	Subcategory	Category label or details	Excerpts from the interviews
Communication of the plan by the daily participation of the team in the practice of the plan since its	8.1 - Same team for the elaboration and practice of the strategy, as a measure that favors management When the same team that	When the same team that practices the strategy draws up the plan, it is easier to achieve the goals and objectives set out in the strategy	*"This is the secret we did it differently. The team he created was the team that built the execution. That is the secret, I think, of management. It is not those who think and those who do. They are the ones who think and do at the same time. This is the secret to working. In my opinion, in my management experience, it only works when those who prepare it coordinate the execution" (E03).*

	practices the strategy elaborates the plan, it becomes easier the achievement of the goals and objectives foreseen in the strategy.		*"Ah, it makes everything easier. It makes everything easier (being the same team that builds the plan and practices it)" (E09).*
	8.2 - When the team that elaborates is different from the team that practices strategy harms the management	The fact that the team that builds the strategy is different and the team that practices it harms the management, the communication of the strategy and the achievement of the plan's goals	*"No, it is that, if this methodology is successful, separating the planner from the investor, it is compromised, in my opinion. This separation between formulation and execution is a further feature of the industry's functionality, where it governs a bureaucratic and normative hierarchy that submits executors to planners. In the specific case of public authorities, this separation cannot exist" (E07).*
	8.3 - Communication of the plan aiming to adapt the goals of the areas to the macro goals of the government plan	The use of strategy communication facilitates the accomplishment of the plan's objectives - it is an instrument to adjust the goals of the areas subordinate to the manager to the macro or main goal of the organizational plan.	*"This was done through a process, let's say, a collective process, where the government first made one, the government first, made an inquiry about the secretaries, saying, asking them what their priorities were and reporting this priority government program. As the secretaries responded, the government coordination, and particularly the governor there, played a decisive role, telling them, among their priorities, what the government's priorities were. And they informed the secretaries and their staff, and their technical teams, advisors, that if these government priorities were not met, the others would not even be received by the government. That was how this technical and political negotiation took place. I will give a concrete example. Our Labor Secretary was not a PT secretary. And in that questioning that we asked him, he*

			presented the series of projects through which he would develop the government's program. It was a PTB board. He presented and was told that the government's priority was not included in the information he gave. What was the government's priority? He was then formally told: here in Rio Grande do Sul is to make the largest state microcredit program in Brazil. And that if he did not do this program, no other item that he had pointed out would be taken into account by the government. And so he did and we did the biggest microcredit program in the country's history there in Rio Grande do Sul" (E07).

Source: Own Elaboration.

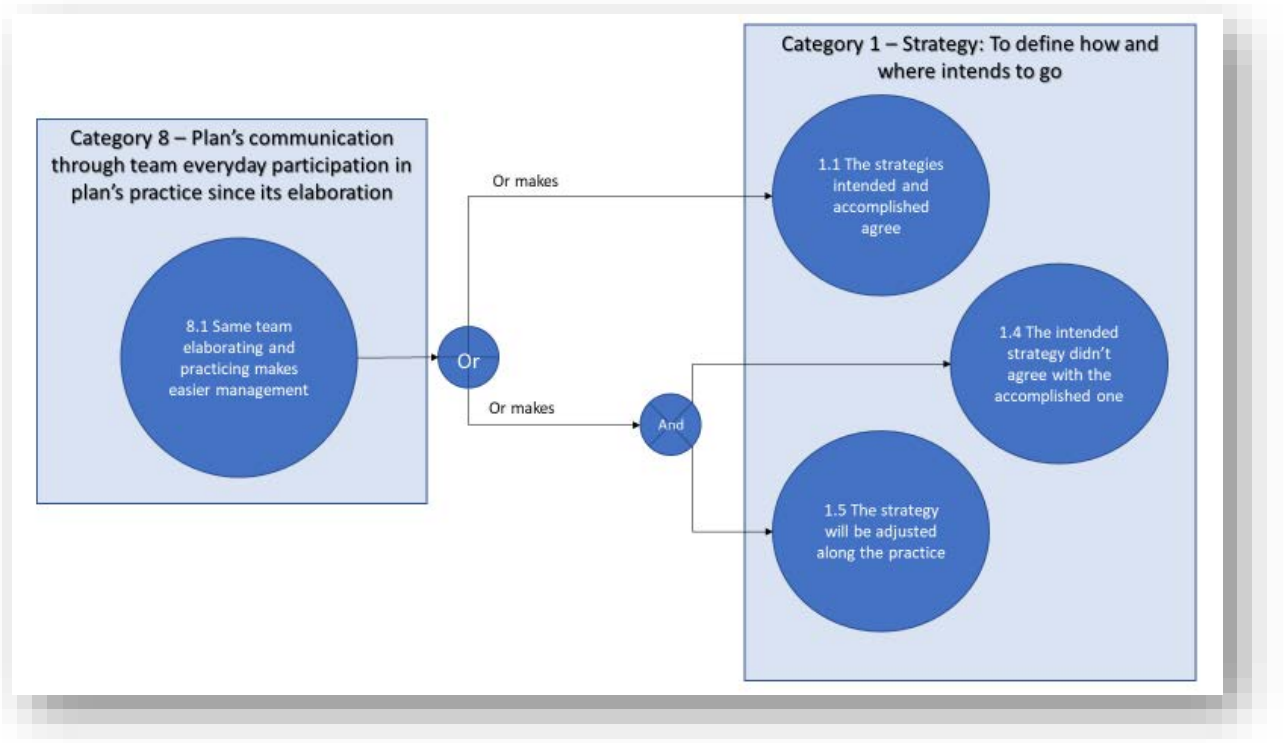

Figure 4 – Cause and Effect Relation between subcategory 8.1 and subcategories 1.4, 1.5 and 1.1.
Source: Own Elaboration.

Figure 4 shows the cause and effect relation of subcategory 8.1 - "The same team developing and practicing the strategy facilitates management" in subcategory 1.1 - "The intended and accomplished strategies agree", or, in a different situation, in the subcategories 1.4 - "The strategy carried out did not agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". In both scenarios, the impact on the plan will always be positive, regardless of modifying it or not, as it allows the strategy to be maintained

according to the work of the practitioners or, if it needs modification, in order to improve the practice and the strategy itself, since practitioners adapt the strategy better and more quickly, according to the identified reality (therefore, the same team builds and practices).

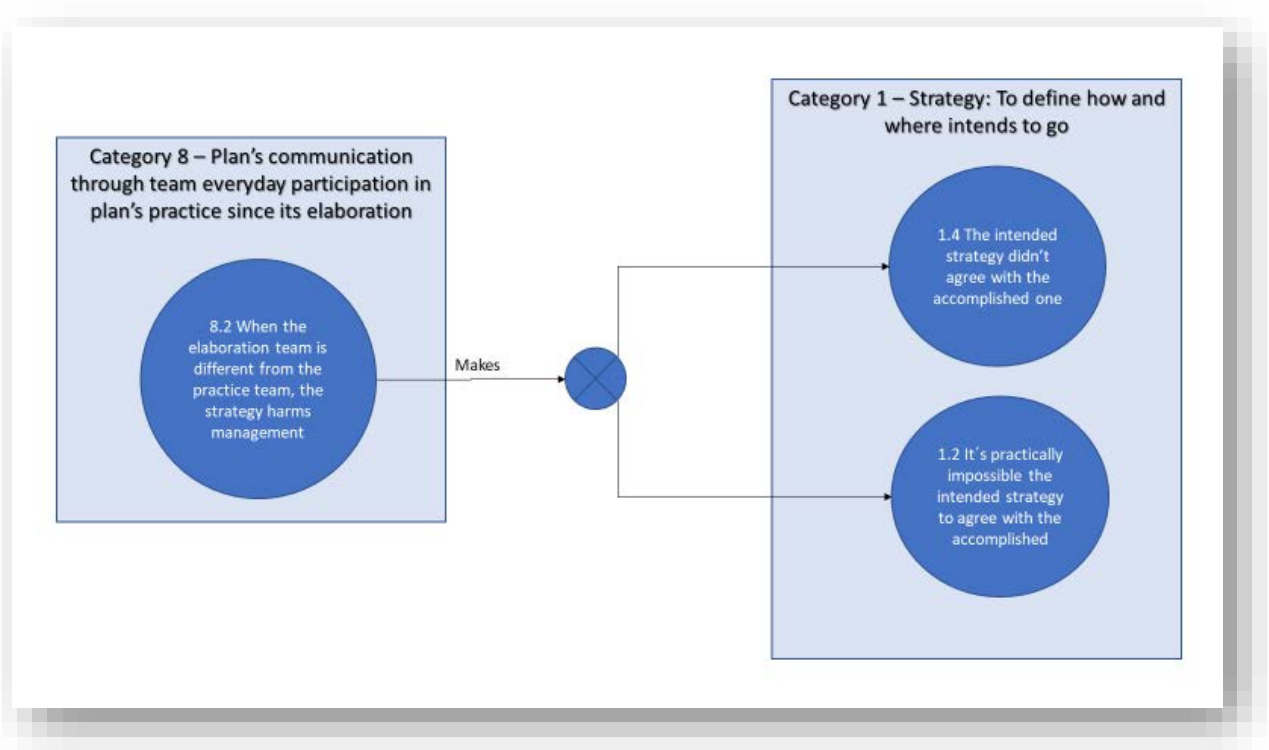

Figure 5 - Cause and Effect Relation between subcategory 8.2 and subcategories 1.4 and 1.2.
Source: Own Elaboration.

Figure 5 shows a cause and effect relationship that has a negative impact on the plan, which needs to be mitigated or even avoided, with the subcategory 8.2 - "When the team that elaborates is different from the team that practices strategy, it harms management", Impacting subcategories 1.4 - "The strategy carried out didn't agree with the intended one" and 1.2 - " It is practically impossible for the intended strategy to agree with the one carried out ". This impact negatively interferes with the strategy and its practice. In this sense, according to the analysis data, the strategy carried out will be impaired, with regard to organizational objectives.

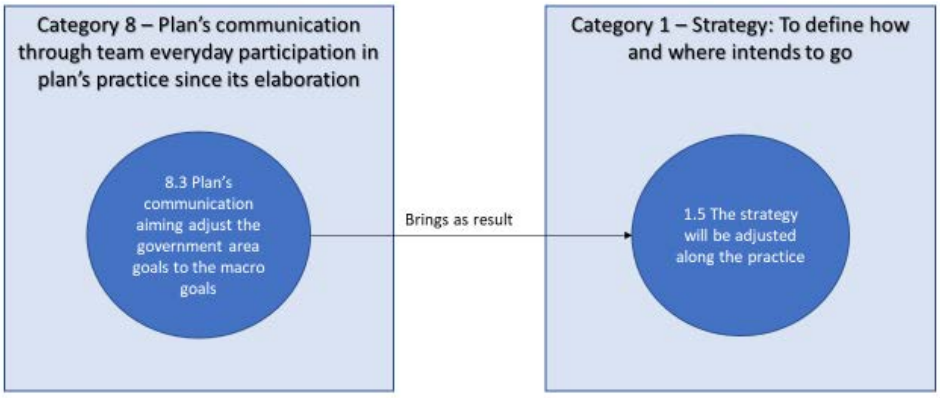

Figure 6 - Cause and Effect Relation between subcategory 8.3 and subcategory 1.5.
Source: Own Elaboration.

Figure 6 shows the sub-category 8.3 - "Communication of the plan aiming to adapt the goals of the areas to the macro goals of the government plan" with a cause and effect relation to category 1.5 - "The strategy will be adjusted over the course of the practice". This relation is able to positively influence the strategy, modifying it to adapt the plan of the smaller areas to the organizational objectives of the institution.

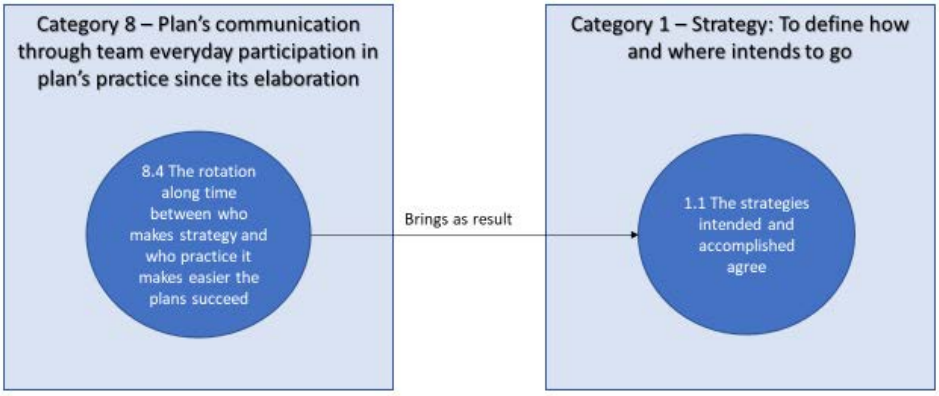

Figure 7 - Cause and Effect Relation between subcategory 8.4 and subcategory 1.1.
Source: Own Elaboration.

Figure 7 shows the subcategory 8.4 - "The rotation over time between those who make the strategy and those who practice the strategy facilitates the accomplishment of the plan" with a cause and effect relation with category 1.1 - "The intended strategy and realized agree". This relation has a positive impact on the plan and its practice, which should be encouraged in the culture and practice of organizational strategy.

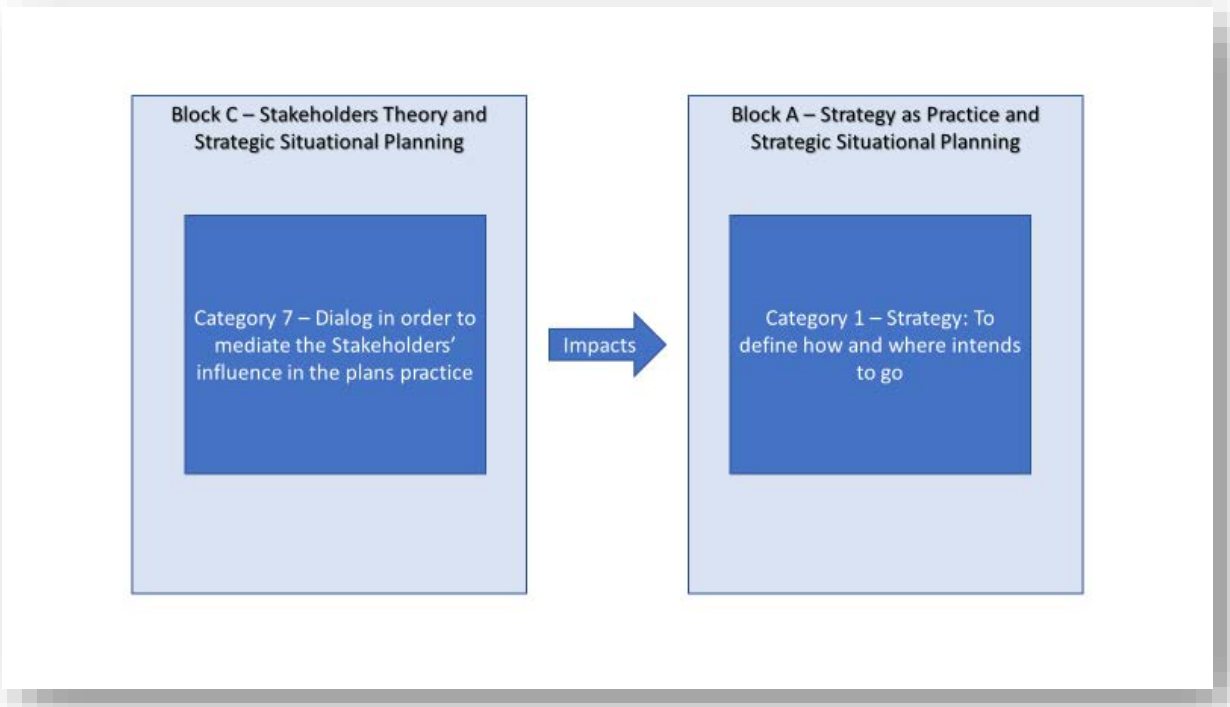

Figure 8 - Relation between the category 7 and 1 from the Blocks "C" and "A".
Source: Own Elaboration.

The cause and effect relation between blocks "C" and "A" are also presented in a synthetic way in Figure 8, in which category 7 - "Dialogue to mediate the influence of stakeholders in the plan's practice" has cause and effect with category 1 - "Strategy: to define where you want to go and how to get there". These relations have a positive and negative impact on the strategy plan and practice, depending on the scenario in which the manager and the stakeholders in question are involved, as noted in the details of the relation between the categories and subcategories of these two blocks (Figures 9 and 10).

Table 3 presents some excerpts from interviews that demonstrate these cause and effect relationships that start from the two subcategories of category 7 (Figures 9 and 10).

Table 3 - Summary of the analysis of the Dialogue category to mediate the influence of stakeholders in the plan's practice

Category	Subcategory	Category label or details	Excerpts from the Interviews
7 - Dialogue to mediate the influence of stakeholders in the practice of the plan	**7.1** - Techniques for reducing the capacity of the interested party contrary to the strategy to influence the plan	The use of techniques capable of neutralizing a possible negative influence of stakeholders on the plan, such as the strengthening of societal support, are quite effective and used by some leaders when dialogue and reconciliation are not possible	*"And often you can no longer mediate, you have to recognize a conflict that is not resolvable. And you, in this case, have to try to overcome this difficulty, let's say, removing this opponent from decreasing his ability to oppose" (E05).* *"In public administration you have a problem, you are looking for a solution to the problem. The solution is not always a financial resource. But the population understands, when you are together, when you are accountable, when you say what is happening, when you do as we did the participatory budget, you gain the population (and this helps to neutralize the influence of groups outside the plan)" (E08).*
	7.2 - Attending to the interests of stakeholders is based on the forces involved and impacts on the practice of the strategy	The correlation of forces between the parties involved, in the case of conflicts and divergence of opinions, determines who influences the practice of the plan and may even change the strategy	*"Because I took four houses from humbler people, who were compensated, paid, etc. But I had no way out, right? I can't touch the Church, I can't touch the CIEP and I can't touch the court. So it is, sometimes the solution of mediation also depends on the forces at stake" (E01).* *"The first step is to imagine that people are different and that conflicts obviously exist in instances. If you definitely couldn't or can't find a common denominator that can accommodate people within ... pacifying interests, then the solution is for you to break away from one side or the other. Then you have to decide for the break. Make an assessment, since it doesn't get it right, so let's dispense with that side. There, go on to another one" (E04).*

Source: Own Elaboration.

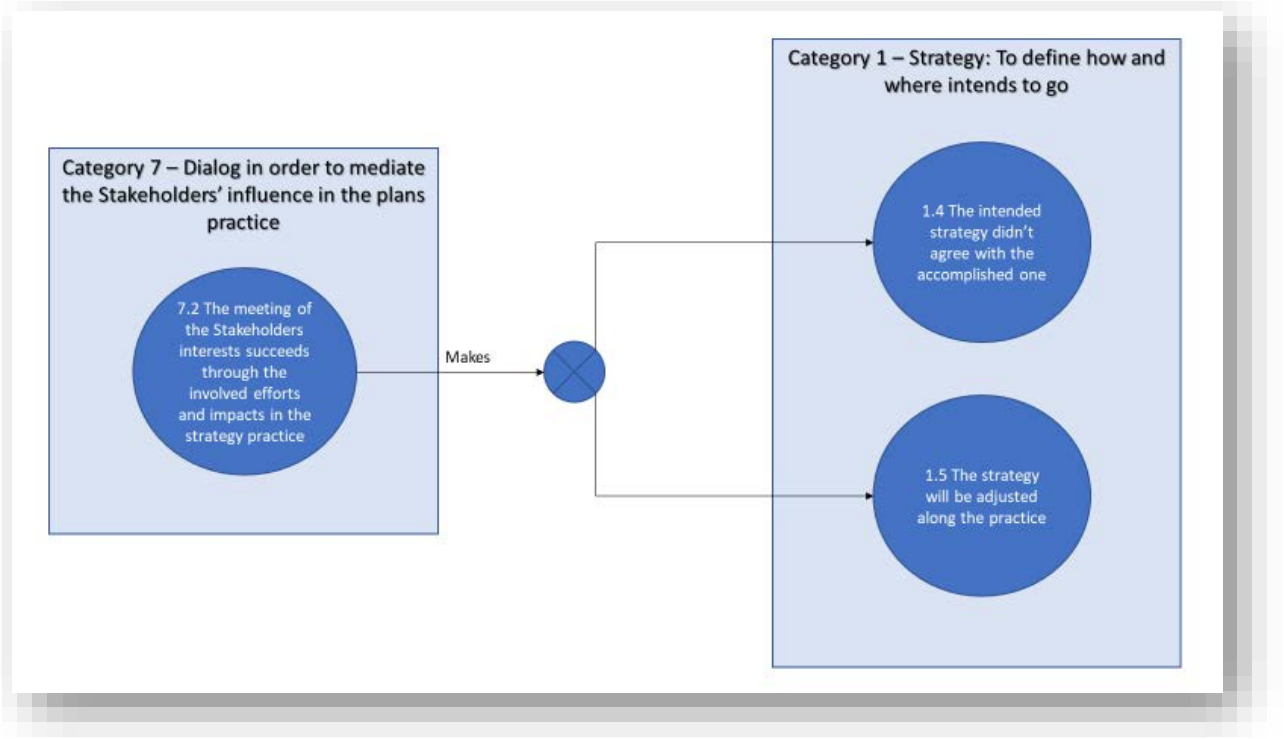

Figure 9 - Cause and Effect Relation between subcategory 7.2 and subcategories 1.4 and 1.5. Source: Own Elaboration.

In Figure 9, derived from the detail in Figure 8, the cause and effect relationship between sub-category 7.2 is presented - "The interests of stakeholders are met according to the forces involved and impact on the practice of strategy" with sub-categories 1.4 - "The strategy carried out did not coincide with the intended one" and with category 1.5 - "The strategy is being adjusted in the course of practice". This relation impacts positively and negatively, depending on how the stakeholder relates to the organization's interests.

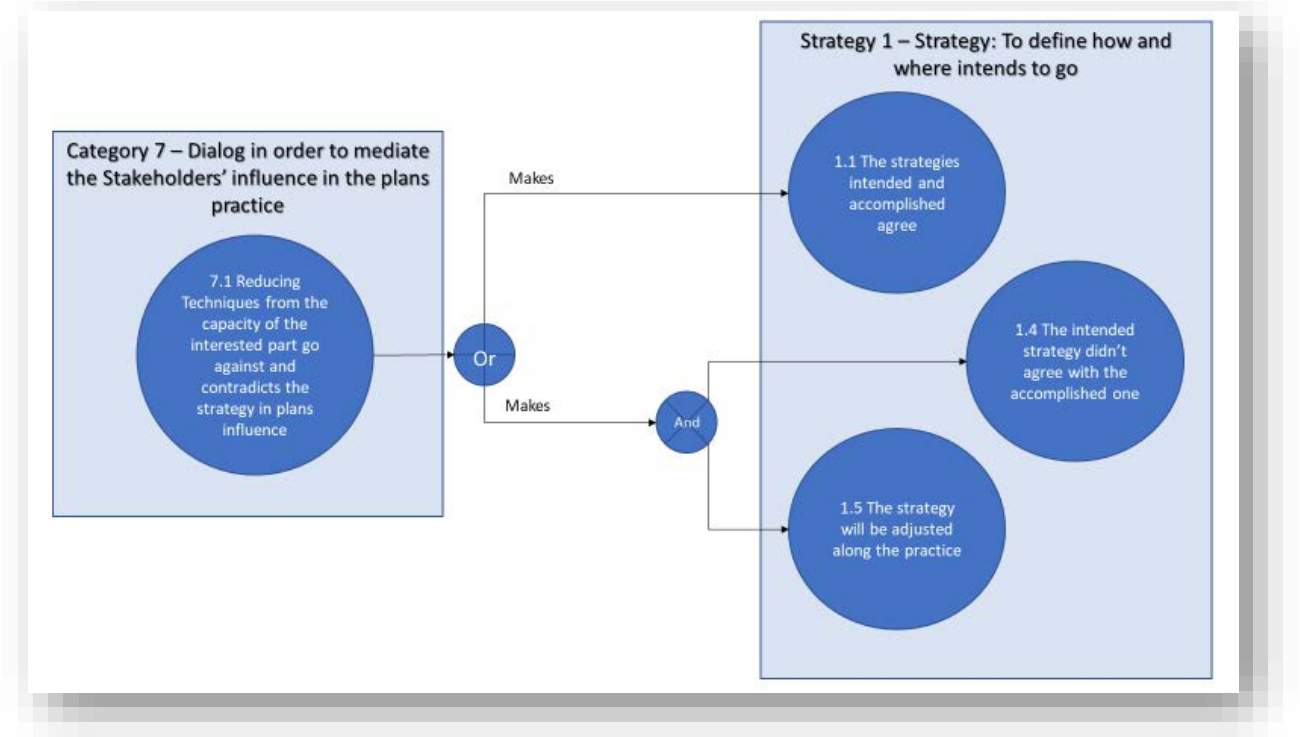

Figure 10 - Cause and Effect Relation between subcategory 7.1 and subcategories 1.4, 1.5 and 1.1. Source: Own Elaboration.

Figure 10 shows the cause and effect relation of subcategory 7.1 - "Techniques for reducing the capacity of the interested party contrary to the strategy to influence the plan" in subcategory 1.1 - "The intended and realized strategies agree", or, in different situation, in subcategories 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". In the first scenario - the relation between subcategory 7.1 and subcategory 1.1 - the impact on the plan will be positive, as it was possible to neutralize the harmful action of the stakeholder to the plan and its practice. In the second scenario - the relations of sub-category 7.1 with sub-categories 1.4 and 1.5 - the impact is negative, but it can be minimized or mitigated due to the negotiation scenario of changes in the existing plan in the cause and effect relation, according to data from the analysis.

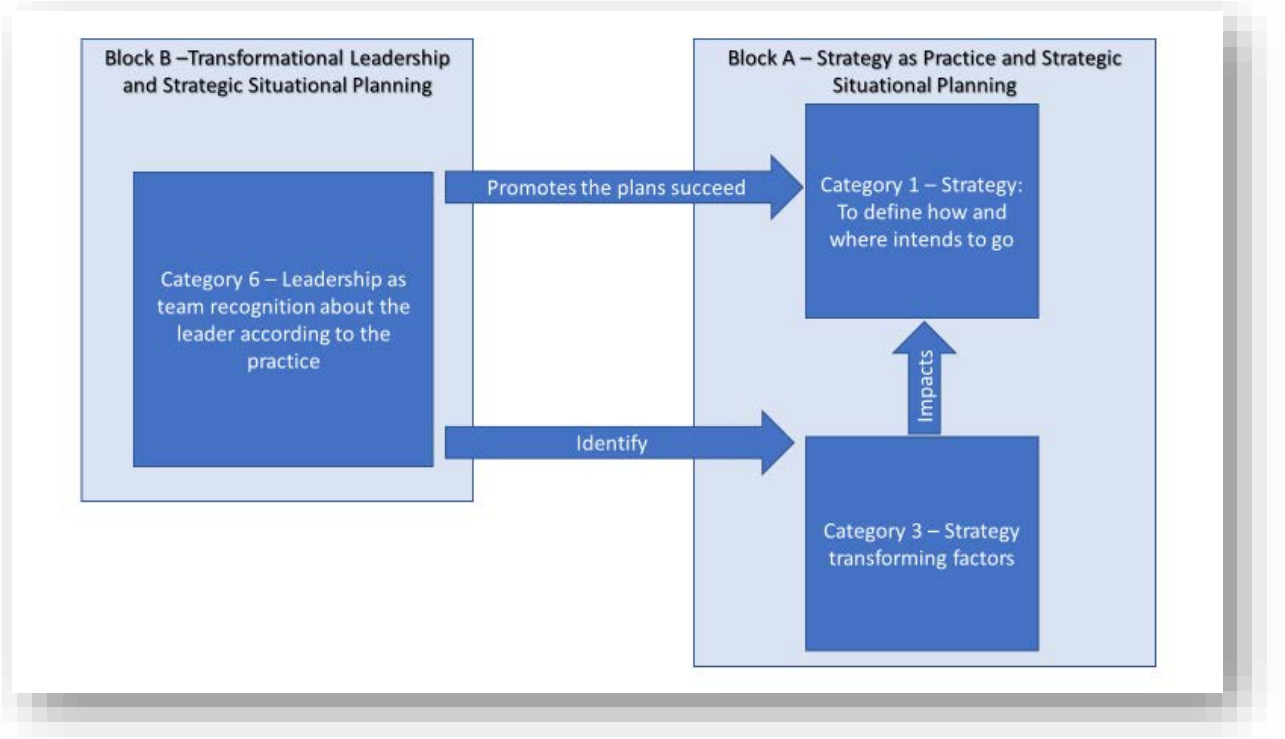

Figure 11 – Relation between the categories 6, 1 and 3 from Block "B" and "A".
Source: Own Elaboration.

The cause and effect relation between blocks "A" and "B" are represented in Figure 11, in which the relation between categories 6 - "Leadership as recognition of the team regarding the leader according to their practice" are explained, 3 - "Transforming factors of strategy" and 1 - "Strategy: to define how and where you want to reach". These relations positively impact the practice of the plan, as detailed in figures 12, 13, 14 and 15.

Table 4 shows some excerpts from interviews that demonstrate these cause-and-effect relations that start from the two subcategories of category 6 (Figures 12, 13, 14 and 15).

Table 4 - Summary of the analysis of the Leadership category as recognition of the team regarding the leader according to their practice

Category	Subcategory	Category label or details	Excerpts from the interviews
6 - Leadership as recognition of the team led about the leader in terms of their	**6.1** - Leadership that involves and motivates the team by the result of the strategy as a result of the collective work	Motivation of the team as a consequence of their involvement and commitment in the final result of the strategy practice. Making the team feel like they own the strategy	*"Even for you to have the authority to draw the attention of those who are not so committed to the project. And you can say, "look, I'm here in passing, but you have three years", as we say. So, what we want you to endorse, is good for the institution, good for society. So this project is also important for you because I will pass*

			and you will stay longer than I do" (E01).
	6.2 - Motivation of the team for being involved with the importance of the strategy and its realization	The importance of the strategy for the organization or for society being used as an element of involvement and motivation of the practitioners of the strategy	*"I remember that we held a seminar on strategic planning, and we start with the theoretical debate. The concepts of culture, the texts of the academy, the reality of the cultural history of other countries. The classic texts on culture, socialist realism, what capitalism was. We went in, we went deep. For people to understand the role they were going to play. So there are times when you have to have a debate, win people theoretically, conceptually. [...] So the motivation comes from people being convinced of their role as a public agent, a transforming agent. And what is that for, right? If that is good, if that is bad. What is the practical effect on the person's life? So I think the main motivation is for you to give conceptual, theoretical and political gain to that action" (E03).* *"And then what motivates a lot is to see that the reality in practice happened." (E03)* *"Look, to be honest with you, the people outside were already motivated, right, just because of the commitment to the project, with the Brizolista thing. Because we didn't have it there, we weren't technicians. At no time, my friend, was technical management; it was political management. We were there, in short, with Brizola, therefore, in that work that intended to be the way for*

			Brazilian socialism. That's what we were in for. So the outside people were super motivated" (E09).
	6.3 - Capacity of the team strengthened by substituting better qualified subjects to practice the strategy	The substitution of practitioners of the strategy by better qualified subjects as an element of motivation and involvement of the team to achieve the goals of the plan	*"And of course we knew that we had weaknesses in the team, there were project managers who were not good, we had to change people, there were several nodes on the way" (E02)* *"And of course we knew that we had weaknesses in the team (which prevented the team's motivation and involvement in fulfilling the plan), there were project managers who were not good, we had to change people, there were several nodes on the way" (E02)*
	6.4 - Extra remuneration and events for result as a motivator to achieve the objective of strategic planning	The use of extra remuneration and events for results achieved are instruments that mobilize and involve practitioners of the strategy to better fulfill the goals and objectives contained in the plan	*"Look, I think it is interesting for you to pay compensation for results (to involve and motivate the team to in order to achieve the goals and objectives of the plan)" (E02).* *"The private sector can, in your plan's goals, establish corporate gains that add value to people's incentives. In the public sector you already have some experiences there, you already have some experiences being carried out, but it is a slower process. I would say that this is the point, Robson, this is the point that is the great challenge in any governance planning, whether it is public or private, it is the involvement of people" (E06).*

Source: Own elaboration.

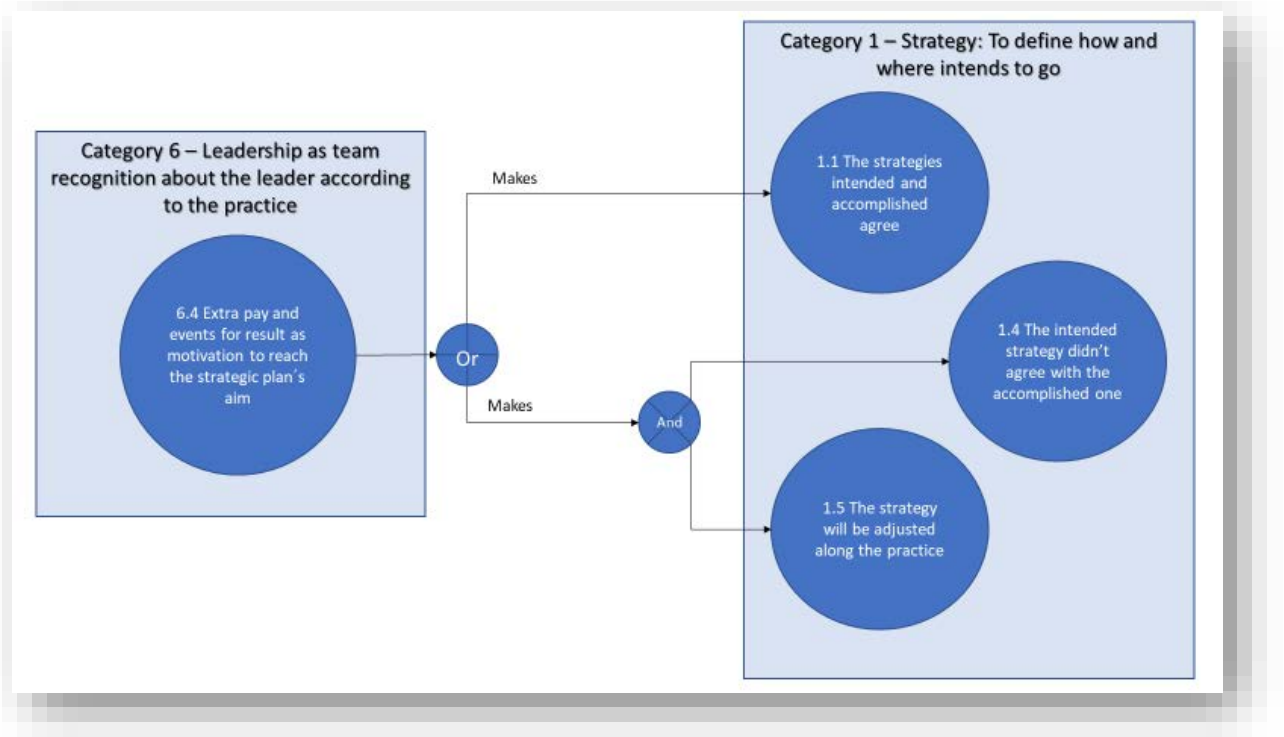

Figure 12 - Cause and Effect Relation between subcategory 6.4 and subcategories 1.1, 1.4 and 1.5. Source: Own Elaboration.

Figure 12 shows the cause and effect relation between subcategories 6.4 - "Extra remuneration and events for result as a motivator to achieve the objective of the strategic plan" with subcategory 1.1 - "The intended and accomplished strategy agree" or with subcategories 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted in the course of practice". The impacts arising from the relation between these subcategories are positive, even when there is no change in the plan due to the success of the action provided for in category 6.4, or when there is a need for changes in the plan due to the action of category 6.4, as this change may improve the strategy and its practice.

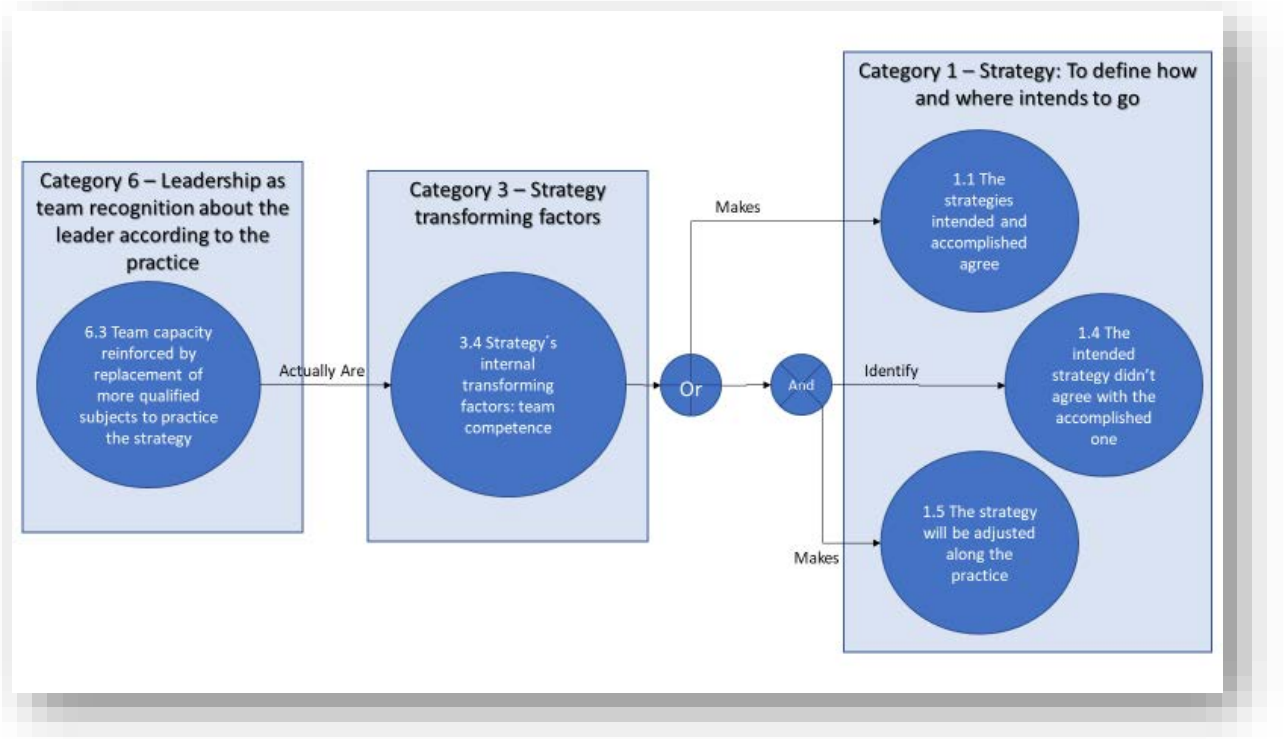

Figure 13 - Relation between the subcategory 6.3 and the subcategories 3.4,1.1, 1.4 and 1.5
Source: Own Elaboration.

Figure 13 shows the cause and effect relation between subcategories 6.3 - "Capacity of the team reinforced with substitution of better qualified subjects to practice the strategy" with subcategory 3.4 - "Internal factors transforming the strategy: team competence" and with the subcategories 1.1 - "The intended and realized strategies agree" or 1.4 - "The accomplished strategy did not agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". The impacts generated in the plan and in practice are positive, being able to generate maintenance of the strategy or even improvement of it as a result of the action foreseen in subcategory 6.3, as shown in the analysis data.

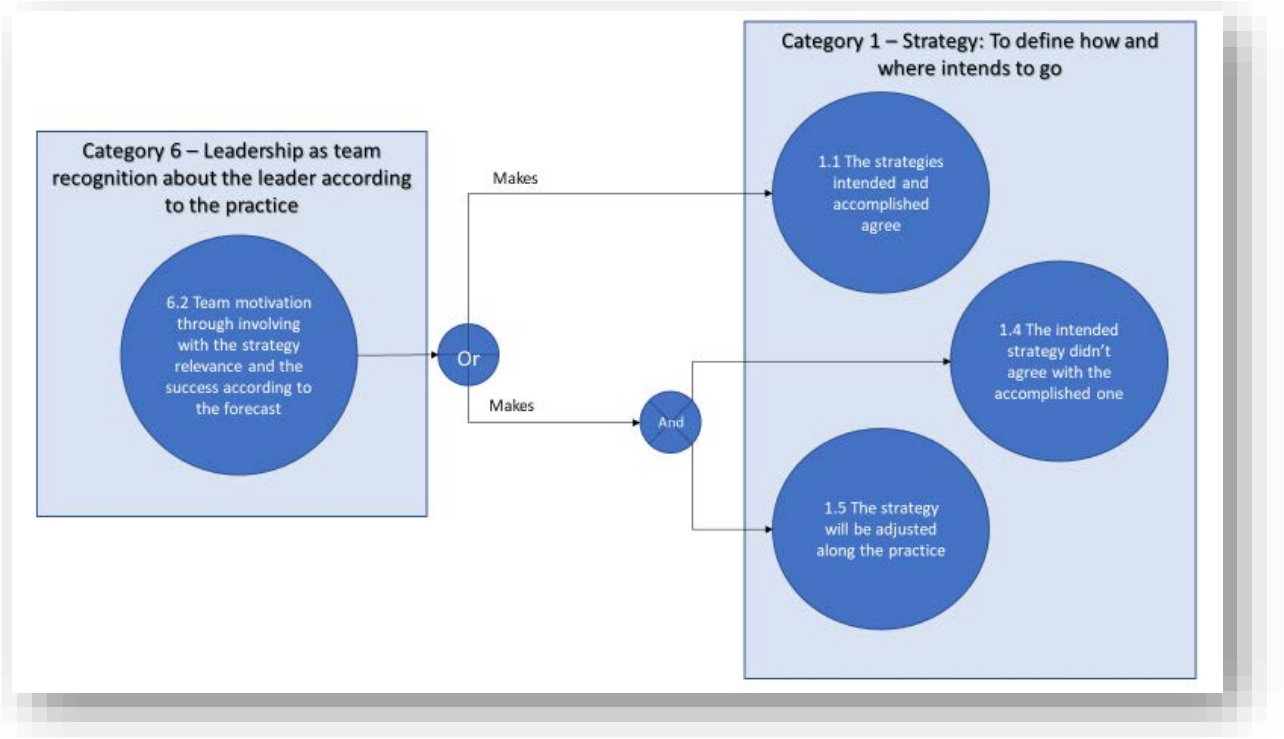

Figure 14 – Relation between the subcategory 6.2 and the subcategories 1.1, 1.4 and 1.5.
Source: Own Elaboration.

Figure 14 shows the cause and effect relation between subcategories 6.2 - "Motivation of the team for involvement with the importance of the strategy and its realization as planned" with subcategories 1.1 - "The intended and accomplished strategies agree", 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". The impacts generated in the plan and in practice are positive, and may generate maintenance of the strategy or even improvement of it as a result of the action provided for in subcategory 6.2, as shown in the data analysis.

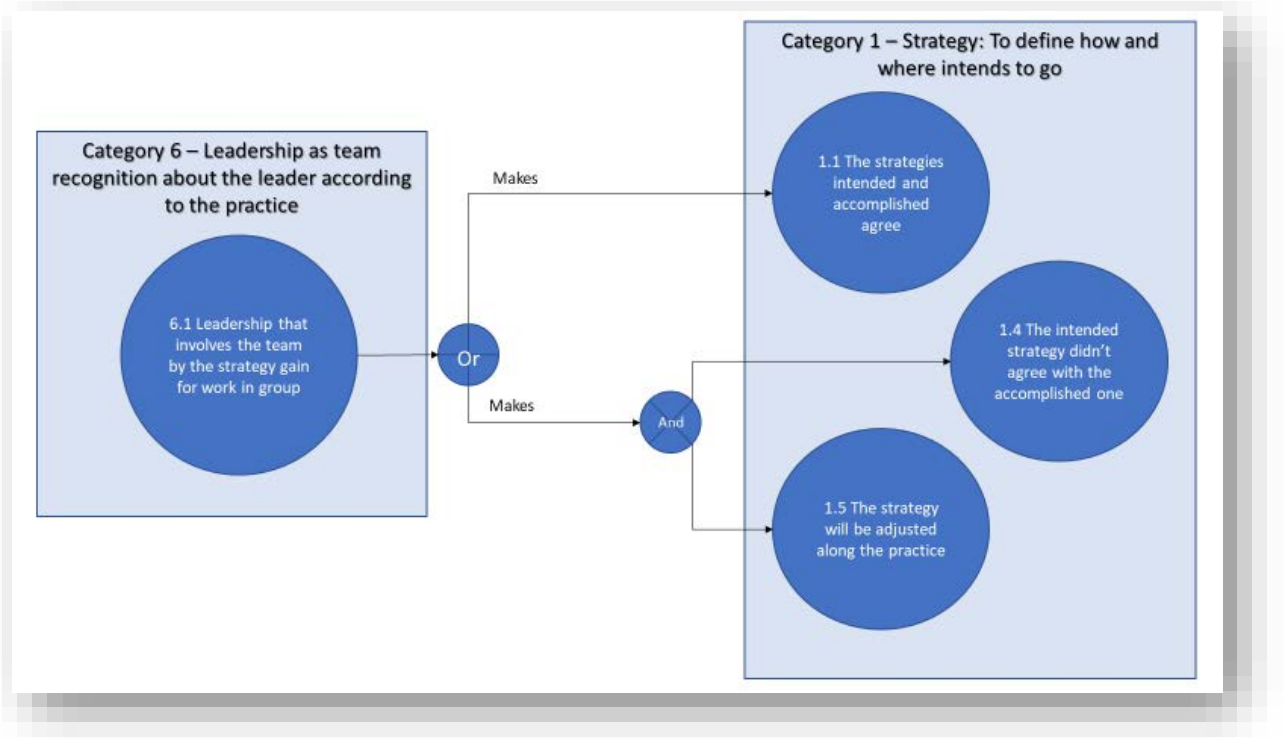

Figure 15 - Relation between the subcategory 6.1 and the subcategories 1.1, 1.4 and 1.5.
Source: Own Elaboration.

Figure 15 shows the cause and effect relation between subcategories 6.1 - "Leadership that involves and motivates the team for the result of the strategy as a result of collective work" with subcategories 1.1 - "The intended and accomplished strategies agree", 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". The impacts generated in the plan and in practice in this relation are positive, and may generate maintenance of the strategy or even improvement of it as a result of the action provided for in subcategory 6.1.

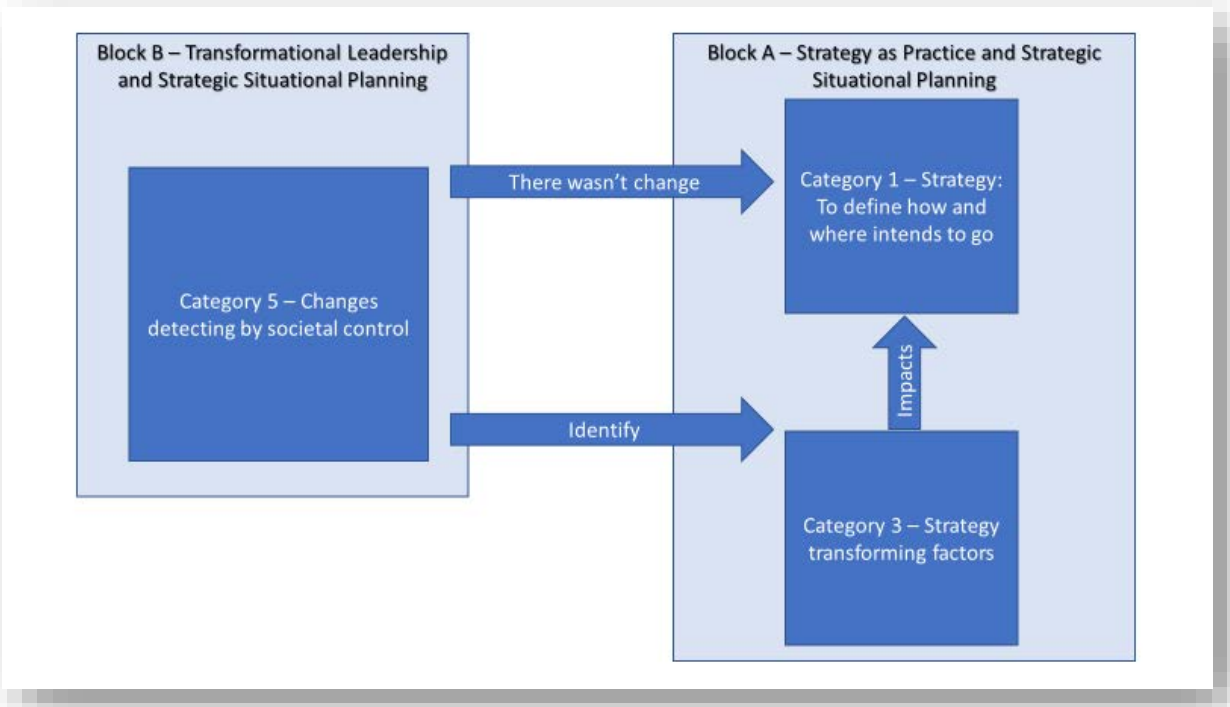

Figure 16 - Relation between the subcategories 5, 3 and 1 from Blocks "B" and "A".
Source: Own Elaboration.

In Figure 16, another set of cause and effect relations is presented between blocks "A" and "B", this time between categories 5 - "Change detection by societal control", 3 - "Transforming factors of strategy" And 1 - "Strategy: to define how and where you want to go". These relation impact both positively and negatively the practice of the plan, as detailed in Figures 17, 18 and 19.
Table 5 shows some excerpts from interviews that demonstrate these cause and effect relations that start from the two subcategories of category 6 (Figures 17, 18 and 19).

Table 5 - Summary of the analysis of the category detection of changes by societal control

Category	Subcategory	Label or details	Excerpts from the interviews
5 - Detection of changes by societal control	**5.1** - Detection of change in the daily monitoring of strategy practice by the manager	Detection of changes in external and internal scenarios that impact the plan through the monitoring of the team's strategy by the manager	*"In the follow-up (the change of scenery is detected) is what I tell you: it was daily, like this, each one and with the team" E03).*
	5.2 - Detection of the change in the plan through periodic meetings with the team: check-list	Detection of the change of scenario, both internally and externally, through periodic meetings with practitioners of the strategy to validate	*"Through of the meetings that we did biweekly. In education, we held biweekly meetings with the entire team. And then it was like a checklist. You made an assessment*

		what was accomplished or not in the plain	*with the team of what was being accomplished, achieved" (E06).*
	5.3 - Detection of change by technical indicators measured periodically in the management process	The use of technical management indicators is an effective tool to identify changes in scenarios	*"Through concrete, concrete indicators from the management office. We institute indicators for each project, indicators related to the disbursement of resources, indicators related to the effects of these disbursements on the project's operation" (E07).*

Source: Own Elaboration.

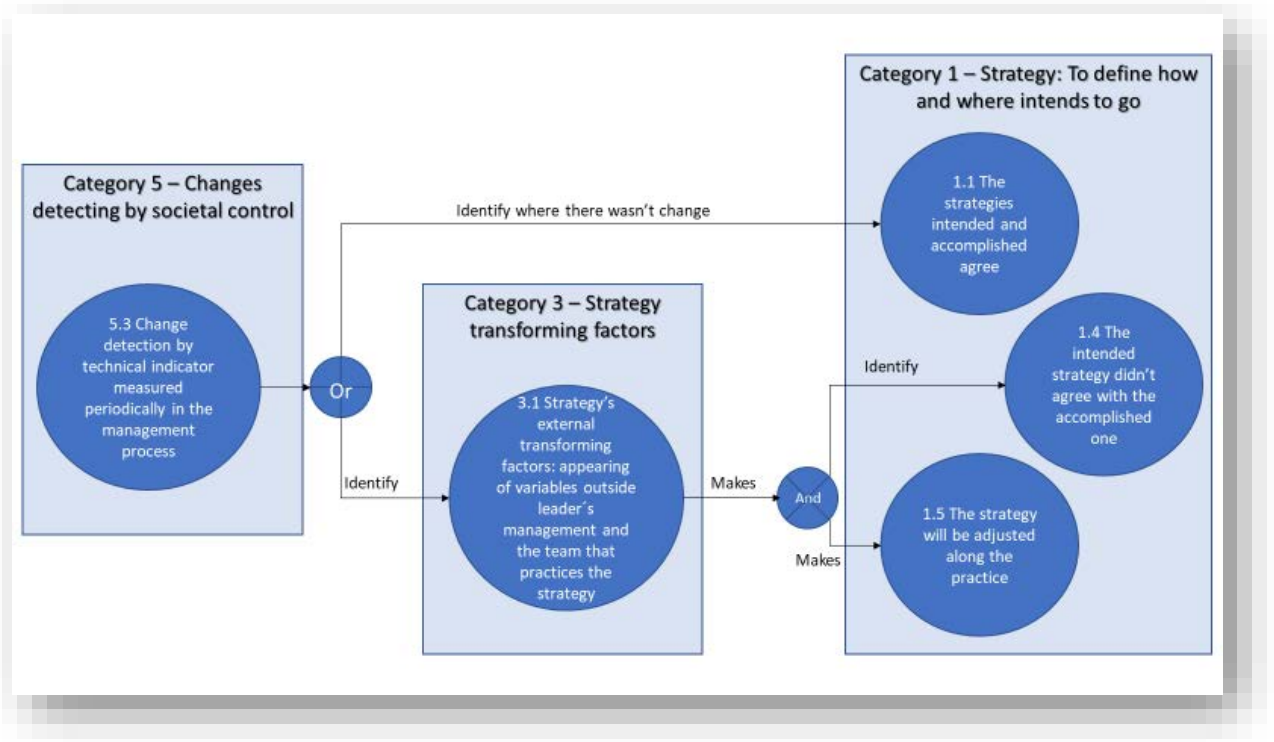

Figure 17 - Relation between the subcategory 5.3 and the subcategories 3.1, 1.1, 1.4 and 1.5.
Source: Own Elaboration.

Figure 17 shows the cause and effect relation between subcategories 5.3 - "Detection of change by technical indicators measured periodically in the management process" and 1.1 - "The intended and accomplished strategies agree"; or with subcategories 3.1 - "External factors transforming the strategy: emergence of variables outside the management of the manager and the team that practices the strategy", 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". The impacts generated in the strategy plan or practice can be both positive - when the indicators present good metrics and there is no need for changes - and negative - when the metrics indicate problems that require changes in the strategy plan and practice.

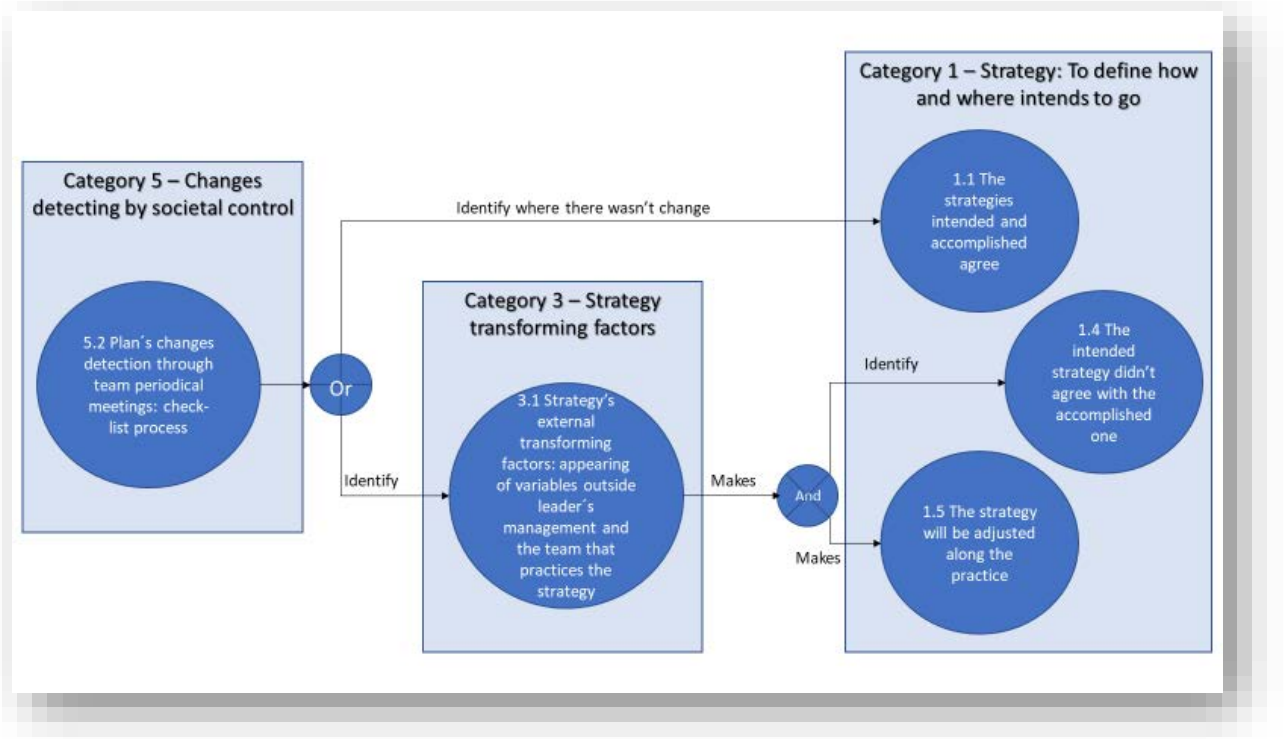

Figure 18 - Relation between the subcategory 5.2 and the subcategories 3.1, 1.1, 1.4 and 1.5. Source: Own Elaboration.

Figure 18 shows the cause and effect relation between subcategories 5.2 - "Detection of plan change through periodic meetings with the team: check-list" with subcategory 1.1 - "The intended and accomplished strategies agree"; or with subcategories 3.1 - "External factors transforming the strategy: emergence of variables outside the management of the manager and the team that practices the strategy", 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses ". The impacts generated in the strategy plan or practice can be both positive - when the check-list meetings show good results and there is no need for changes - and negative - when the check-list meetings indicate problems due to non-target goals achieved and that require changes in the strategy plan and practice, as demonstrated in the analysis data.

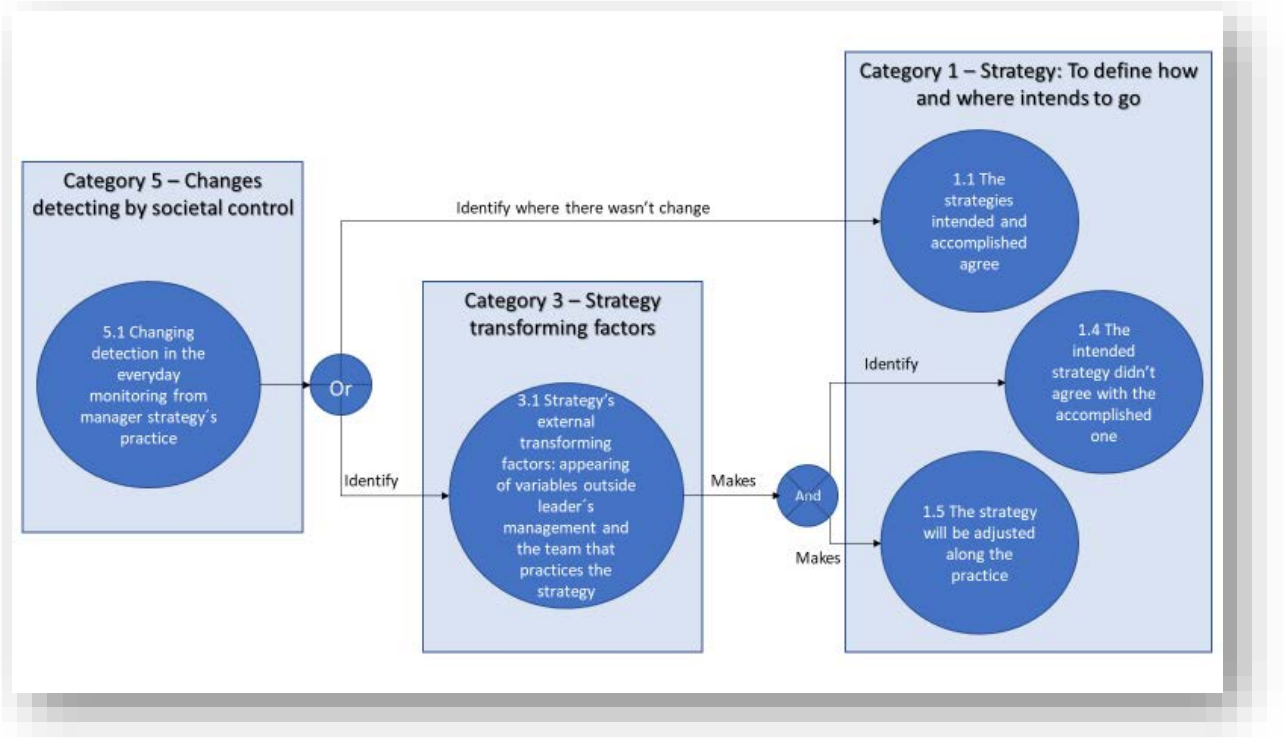

Figure 19 - Relation between the subcategory 5.1 and the subcategories 3.1, 1.1, 1.4 and 1.5. Source: Own Elaboration.

Figure 19 shows the cause and effect relation between subcategories 5.1 - "Detection of change in the daily monitoring of strategy practice by the manager" with subcategory 1.1 - "The intended and accomplished strategies agree"; or with subcategories 3.1 - "External factors transforming the strategy: emergence of variables outside the management of the manager and the team that practices the strategy", 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses ". The impacts generated in the strategy plan or practice can be both positive - when there is no need for changes due to the non-detection of variables outside the management of the manager or the team that practices the strategy or when these variables don't generate factors that can interfere in the strategy - how much negative - when the variables that were related to the management of the manager and the team are detected and cause impacts that require changes in the strategy plan and practice.

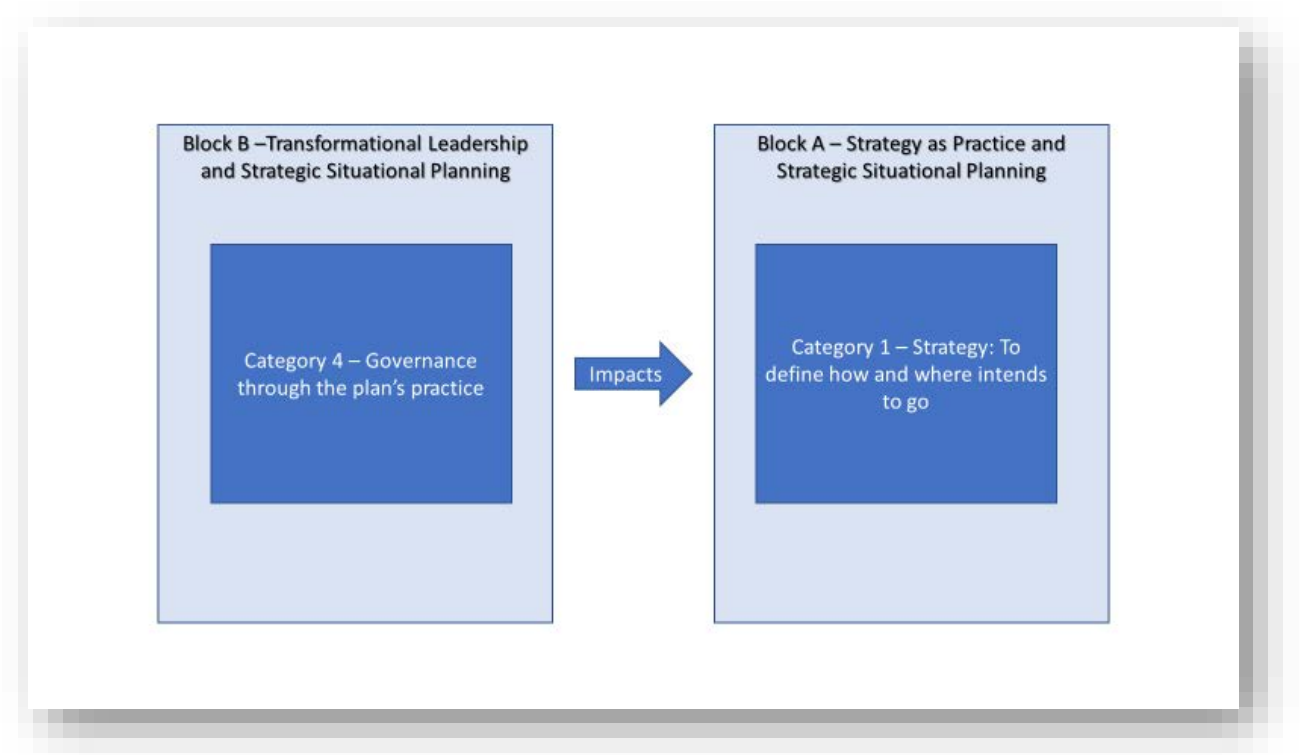

Figure 20 - Relation between the categories 4 and 1 from the Blocks "B" and "A".
Source: Own Elaboration.

Figure 20 shows another set of cause and effect relations between blocks "A" and "B", this time between categories 4 - "Governance of the plan's practice" and 1 - "Strategy: to define how and where you want to go". These relations positively impact the practice of the plan and are explained in Figures 21, 22 and 23. Table 6 presents some excerpts from interviews that demonstrate these cause and effect relations that start from the two subcategories of category 4 (Figures 21, 22 and 23).

Table 6 - Summary of the analysis of the category governability of the plan's practice

Category	Subcategory	Category label or details	Excerpts from the interviews
4 - Governability of the plan's practice through social participation	**4.1** - Governance by societal support	Societal participation has a strong influence on the plan and on the practitioners of the strategy	*"You only have governance if you have an internal structure and if you have the credibility of society. If you don't have these two factors, you don't have any plans "(E01)* *"And then I had a relationship with society, which also determined whether my decision was correct. There it was to establish the democratic with society "(E03)*

	4.2 - Governance by validating the plan in relation to that carried out with the practitioners of the strategy	Governability with the practitioners of the strategy is fundamental for the correct fulfillment of the plan	*"We did a reassessment with the actors involved in that area and made the necessary course correction" (E06)* *"We sent teams in the management office, together with technical teams from the secretariat, making this group directly affect the project managers and, often, in the territory itself, where they were deployed" (E07)*
	4.3 - Governance combined with the compensatory balance between the plan, the team's ability to execute and the manager's trust in the team	Governance, when combined with a certain compensatory balance between the plan, the practitioners' ability to execute it and the confidence of these practitioners in the leader, helps in the practice of the strategy	*"One of the most important issues for us to realize this and deal with properly, is that you have to have a group of people who work with you that in addition to being professionals and being prepared to perform the functions they are performing, they are also your confidence. Confidence. So you have these people as sensors. So, the perception that something is changing, it is quickly identified by these sensors. So when it comes to you, it almost comes with a solution" (E04).*

Source: Own Elaboration.

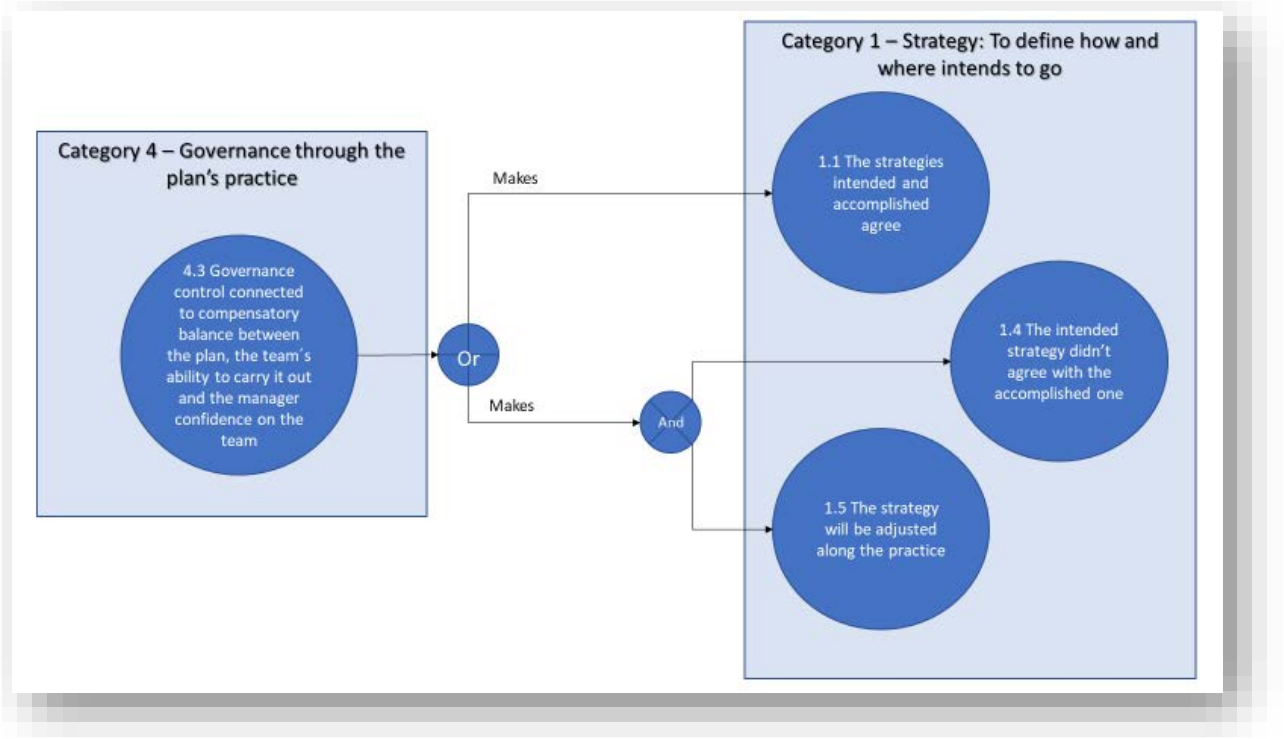

Figure 21: Relation between the subcategory 4.3 and the subcategories 1.1, 1.4 and 1.5.
Source: Own Elaboration.

Figure 21 shows the cause and effect relation of subcategory 4.3 - Governance combined with the compensatory balance between the plan, the team's execution capacity and the manager's trust in the team" in subcategory 1.1 - "The strategies intended and carried out agree ", or, in a different situation, in subcategories 1.4 -" The strategy carried out did not agree with the intended one "and 1.5 -" The strategy is being adjusted as the practice progresses ". In both scenarios, the impact on the plan will always be positive, regardless of modifying it or not, as it allows the strategy to be more easily maintained due to the governability of the plan or, if it needs modification, it will be more easily driven by team that practices the strategy and by the manager due to the governance over the control of the plan, the team's capacity and the relation of trust with the manager, as demonstrated in the data analysis.

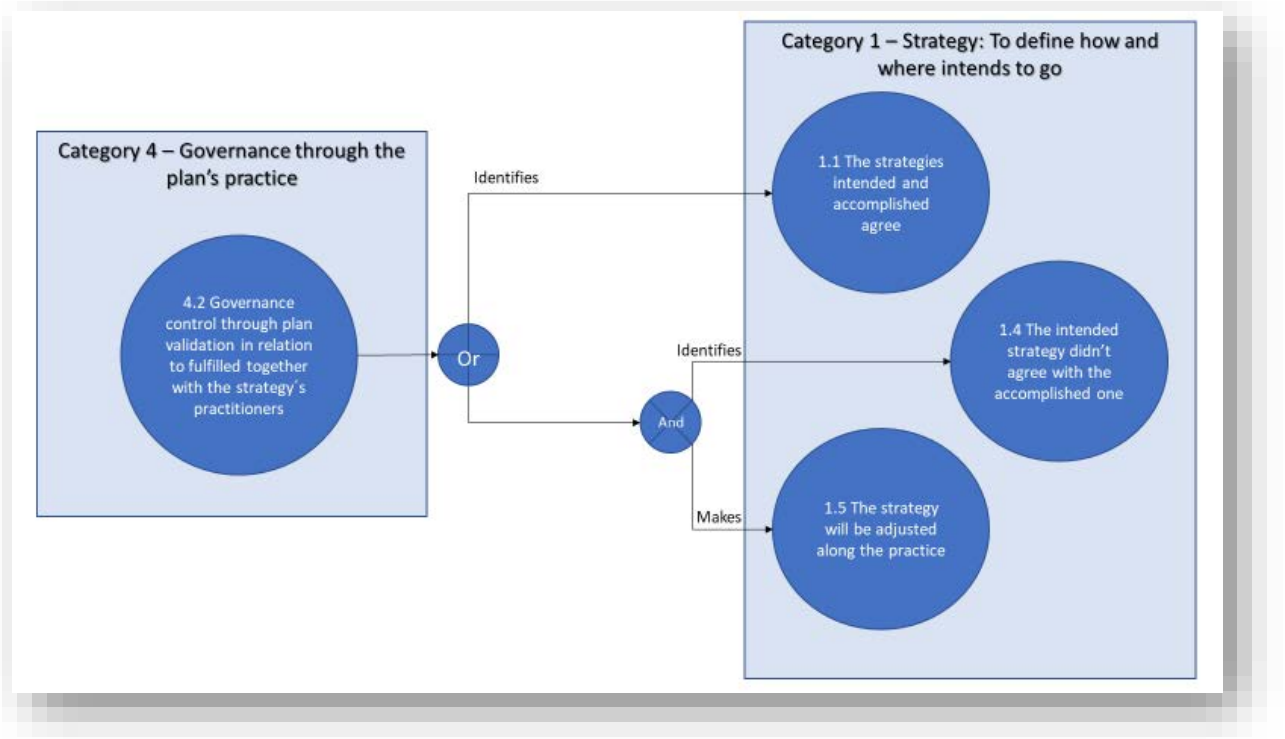

Figure 22 - Relation between the subcategory 4.2 and the subcategories 1.1, 1.4 and 1.5.
Source: Own Elaboration.

In Figure 22, the cause and effect relation of subcategory 4.2 - "Governability for the validation of the plan in relation to the one executed with the strategy practitioners" is presented in subcategory 1.1 - "The intended and accomplished strategies agree", or, in a situation differently, in subcategories 1.4 - "The strategy carried out didn't agree with the intended one" and 1.5 - "The strategy is being adjusted as the practice progresses". In both scenarios, the impact on the plan will always be positive, regardless of modifying it or not, as it allows the strategy to be more easily controlled by the management of the governance of the plan and, if it needs modification, it will be more easily conducted by team that practices the strategy and the manager, depending on the governability of the plan validation between the manager and the team.

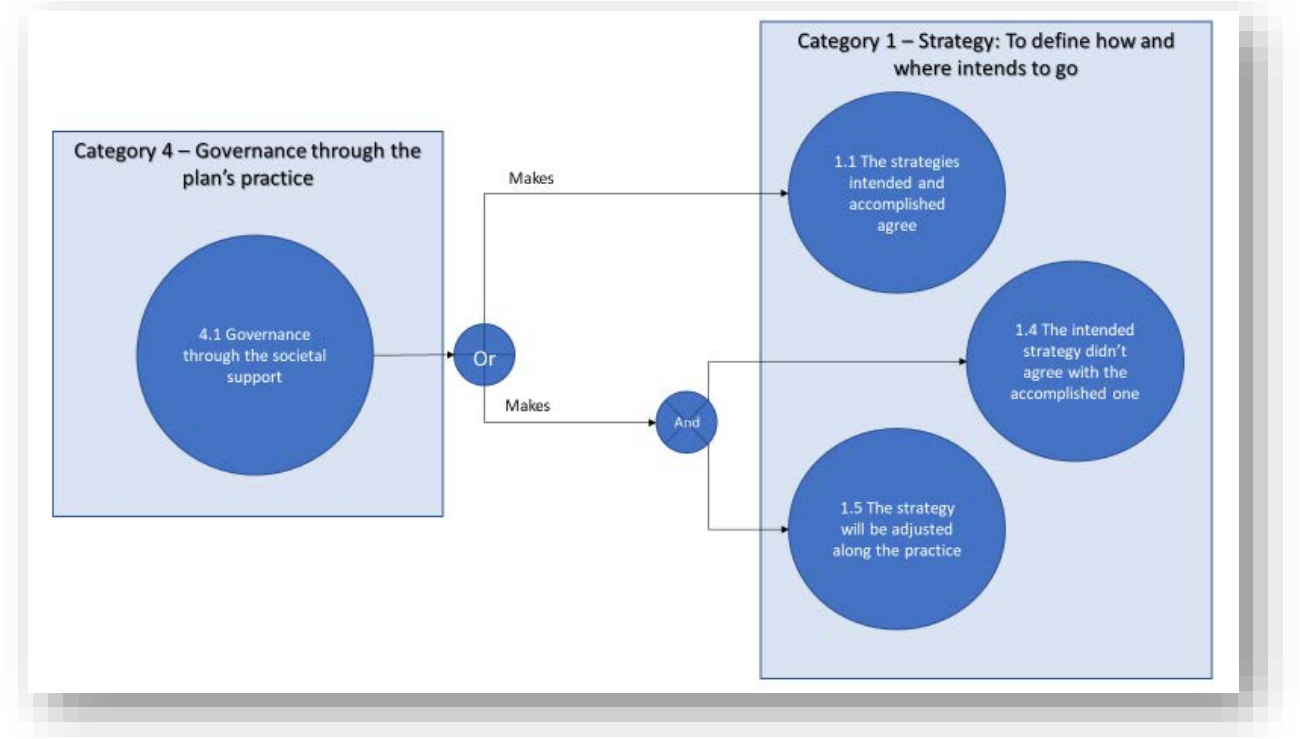

Figure 23 - Relation between the subcategory 4.1 and the subcategories 1.1, 1.4 and 1.5.
Source: Own Elaboration.

Figure 23 shows the cause and effect relation of subcategory 4.1 - "Governability through societal support" in subcategory 1.1 - "The intended and accomplished strategies agree", or, in a different situation, in subcategories 1.4 - "The strategy carried out it did not match what was intended" and 1.5 - "The strategy will be adjusted as the practice progresses". In both scenarios, the impact on the plan will always be positive, regardless of modifying it or not, as it allows the strategy to be more easily supported due to societal participation in its validation, or, if it needs modification, it will be more easily conducted by the team that practices the strategy and by the manager due to the societal support and support to its governance.

9. Conclusions

Through this research, we sought to assist the senior manager of a public organization in the practice and execution of the formulated strategy, to enable continuously the accomplishment of its mission, according to the needs of the stakeholders and the dynamics of the internal and external environment, covering, therefore, the mobilization of its team.

In response to the research problem, in the data analysis, elements were offered and allow considering that the combination of the four approaches studied - Strategy as Practice, Situational Strategic Planning, Stakeholder Theory and Transformational Leadership - assists in the successful implementation strategy, as long as the SSP has a central role in the strategy's practice and management, as demonstrated in the proposed framework.

The framework allows establishing a reference to guide the leader of the public organization in the governance of the plan, in the strategy practice in the face of complex and diverse change scenarios, in the

mediation of conflicts between the diffuse and divergent interests of the organization's stakeholders and the motivation of the organization team, as well as in the leadership role played by the leader with his team.

Another characteristic that is very peculiar to the public environment, and that complements SSP and other approaches, is the societal management model, described in the theoretical foundation of this work and which emerged in the analysis of the data and the proposed framework. The societal model of public management is a component that alters the strategy's plan and practice, as well as its governance.

The suitable treatment of societal participation, as a variable with a high capacity to influence the strategy and its practice, can make it beneficial to the plan, bringing contributions that can improve the strategy itself and its practice. It is even clear from the analysis of the data that societal participation in the management of the public organization serves an essential purpose of the public environment, especially in direct administration, which is the good of the public interest. In this way, the interest of one of the largest and most important stakeholders in this environment reconciles: society. And the SSP, as a central element of the management of the plan and its practice, being complemented by the other three approaches (Strategy as Practice, Stakeholder Theory and Transformational Leadership), forms a framework capable of supporting most of the existing requirements in the public environment , such as the dynamics of changes in the external and internal environment of the organization, which end up influencing the plan, its governance and its practice in the face of these changes and the diffuse and divergent interests of the interested parts.

On the other hand, ignoring the existence of this stakeholder, that is, society, in the public environment, especially the direct administration, exposes a serious threat to the practice of the plan and the achievement of strategic objectives.

One of the important elements that emerged in the analysis process is the perception that the failure to reach the goals initially, defined in the plan, does not necessarily mean a failure of the strategy; contrariwise, it can perfectly indicate an improvement in it.

In addition, the way in which the manager and the practicing team deal with the dynamics of the external and internal environment can impact the plan, as well as the way in which this governance is conducted, thus determining the failure or success of the strategy practice.

Another important element suggested by both, the data analysis and the structuring of the framework, was the gain in quality of the practice and of the strategy itself, when the team that practices is the same that builds the plan. Ignoring this issue harms the achievement of organizational objectives and the successful implementation of the strategy.

The detailing of the relations between the blocks through the subcategories, exemplified with excerpts from the interviews, is another aspect of the analysis that can be worked on in a future article to further deeply the proposed framework.

The structuring and improvement of the framework were, therefore, the main benefits of this research. The intended contribution of this product was to be an alternative to guide, from real experiences from the data analysis process, the high leader of a public organization through the complex, challenging and dynamic scenarios present in the public management environment, without forgetting from meeting the organizational mission, to the needs of stakeholders, to the constant dynamics of external and internal environments, mobilizing its team to along solve challenges and problems in the practice of strategy in the

public area.

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Academic Process Oriented to the Reputational Capital of Brazilian HEI Brands

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Abstract

The reputation of a university must be positive, whether it is private or public, given the competitiveness of its environment. Reputation is an indicator of organizational success and can be monitored by the brand's reputational capital, which corresponds to the harmony between the characteristics established by the managers - brand identity, and the perception defined by its stakeholders - brand image. In a complementary way, business processes are useful tools for optimizing the roles and outcome of organizations. The objective of this work was to model an academic business process, to increase the efficacy of higher education training, guided by the reputational capital of the brands of universities in Brazil. A quasi-systematic review was carried out to investigate academic business processes - identity; bibliographic review to understand reputation and competitiveness – image; and was elaborated a diagram of the academic business process model with UML resources, SIPOC approach, relating identity and image through guidelines: elaboration and evaluation of student work individual plan, student self-efficacy stimulus, individual teaching advice, positive university culture, interaction with society and co-creation of brands by students from Brazilian HEIs - reputational capital.

Keywords: academic business process, brands reputational capital, positive university culture, student planning, interaction with society

1. Introduction

Business processes, even if informal and undocumented, have an impact on the actions of an organization, which when positive, add value to what is offered to the customer, be it a product or service. Business is understood as occupation, activity, or work that is carried out for profit, according to pressure exerted by market forces. Within the scope of Higher Education Institutions (HEIs), several researchers like Woodall; Hiller; Hesnick (2014), Williams, (2013), Bunce; Baird; Jones (2017) agree that the presence of business is evident for private HEIs, with the commodification of education; considering the students, in this way, as client or consumer; however, there is resistance to acceptance of public HEIs as a business.

There are those who justify the impossibility of public HEIs working with business processes because they do not suffer from market pressure, however, according to Baldam; Valle; Rozenfeld (2014), in public organizations, the role of the market, with similar impositions, is fulfilled by the increase in tasks without the admission of new human resources, by the need for more evidence to ensure the adequate use of public resources and therefore, more restrictions than private organizations of like nature.

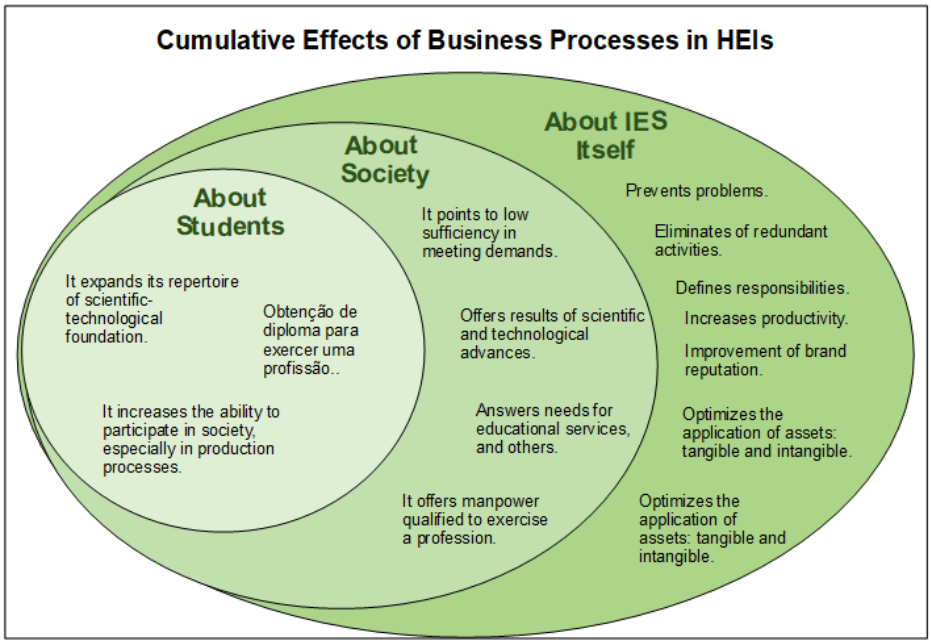
According to Baldam; Valle; Rozenfeld (2014), there is often the involvement of customers in the production of the service. Thus, as this is the scenario of the HEIs - students need to cooperate to build their professional skills and competences; it is expected that their consumers are involved in production, which does not prevent them from dealing with business and seeking ways, such as processes, to increase its effectiveness.

The end service of universities - professional academic training, in this work, is understood as a business process. Organizations demand articulation, continuous progress, versatility and constant innovative improvement, according to Baldam; Valle; Rozenfeld (2014), to face the obstacles around, and considering these conditions, processes are essential.

It is evident that there are business processes in Brazilian public HEIs, because there is a "Guide to the Management of Government Processes", of the National Program for Public Management and Red tape, of the Ministry of Planning; according to which the management of business processes in IES promotes improvements, be it in the achievement of its objectives, in the application of its resources, in the prevention of problems and in the increase of productivity; and it is worth investigating ways to optimize the processes present in universities, due to the roles they play in society: professionalization, promotion of scientific and technological advancement, meeting existing demands in society and indication of social under-sufficiency, and in science and technology (Brazil, 2011).

Implementing business processes, regardless of the origin of its capital and the nature of its profits, is valid, since through these it is possible to integrate strategies and objectives of an organization with expectations and needs of customers and society, according to Burlton (2001). The effects that business processes have on students echo the effects on society; which, in turn, echo over the university (Figure 1). Among other effects, there is an improvement in the use of assets, such as the reputational capital of brands.

Figure 1. Effects of Business Processes in HEIs



Source: Elaborated by authors.

To speak of a process oriented to the reputational capital of brands, is to speak of serving the citizen effectively, and devoting attention to intangible profits. In a business and market environment, Hemsley-Brown *et al.* (2016) recommend that higher education institutions should develop distinct identities, understanding about how meaning, image and reputation of brands will enable HEIs to communicate more effectively with stakeholders, such as teachers, students, graduates, employers and society in general. Reputational capital is the harmony between identity - which is central, distinctive and lasting in the organization, according to its managers; and its image - mental model through which the parties involved perceive it.

The reputation in this work corresponds to the value judgments of the extern community of the organization, considering its performance evaluation over a wide period of time, in areas that society deems important, according to Vidaver-Cohen (2007) and Suomi (2014). The more tuning in between brand image and brand identity, the greater your brand reputation capital, and the closer the organization is to consolidating its reputation.

The reputation function is equivalent to that of a limit that signals that a goal has been achieved; in an organization. Through this, it is known how close the achievement of its objectives and customer service are. Additionally, if the perception of reputation is positive, there is an increase in customer satisfaction in identifying with the brand and participating in it, according to Ahearne *et al. (*2005) and Foroudi (2017). Therefore, to care for the brand's reputational capital is to care for a satisfactory reputation, and for the achievement of the organization's objectives, for customer service - the main profit of public institutions.

The association of the concept of processes with exclusively products and other tangible profits, comes from the industrial era; today it is necessary to expand these conceptual boundaries, in order to adapt them to the predominant sources of wealth, focused on knowledge - citizen service, reputational capital and other

intangible assets such, according to Maduro; Fernandes and Alves (2018), identity, image and corporate reputation; which have an increasing value in the management of the HEIs involved in the market context.

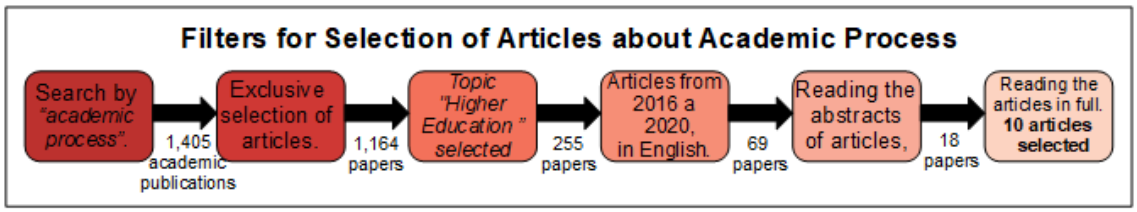
For Seethamraju (2012), business processes themselves are considered corporate assets, as they constitute a relevant portion of an organization's costs and the main differentials of the global competitive environment and according to Leijerbolt, Chapleo, O'Sullivam (2018), it is essential to understand how publicly owned organizations should manage the brand. The absence of a favorable brand reputation would imply discontinuity, considering the fierce competition between the HEIs, according to Aula; Tienari (2011) and Suomi (2014). Thus, research on brands and HEIs is necessary.

Like this, the objective of this work was to model an academic business process, oriented to the reputational capital of the HEI brands, to increase the effectiveness of higher education training, possibly applicable to Brazilian universities.

2. Methodological Procedures

To investigate the academic business process contained in Brazilian HEIs, a quasi-systematic review was performed, using the "academic process" search string in the CAPES Portal search engine, linked to the MEC, initially obtaining 1,405 academic publications. Then a filter was applied for exclusive selection of articles, obtaining 1,164. Afterwards, the topic "higher education" was selected with a reduction in the number of articles to 255. With the definition of the time scope from 2016 to 2020 and English as the language, 69 articles remained. Then the abstracts of these were read, reaching a total of 18 articles. The main inclusion criterion was not to deal with parallel themes such as its impacts on the increase in the number of enrollments and internationalization of universities; and complementary themes such as contemplating students with cognitive deficits, and obstacles to plagiarism; that despite being important, they escape the desired scope and after reading the articles in full, the final number of 10 articles was reached (Figure 2).

Figure 2. Flow of Systematic Review on Academic Process



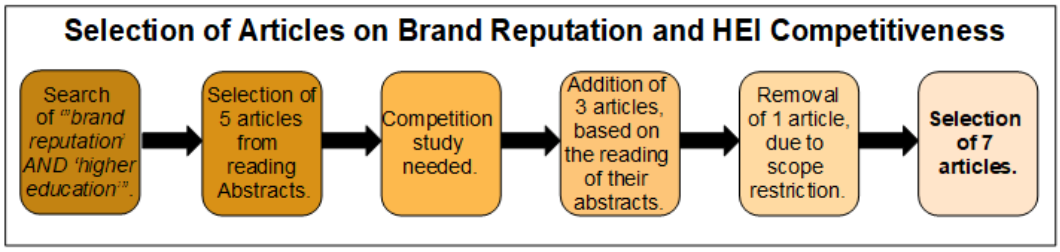
Source: Elaborated by authors.

According to Hemsley-Brown *et al.* (2016), strategic decisions, such as the definition of business processes, result from a greater understanding of the identity, meaning, image and reputation of the brand, and vice versa; like this a bibliographic review was carried out, using the CAPES Portal search engine, with a search string "'brand reputation' AND 'higher education'", with no predefined time scope, with results ordered by the most accessed, with a selection of 5 articles.

From reading the articles on brand reputation and higher education, there was a need to identify articles on competitiveness since, private firms, HEIs and other public organizations have turned to the market and

for competitiveness, according to Alves; Raposo (2010) and Suomi (2014); thus, through extensive research, 3 articles were added to the selection, from the reading of the titles and abstracts, of which 1 was excluded from reading in full, for presenting very restricted conclusions (Figure 3).

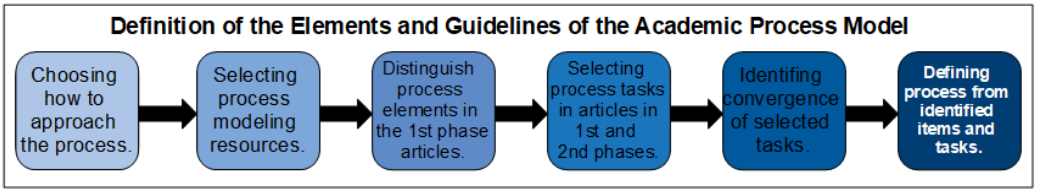
Figure 3. Flow of Bibliographic Review on Brands and Competitiveness of HEIs in Brazil



Source: Elaborated by authors.

After the investigation of the university education business process and the understanding of brand reputation and HEI competitiveness, it followed to definition elements and guidelines for the composition of the process model (Figure 4) - activities, according to ABPMP (2013), corresponding to creation of representations of business processes, with details of how it works.

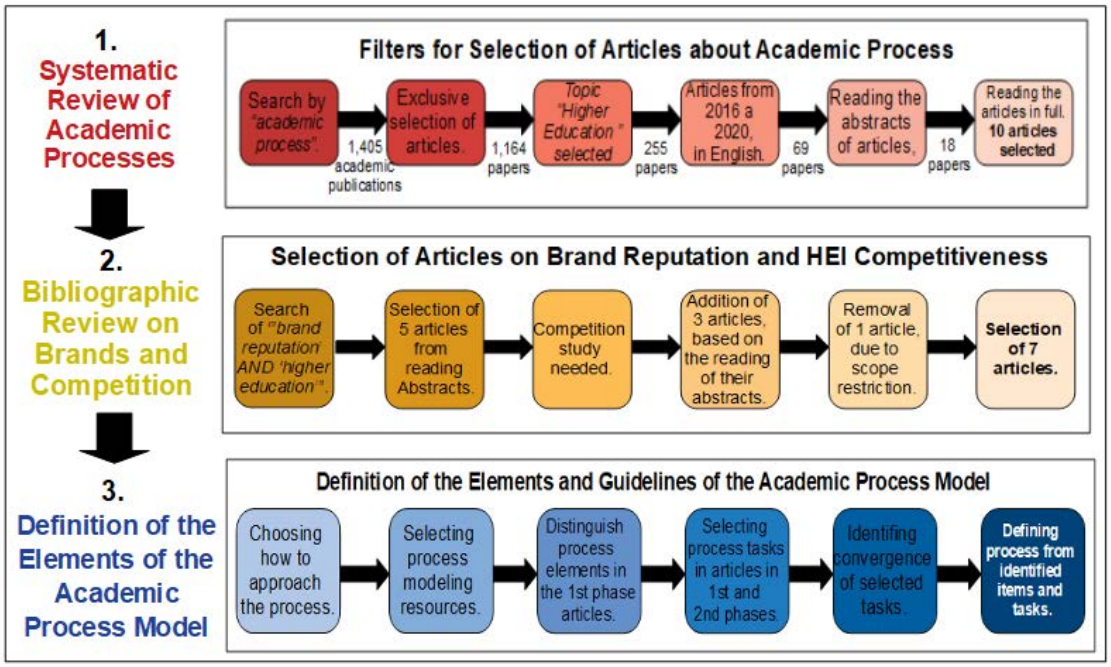
Figure 4. Flow of the Phases Academic Process Model Phases



Source: Elaborated by authors.

In this way, the methodological flow of this work consists of 3 parts, for investigating academic business processes, for understanding brands and competitiveness and for defining the elements and guidelines of the business process model of academic training (Figure 5).

Figure 5. Methodological Flow for Outlining the HEI Academic Process Model



Source: Elaborated by authors.

3. Results

In this section presents results obtained from the three methodological steps explored.

3.1. Academic Process

The articles selected from the academic processes review cover multiple locations: Nigeria, Tehran, Russian Federation, Africa, England, Romania and Chile; and it highlight, for example, self-efficacy, student autonomy, student engagement as essential in the formation of higher education (Table 1). Thus, the spatial scope and constructs of the conceptual basis related to academic formation processes are evidenced.

Table 1. Articles Selected in the Systematic Review on Academic Process

Authorship	Objective	Conclusion	No.
Kayode, Yusoff and Veloo (2016)	Validates process management to study the effectiveness of Nigeria's higher education.	Process management facilitates the identification of elements that influence the effectiveness of higher education.	1
Bayat and Salehiniya (2018)	Examines relationship between the perception of educational research and academic self-efficacy in Tehran students in 2016.	Ao aumentar a percepção da pesquisa educacional entre os alunos, a autoeficácia acadêmica também aumenta.	2

Authorship	Objective	Conclusion	No.
Fedotova *et al.* (2017)	Analyze the methodological tools for teaching humanities and sciences in the Russian Federation.	Case studies are expected to improve the efficiency of students' autonomous work in the search for solutions.	3
Beyers (2016)	Examining how a Faculty of Theology at the University of Pretoria will remain relevant and desirable for South African society.	Guidelines: engage contextually with society, engage in interreligious dialogue and remain connected to communities of faith.	4
Alexiadou, and Essex (2016)	Investigating the ways in which a teacher training course in England prepares student teachers for inclusive practices in science education.	Despite positive examples, inclusion can remain an abstract principle, even filtering practices in the context of the classroom.	5
Frasineaunu (2019)	Dealing with the abandonment of the first year student of higher education in Romania.	Necessary applying corrective activities in problematic disciplines.	6
Tan, Muskat and Zeher (2016)	Identify research on the student's experience in higher education inside and outside the classroom.	Trends in research flows on experience: learning; for improvement; and associated with student satisfaction.	7
Valenzuela *et al.* (2018)	Describe the Learning Method Connected to the Organizational Environment, introduced in a public university course in Chile.	Students exhibit favorable perceptions of their learning and academic process in courses that implement the method.	8
Sunder and Mahalingam (2017)	Investigates the Lean Six Sigma (LSS) in HEI. LSS is a business process methodology focused on the service sector.	LSS is applicable in higher education institutions and can provide positive benefits in this context.	9
Yin (2018)	Examining the relationship between student motivation, engagement and mastery of generic skills.	The study confirms the relationship between student motivation, engagement and mastery of generic skills.	10

Source: Elaborated by authors.

With the reading of the articles selected in the 1st phase of the methodology, elements of the academic processes were identified, such as the actors involved, rules, normative documents and those responsible, necessary materials - considered relevant for researchers in each process of university education that was studied. Each composition article in Table 1 was identified by a number, used to facilitate association with the respective source (Table 2).

Table 2. Elements that make up the academic process according to selected articles

Components of the academic process	Sources									
	01	02	03	04	05	06	07	08	09	10
Academic Guidance						X				
Academic Relations						X				
Academic Self-Efficacy		X				X				
Community Service	X			X						
Competences			X							
Competition					X					
Curriculum	X			X	X					
Disciplines					X					
Diversity					X					
Engagement with Organizations								X	X	
Engagement with Society	X		X	X				X	X	
Evaluation	X				X	X	X		X	
Inclusion					X	X				
Infrastructure					X					
Laws (Regulations)					X					
Motivation										X
Professional Orientation			X			X		X	X	
R&D	X									X
Reception						X				
Society	X			X						
Socio-emotional Skills						X		X	X	
Student Autonomy			X							
Student Commitment								X	X	X
Student Engagement with Activities									X	X
Student Experience							X			
Student Performance	X	X				X	X	X		
Student Planning										X
Students					X	X			X	
Teacher Training					X					
Teaching, Methods	X		X		X	X	X		X	
Work, World of (Market)			X		X	X		X		

Source: Elaborated by authors.

3.2. Brands Reputation and HEI Competitiveness

Scientific investigations classified by means of bibliographic review on brands and competitiveness in HEIs were carried out between 2014 and 2019, and deal with multiple aspects of the subject - organizational brand, dimensions of brand reputation, effective construction of HEI brand, planning of brand, the student's role as a brand co-creator, university culture and strategic management as a tool for improving HEI's reputations (Table 3). The relationship between brands and strategic planning is a two-way street, reputation is an intangible asset of an organizational brand, it refers to organizational performance and competitive advantages - guidelines for brand management tasks and competition for HEIs.

Table 3. Seleção da Revisão Bibliográfica sobre Marcas e Competitividade em IES

Authorship	Objective	Conclusion
Leijerbolt, Chapleo and O'Sullivam (2018)	Exploring the brand management processes in the public sector and their implications from the perspective of employees.	Departments, or divisions, can form a organizational strong brand, stimulating commitment to the organization's brand.
Suomi, K. (2014)	Examining the dimensions relevant to the brand's reputation, especially in the context of master's programs.	The brand's reputation in the field of higher education is a complex and multidimensional construction.
Hemsley-Brown *et al.* (2016)	Describing research that contributes to strengthening the HEI brand architecture in the international market.	New ideas for the effective construction of the brand in a higher education institution.
Foroudi *et al.* (2017)	Identify the consequences of the planned brand identity in the context of higher education.	Brand elements, service attributes and public relations have a positive influence on the planned brand.
Foroudi *et al.* (2019)	Examining the role of students' value co-creation behavior in building the image and reputation of a university.	It confirms the central role of co-creation of students in the production and maintenance of the university's brand image and reputation.
Budd (2017)	Understanding how students make university-related decisions, not just what choices they are based on; but how they understand the respective roles of the student and the university.	Distinctions between German students - from public HEIs, and English students - from private individuals, are based less on tuition fees, and classifications, and more on their university cultures and the world beyond diplomas.

Authorship	Objective	Conclusion
Maduro, Fernandes, Alves (2018)	Assist management convergence as a strategic lever and innovative tool to improve corporate reputation in HEIs.	It is possible to indicate ideas for improvement to increase the competitiveness of HEIs.

Source: Elaborated by authors.

Based on the study of articles about brand reputation and a competitive market for universities, guidelines for its brands management tasks were identified (Table 4).

Table 4. Guidelines for IES' Brands Management Tasks

Sources	Guidlines
Leijerbolt, Chapleo and O'Sullivam (2018)	It is essential to understand how publicly owned organizations should manage its brands.
Suomi (2014)	Relevant dimensions for the IES brand reputation are: 'personal study advice' and 'interaction with society'.
Hemsley-Brown *et al.* (2016)	Broad dissemination of the results of the students' projects is necessary, and the consequent formation of a positive university culture.
Foroudi *et al.* (2017)	With the positive perception of reputation, there is an increase in customer satisfaction, who identify with the brand and participate in its co-creation.
Foroudi *et al.* (2019)	It highlights the need for co-creation of institutional value by the student.
Budd (2017)	Students make decisions, for example, according to the rigor of the market and family pressure, and not only from the them relationship between - consumer or customer, with universities.
Maduro, Fernandes and Alves (2018)	Brand management is a strategic lever and an innovative tool to improve corporate reputation in HEIs and the promotion of positive associations in the minds of the target audience is fundamental for building good relationships.

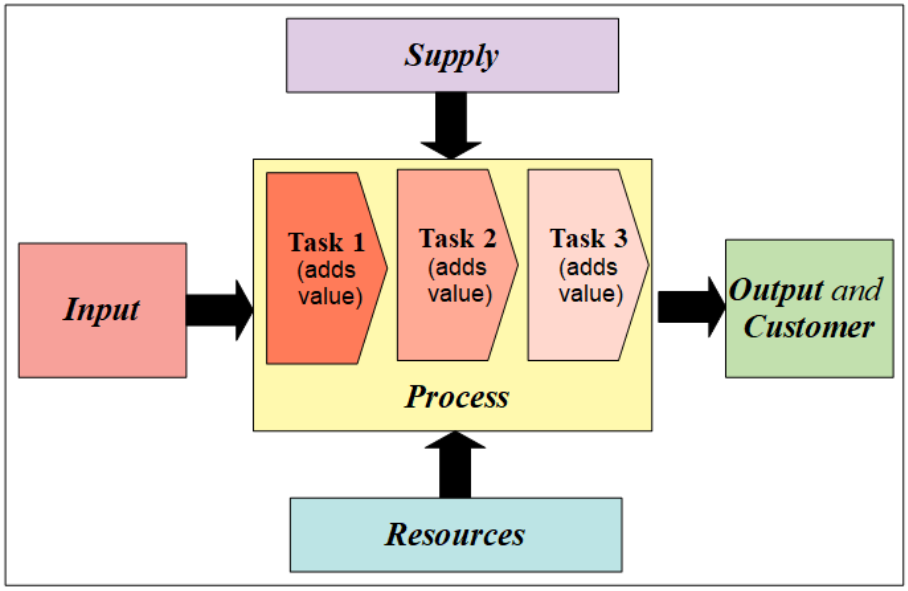
Source: Elaborated by authors.

3.3. IES Academic Process Elements and Tasks

The chosen business process modeling approach was SIPOC - Supplier, Input, Process, Output and Customer, consisting of, according to ABPMP (2013) in: Supplier - who or what provides documents, information, rules, materials and must meet specifications; Inputs - everything that is transformed in the process, such as data, materials and people to be treated; Process - set of interrelated activities that transform inputs into results; Output - result of the process and Customer - those who receive the generated products. SIPOC does not adopt a standard or set of notations. However, in this work the UML (Unified Modeling Language) notation was applied, which although it is used for analysis and design of computer systems, has its activity diagram used to model business. In this diagram, following the guidance of Brasil (2011):

(a) the inputs must be positioned on the left, (b) suppliers and references, above, (c) process, in the middle, (d) resources, below and (e) values end, on the right. Thus, it is noted that the SIPOC approach, in this work, resources were added, which are consumed in the process, helping in the expected transformation, but not transformed as the inputs are (Figure 6).

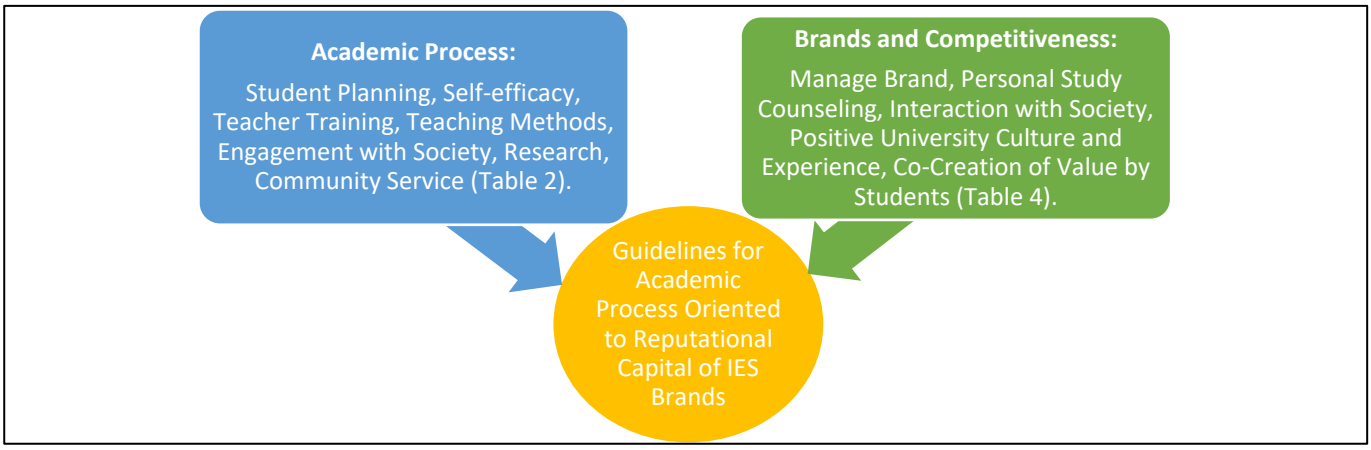
Figure 6. Process Diagram from the SIPOC Approach



Source: Elaborated by authors.

From the confluence of the elements of composition of the academic process according to articles selected in the 1st phase of the methodology (Table 2), and from the guidelines for the management of IES brands (Table 4), there are the guidelines for the university brand management tasks (Figure 7).

Figure 7. Convergence of Studies on Academic Process, Brands and Competitiveness



Source: Elaborated by authors.

4. Discussion

In this section, the modeling of the process was presented, according to the guidelines aimed at academic training - student planning, individual teaching advice, positive university culture, interaction with society and co-creation of students and self-efficacy - considered relevant from the study on the reputation of brands and competitiveness in HEIs and on the academic process.

4.1. Modeling the Academic Process Oriented to the Reputational Capital of IES Brands

The Academic Process Oriented to the Reputational Capital of IES Brands, Figure 8, starts in the upper left corner of the model, and is represented, in UML, by a circle, in black. Tasks are represented by rectangles with rounded corners. All tasks of the same nature were identified by the same color; for example, all actions related to 'scientific initiation' were represented by elements in blue. Decisions are represented by lozenges. From these lozenges there are flows containing labels that represent the results of the decision. From the lozenge on whether the supervisor approves the plan, there is a flow with the label 'YES', and in this case, we move on to a next decision; and there is another flow with the label 'NO' that makes the process return for the academic advisor's assessment. The decision is described in braces, next to the corresponding lozenge. All tasks that must be carried out in parallel are delimited by horizontal bars. In the diagram there are two blocks of parallel tasks. To indicate the end of the process there is a circle with a smaller inner circle - lower right corner of the diagram.

After the beginning of the process, in the next task it is recommended that the student schedule a pedagogical orientation meeting - mentoring. From this, a set of parallel tasks, analyzes - of offering disciplines, proposals for scientific initiation, extension projects, internships and monitoring - are located; to be carried out by a group of students together with their respective pedagogical advisor.

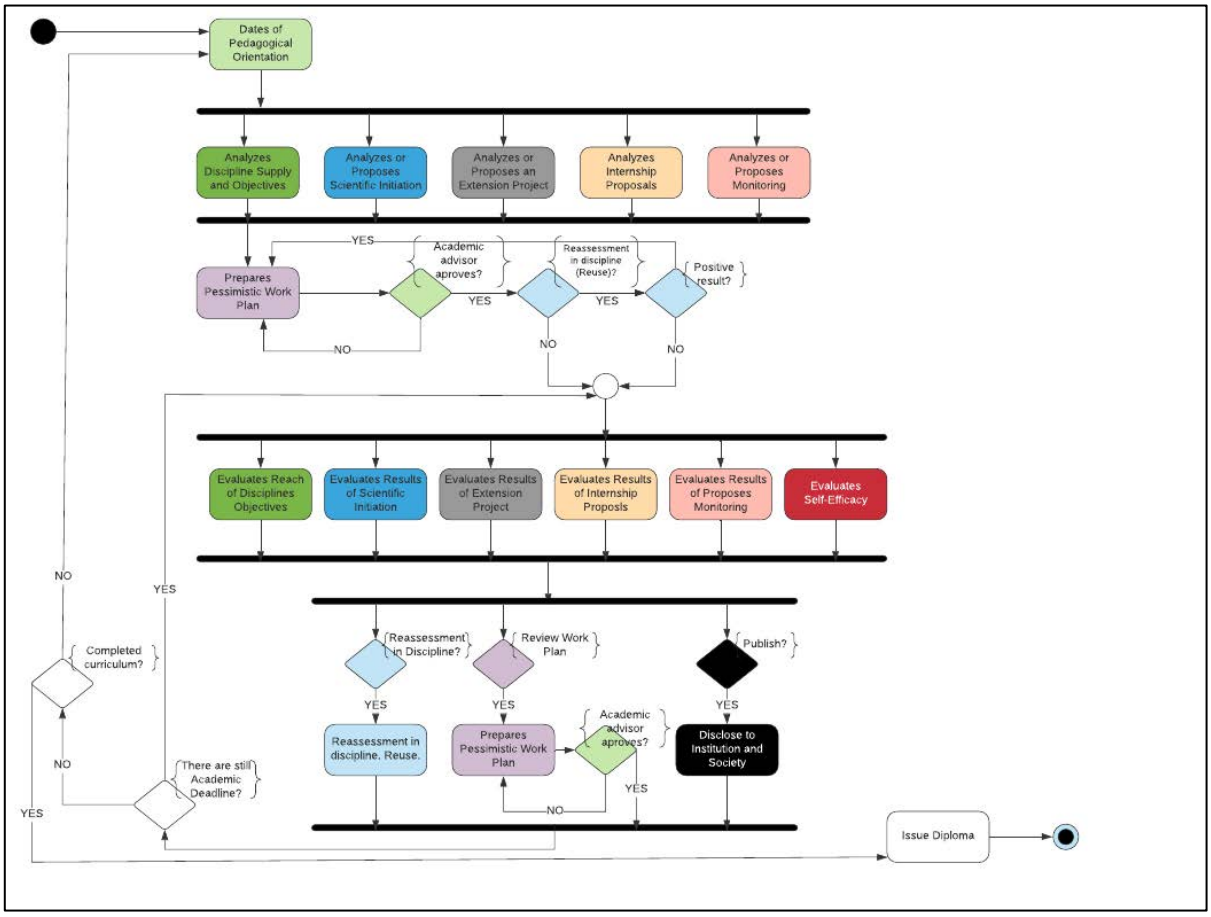
Then a Work Plan is prepared for each student. This is called ‘pessimistic’ because it provides for failure in the reevaluation of disciplines, equivalent to the use of studies, provided for in art. 47 of the law of directives and bases of education, or LDB (Lei de Diretrizes e Bases da Educação), Brazil (1996), useful to regularize the student situation in case of pending course unit, or even to take advantage of previous studies - acceleration. When the advisor approves the work plan, and the student is successful in taking advantage of studies, the plan must be adjusted - with the exclusion of the disciplines in which the student obtained approval in the reuse, and reassessed by the teacher responsible for the pedagogical guidance.

Once the plan has been elaborated, during the academic period, students should, together with the advisor, periodically evaluate the referral: of the disciplines, CI and extension projects, and everything else that makes up the plan. This step in the process corresponds to the second block of parallel tasks. If necessary, the student is guided to seek ways of recovery in the discipline; or the plan may still to be adjusted. Students are also encouraged to disclose the results of ongoing projects, to the institution and to society. These tasks, in the diagram, appear from the second occurrence of the green box, which reads ‘Evaluates Reach of Disciplines Objectives’.

During the school term, the Work Plan is reevaluated, as well as the student's self-efficacy and the need to disseminate results. After the school term, it is checked whether the curriculum is completed, represented by a white lozenge, in the left lower part of the diagram. If so, represented by an arrow with a YES label,

the diploma is issued and the process is completed - bottom right corner of the diagram. Otherwise, a new work plan is elaborated, as well as the evaluation cycle of the routing of the disciplines and projects that comprise it.

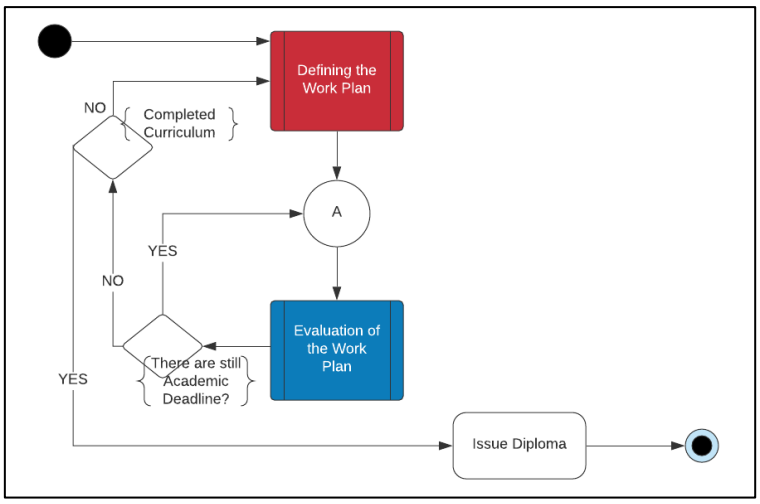
Figure 8. Academic Process Oriented to the Capital of IES Brands



Source: Elaborated by authors.

A simplified view of the process under study is presented in Figure 9. In other words, in Figure 8 the details of the tasks and decisions that make up each process in Figure 9 are presented.

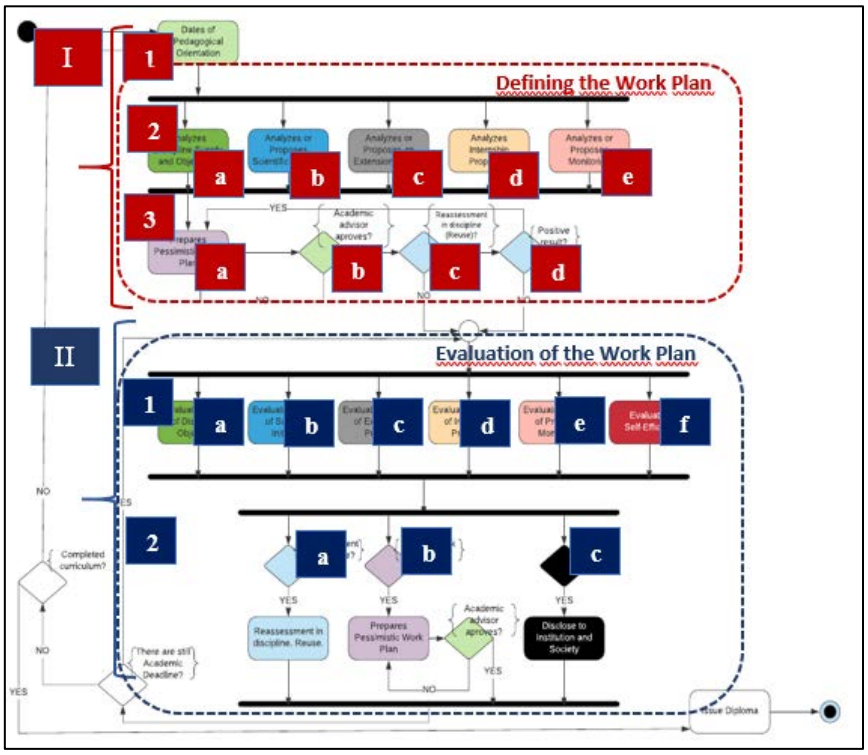
Figure 9. Simplified View of the Academic Process



Source: Elaborated by authors.

Figure 10 presents the elements of Figure 8 with labels to facilitate their identification, used in the discussion of the guidelines. The representative models correspond to UML activity diagrams, built with the application of the proprietary online tool, named Lucidchart.

Figure 10. Simplifying the Academic Process Oriented to the Capital of IES Brands



Source: Elaborated by authors.

To construct the diagram according to the SIPOC approach (Figure 6), the elements of the academic process (Table 2) were categorized into suppliers, documents, requirements, resources, inputs, process, results or customers; according to SIPOC concepts (Table 5).

Suppliers, input, resources, results and customers were added to Figure 9, obtaining Figure 11. Among the suppliers, the Discipline Offering, made available by IES sector, was added and can be understood as a derivation of the Curriculum provided by the higher education.

There is evidence about the importance of the academic process in the research by Alexiadou and Essex (2016), which deals with the improvement of pedagogy to effect the inclusion in the school of children with learning barriers. According to the authors, this improvement should have been made through a process. However, the inclusion was made effective in the curricula and practices through norms, and determination with competitive bias, which resulted in sterile actions for students and teachers. In order to avoid equivalent frustration, this work sought to achieve synergy between academic HEI processes and brand and market reputation; that is, without exclusivity to the competition.

The competitive advantage for HEIs, shown in Table 3, was represented in the diagram as intermediate outputs (Figure 11) because it corresponds to a result whose client is the university itself and is obtained throughout the training process. Along with this result, community services and labor were also represented. In the model they were coupled to the process, by component originally used to model 'compound state'.

On the other hand, although the graduate from higher education is not shown in Table 3, these were considered clients, as predicted by Baldam; Valle; Rozenfeld (2014) when stating that customers are involved in service processes.

Table 5. Categorization of the Elements of the Academic Process according to the SIPOC Approach

Categorias SIPOC	**Elements to compose the academic process**
Supplier	Curriculum
	Laws (Regulations)
Input	Students
Process	Reception
	Academic Self-Efficacy
	Student Autonomy
	Evaluation
	Student Commitment
	Competeces
	Student Performance
	Disciplines
	Diversity
	Engagement with Society
	Engagement with Organizations
	Student Engagement with Activities
	Student Experience
	Socio-emotional Skills
	Inclusion

Categorias SIPOC	Elements to compose the academic process
	Academic Guidance
	Professional Orientation
	R&D
	Student Planning
	Academic Relations
	Motivation
Outputs	Community Service
	Competition
Consumer	Society
	Work, World of (Market)
Resources	Teacher Training
	Infrastructure
	Teaching, Methods

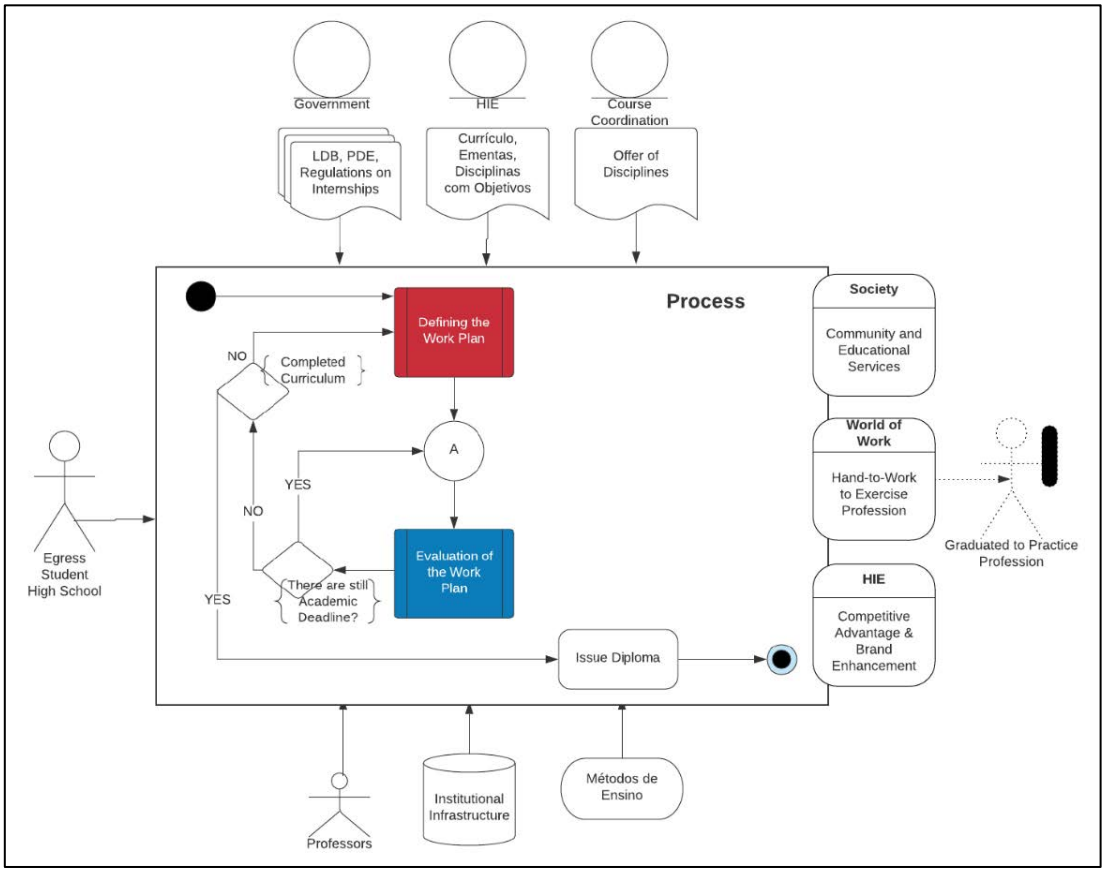
Source: Elaborated by authors.

To achieve competitive profit and continuous quality improvement in training and management strategies, HEIs apply multiple quality methods in order to improve university processes, according to Emiliani (2005) and Sunder; Mahalingam (2018).

Among the suppliers there is the Government, which establishes the regulations for Higher Education, such as the LDB, the national education plan – Plano Nacional de Educação (PNE) and the internship rules; the HEIs that define the curricular political plan – Plano Político Curricular (PPC) and disciplines' programs; as well as the derivation of the IES - Course Coordination, which defines the offerings of disciplines. The input is the student, graduated from high school, who will be transformed by the academic process. The resources are the teachers, the institutional infrastructure and the teaching method, which are necessary for the transformation, but do not suffer them and the result is the graduate.

It is worth mentioning that among the results there could be reference to scientific and technological advances, associated with the client society. However, this work focuses specifically on graduations that contribute timidly to the aforementioned advances.

Figure 11. Elements of the SIPOC Diagram of the Proposed Academic Process



Source: Elaborated by authors.

4.2. Student Planning

Yin (2018), in empirical research on the relationship between engagement, motivation and mastery of generic skills, concludes that undergraduates should be encouraged to cultivate qualities such as persistence, self-confidence, and valuing academic learning. At the same time that instructors are provided with training in self-regulated learning strategies for their students, such as self-planning, self-monitoring and time management.

It is important, according to Martin (2007), to understand students' self-regulatory behavior such as planning, task management and persistence; which are predictive constructions of performance and adaptation to academic tasks.

In the Academic Process Oriented to the Reputational Capital of the HEI Brands, student planning is implemented through subprocesses I - 'Definition of Work Plan' and II - 'Evaluation of Work Plan', Figure 10.

It is possible to observe that, in a simplified way, the Process has 2 main subprocesses (Figure 10): I - definition of the work plan, with labels highlighted in red color, composed by the elements: 1 - pedagogical orientation, analysis agenda 2a - of disciplines, 2b - of CI projects, 2c - of extension, 2d - internships, 2e - monitoring, 3a - elaboration of the work plan, 3b - of decision, for evaluation of the plan by the advisor, 3c - of decision, about the need to reuse studies, and 3d - decision, about the result of possible reuse of studies. Subprocess II - evaluation of the work plan, with labels highlighted in blue, consists of: 1a - analysis of disciplines, 1b - of CI projects, 1c - extension, 1d - stages, 1e - monitoring, 1f - self-assessment, or self-

efficacy; 2a - decision, reassessment of discipline, 2b - decision, revision of the work plan and 2c - disclosure to society and institution.

In Figure 10, the two main sub-processes are highlighted - composed of tasks and conditions. One is aimed at the elaboration of the work plan, in red, and the other, for the evaluation of the work plan, with possible readjustment of it under the authorization of the teacher, in blue - presented in a compact form in Figure 9.

4.3. Personal Study Counseling

When studying the reputation of HEI brands, Suomi (2014) reaches 11 dimensions, among which services and student support stand out, specified in adequate communication and 'personal study advice'. In line with the conclusions of the previous author, Frasineaunu (2019), focused on investigating the academic process, states that the lack of adaptive skills to the academic process causes student withdrawal, and suggests as a solution what he calls orientation and support sessions.

The dynamics of counseling in the proposed process corresponds, initially, to a meeting with a group of students, to discuss about the offered disciplines, CI projects, extension notices, internship proposals, and monitoring; then, each student, individually, to prepare their Work Plan (Figure 10, items I.2.a to I.2.e).

In this meeting, the teacher, as a pedagogical advisor, coordinates the discussions, explaining the importance of each of the disciplines for student training, as well as about the value of extension, scientific initiation, internship and monitoring; encouraging the participation of students, so that they socialize their experiences and fears; and, subsequently, validates the Work Plans.

Counseling is an extra service provided to the student, which expands the them experience, which has stood out as a competitive strategic factor for higher education providers, according to Mok (2007) who studies university internationalization, and Tan; Muskat; Zeher (2016).

4.4. Academic Self-Efficacy

Throughout the academic period, periodically, in continuity with the counseling process, meetings should take place, with the same dynamics, to evaluate the partial results of the activities contained in the Work Plan (Figure 10, items II.1.a to II.1. e), and academic self-efficacy (Figure 10, item II.1.f). Through the evaluation of self-efficacy, which occurs periodically, together with the analysis of the Work Plan, the student has the opportunity to self-assess to realize his limitations and potential, which can contribute to his academic and professional training, and with the brand's reputation HEI.

Academic self-efficacy, according to Bayat and Salehiniya (2018), corresponds to the student's positive perspective in his ability to face the challenges of the academic training process. On the same theme, Frasineaunu (2019) explains that shyness, indecision and pessimism generally lead the student to oversize the challenges of academic activities, coming to understand them as insurmountable, for disbelieving their ability to overcome.

In conceptual consonance with academic self-efficacy, Yin (2018) indicates that students from universities more focused on research generally have more favorable perceptions of their motivation, engagement and mastery of generic skills. Ruão and Carrillo (2005) and Maduro; Fernandes and Alves (2018) consider that promoting positive approximations in the mental retina of university stakeholders is fundamental for building good relationships, and according to Foroudi *et al.* (2019) the more students obtain positive returns

in relation to the university, they present greater satisfaction with their educational experience and with more commitment they position themselves with the university's brand.

Also, through the evaluation of the Work Plan, it is possible to identify the need to take advantage of studies (Figure 10, item II.2.a), as already said, provided for in art. 47, from LDB (Brasil, 1996). The implementation of studies in parallel with the realization of the disciplines reduces the chances of dropping out, and consequently, reinforces self-efficacy and positive student-university associations. This is a request to be made to the higher education provider - possibility of taking advantage of studies during the course.

4.5. Interaction with Society

The interaction with society, also called in-service learning, provides practices, new universes of learning - standardization, commitment; by allowing the student to confront real problems, and of different complexities, and to anticipate the post-training involvement with the community, according to Kayode; Yusoff; Veloo (2016).

This is also another dimension of brand reputation, resulting from the study by Suomi (2014) - interaction with society, which, according to the author, stimulates the formulation of new solutions and ideas, promotes research, influences decision-making, educates professionals for companies and stresses that universities should have more visibility in society, avoiding the risk of students limiting themselves exclusively to the academic environment, distancing themselves from communities, in order to compromise the intertwining between theory and practice through the collaborative alliance between university and society.

In the Academic Process Oriented to Reputational Capital of IES Brands, interaction with society in general occurs through the analysis and evaluation, with the pedagogical advisor, of extension projects and the dissemination of the results from the Work Plan (Figure 10, items I.2.c, II.1.c and II.2.c). In their analysis, the teacher explains the role of extension, including voluntary; as well as encourages students to propose projects of this nature, not limited to existing proposals. Also, for the dissemination of the results of the extension projects, it causes interaction with society, and can even organize an event to present the fruits of the extension initiatives, and collect information from the target audience about the possibility of continuity and improvements. In this way, the university also gains visibility, and thus improves the reputation of the IES brand.

In the aforementioned process, there is also interaction with organizations, through CI projects, and internship (Figure 10, items I.2.b, I.2.d, II.1.b and II.2.d), in addition to disclosure previously mentioned, which must reach companies. In the same way, the teacher, in the role of pedagogical advisor, must present the importance of scientific and technological initiation (IT), and of the internship to the student; and encourage them to make CI and / or IT proposals, and seek internships; not being restricted to what is proposed by the HEI.

Fedotova *et al.* (2017), on interaction with organizations, when researching the teaching of humanities in the Russian Federation states that higher education goes through challenges aimed at professional functions and social performance in real conditions, capable of stimulating the cognitive activity of students, simulating the conditions of their future professional activity.

The interaction with society still allows, according to Valenzuela (2018), that future professionals experience key aspects of professional performance, such as competition and teamwork - which, potentially, allows the development of creative and possible proposals, related to problems real organizational changes.

4.6. Positive University Culture

Beyers (2016), when researching the teaching of theology, concludes that there must be a student engagement with society with inter-religious dialogue and remain connected to communities of faith, allowing theology to be involved with society, and vice-versa. versa, addressing social problems, and discussing possible solutions.

In this way, with engagement with society, the student's learning is favored, under real conditions, and, at the same time, good relationships with the world are built, a positive university culture, and with a beneficial impact on the brand's reputation. Frasineaunu (2019), when investigating the causes of academic abandonment, concludes that these do not always have an internal dimension and among the external factors that motivate this, are the anti-school, anti-work and anti-disciplinary culture.

Thus, aiming to compose a positive academic culture, which can counter the mentioned cultures, and minimize abandonment, among the items of the Academic Process Oriented to the Capital of IES Brands is the disclosure of the impacts of extension projects, CI, monitoring , and stage (Figure 10, item II.2.c). Making the university community, as well as the whole society, including companies, know the fruits of the academic actions of the HEIs.

Students, according to Foroudi (2019), when sharing information highlighting the potential of HEI - research results, scope of extensions, adoption of innovative teaching methodologies with other people, they assume a responsible posture, which produces a positive university culture, that is, pleasant, motivating. Thus, it adopts a positive attitude towards the university, encourages satisfaction with its own educational experiences in higher education, as well as that of its peers, and is more committed to the university's brand; which is reflected in the brand's reputation, in obtaining gains in relation to competitors, and in the motivation for studies, which is reflected in performance.

Reinforcing the idea of widely disseminating the results of students' projects, and the consequent need for a positive university culture, there is the research by Hemsley-Brown *et al.* (2016), through which they conclude that the commitment to a certain university influences, and is influenced, by the students' perceptions of the brand image and reputation.

4.7. Co-creation of Students

Co-creation corresponds to the set of student actions that add value to the brand, because when students develop a positive perception of the university, when experiencing satisfactory learning experiences, they seal commitment to the IES brand.

In the Academic Process Oriented to the Reputational Capital of IES Brands, student co-creation is implemented by encouraging students to have goals, through their Work Plans, as well as to propose projects, whether of extension, CI, or others, and the publicize the results of their projects. This stimulus is obtained from the pedagogical advisor - through explanations about the objectives of the projects, as well

as the analysis of existing proposals; the colleagues with whom they share the meetings to prepare and evaluate the Work Plan; and the university community - who start to share results.

Given the investigations by Hemsley-Brown *et al.* (2016), which show the positive relationship between research, student commitment and IES brand perception; the surveys also correspond to the way students take on the role of co-creator of the brand.

5. Conclusion

Although there are those who consider the impossibility of association between HEI and brands; either because the competition associated with the latter could supposedly tarnish education, transferring part of the students' learning responsibility to the service providers; either because it concludes that there are no profits or market pressure for public institutions. This recognizes the sharing, between users and providers, of responsibilities in all sectors of service provision, and proposes the improvement of the concept of profits closer to the era of knowledge, and of market pressure in order to contemplate the effective service to citizens and intangible assets, as well as the specificities that pressure the public sector, such as limitations for hiring personnel and for the acquisition of materials, excessive accountability, and expanding job demands without adjusting conditions and resources.

A modeling of the business process in academic education is presented, with a view to obtaining positive effects on the formation of the future professional, such as the achievement of the diploma necessary for the exercise of a profession; about society, which benefits from resulting community services that promote student interaction with real situations; and for the institution itself, which has its tasks improved, it optimizes the application of assets, whether tangible or intangible, and causes a positive perception about its brand.

The approach adopted for the representation of the model is adapted, with positioning of the elements of composition, with the addition of resources between the items that compose it, of intermediate results, and for the HEIs is went the suggestion is made to incorporate the reuse of studies from current disciplines.

The Academic Process Oriented to the Capital of IES Brands promotes a dialogue between requirements established by multiple academic processes of IES, and brand reputation and competition; arrives at guidelines for the composition of the process in focus: elaboration and evaluation of individual work plan, evaluation of the student's self-efficacy, implementation of the use of studies during the realization of the disciplines, individual teaching mentoring, positive university culture, interaction with society co-creation of brand by students.

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Nonlinear Feed Formulation For Broiler: Modeling And Optimization

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Summary

The current scenario requires the application of new computational tools for the feed formulation strategy that uses mathematical modeling in decision making. Noteworthy is the nonlinear programming, which aims not only to formulate a diet that meets the needs of the animal, but also the minimum cost and the maximum profit margin. Thus, the work aimed to validate the use of the nonlinear model (NLM), with maximization of the economic return, through estimates of animal performance and feed costs, according to the price variation of the kg of the broiler (price historical average of 2009 and 2010), the phases of creation and sex. For this purpose, 480 broiler broiler chickens, 240 males and 240 females of the same strain (Cobb 500) were used, from 1 to 56 days of age. The experimental design was entirely randomized, totaling 6 treatments (increasing or decreasing the average historical price of live chicken by 25% or 50%), with 4 replicates and 10 broiler chickens per experimental plot. Performance (weight gain and feed consumption), total energy consumption and profit margin were evaluated. Regarding the formulation principle (Linear and Nonlinear), the performance was very similar in relation to the studied parameters. However, when simulated values of 50% below the historical average, performance was significantly impaired in this specific condition. However, due to the profit margin, it demonstrated that the principle of nonlinear formulation allows to significantly reduce losses (P <0.05), mainly in unfavorable conditions of the price of chicken in the market. It is concluded that the nonlinear principle is more appropriate, since the requirements of all nutrients are automatically adjusted by the mathematical model and with the premise of increasing profitability, different from the linear one, which is to achieve maximum performance and not is directly related to the economic factor.

Keywords: data modeling, nonlinear programming, nutritional strategies, optimization, profitability.

1. INTRODUCTION

The industry's search for a constant increase in productivity and profit, which involves not only greater slaughter weight at a younger age, but also higher carcass and cut yields; in addition to the

growing consumer demand for lean meat intake, it imposes a challenge on feed formulators. This is because dealing with cost-benefit relations presupposes the integration of biological and economic aspects [3].

The commercial formulation of diets for broilers consists of combining ingredients in appropriate proportions to achieve the appropriate and desired nutritional profile, aiming at the optimum level between performance and cost and, consequently, maximum profitability [10].

An alternative to help in making decisions and defining better and more economical products is the use of computational modeling. This methodology seeks to transform pertinent concepts and knowledge into mathematical equations and implements them through logical processes, simulating real situations on a computer [14].

Efficiency in feed formulation is one of the needs of the animal production industry. Animal performance and development are directly linked to food intake and in order to meet the animal's requirement at a certain stage of production, it is very important that the diet is formulated efficiently [17] [19].

To improve the commercial production process, precision models of feed consumption, growth and carcass yields are of crucial importance for the economy [20].

Thus, the linear model (LM), by defining only the minimum cost of the feed, will not necessarily allow a maximum profit, hence its great limitation. This limitation promoted the development of the nonlinear concept, which seeks the best gain rates, however, allying the minimum cost diets that meet nutritional requirements [8].

The present study aimed to validate the use of a nonlinear simulation spreadsheet, with maximization of the economic return, through estimates of poultry performance and production costs, according to the variation in the price of kg of broiler and the phases from creation.

2. MATERIAL AND METHODS

The experiments were carried out in the Animal Science Sector of the Faculty of Veterinary Medicine of Araçatuba (FMVA), at Universidade Estadual Paulista (UNESP). Two experiments I (females) and II (males) were carried out, consisting of diets formulated according to the linear (minimum cost) and nonlinear (maximum profit) systems. Commercial broiler chickens (Cobb 500) were used, with 240 males and 240 females, from 1 to 56 days. The experiment was approved by the Commitee for Ethical Use Animals (CEUA) of São Paulo State University (UNESP) at campus Faculty of Veterinary Medicine (FMVA) at campus Araçatuba / SP under protocol number 008872012.

The experimental design was completely randomized, totaling 6 treatments for each experiment, and four repetitions according to the price per kg of chicken paid (normal LM, + 50%, + 25%, -50%, -25% and normal NLM) .

Subsequently, to assess the economic viability, a completely randomized design was used, with 10

treatments and four replications.

To house the broiler chickens, a masonry shed (7.85 x 45.70 m) was used, with East-West orientation, air-conditioned by an adiabatic evaporative cooling system with negative pressure ventilation, covered with tiles made of insulating material (expanded polystyrene) disposed between reflective metal plates. Inside, the chickens were placed in boxes, with a tubular feeder and pendulum drinker for each, with dimensions of 1.4 x 3.0 m, which were constituted in the experimental plots, with a bed of wood shavings and an animal density 2.38 chickens/m².

One-day-old broiler chickens were weighed and randomly distributed in 48 boxes (four replicates with 10 chickens per treatment). As initial heating sources, porcelain cones with electrical resistance of 400W were used, with one remaining in each compartment during the first 15 days of creation.

The diets were formulated based on corn, soybean meal, soybean oil, vitamin supplement, mineral supplement, limestone and dicalcium phosphate, using the recommendations of [16], according to the linear (minimum cost ration) and nonlinear (maximum profit ration) according to the mathematical model of [5] that determined the feeding strategy for males and females of broilers, defined by the Practical Program for Feed Formulation (PPFR) (Tables 1 and 2).

The results were subjected to analysis of variance to verify the effects of treatments according to the PROC GLM system procedures [18]. In order to verify the significance of the differences between treatment means, the T test (LSD) was applied.

As there are differences between the growth rates for males and females, with different nutritional recommendations, and due to the different formulations imposed by nonlinear programming, the possibility of using a factorial scheme was disregarded [15].

According to [4], the responses for the production of broilers, corresponding to age and the energy content of the diet, understood as being "nutritional density", are defined through the quadratic function, as to the equations.

The complete models adjusted for broilers from 1 to 20 days[1]:

$$\boldsymbol{Female\ live\ weight} = -2629,392616 + 1,786173 * ME - 15,325394 * A - 0,000298 * ME^2 + 0,009547 * A * ME - 1,03314 * A^2$$

$$\boldsymbol{Male\ live\ weight} = -3354,330916 + 2,275183 * ME - 26,024964 * A - 0,00038 * ME^2 + 0,012768 * A * ME - 1,238741 * A^2$$

$$\boldsymbol{Female\ feed\ consumption} = -2141,109982 + 1,396249 * ME + 26,434941 * A - 0,000223 * ME^2 + 0,007556 * A * ME + 2,376905 * A^2$$

$$\boldsymbol{Male\ feed\ consumption} = -2733,306358 + 1,782576 * ME + 26,410652 * A - 0,000285 * ME^2 + 0,008886 * A * ME + 2,819171 * A^2$$

[1] ME and A represent the Metabolizable Energy and the Age, respectively.

The complete models adjusted for broilers from 21 to 56 days[1]:

$$\boldsymbol{Female\ live\ weight} = -31935 + 20,016453 * ME + 83,445201 * A - 0,03237 * ME^2 + 0,003767 * A * ME - 0,232548 * A^2$$

$$\boldsymbol{Male\ live\ weight} = -25781 + 15,988609 * ME + 64,70638 * A - 0,002608 * ME^2 + 0,015006 * A * ME - 0,213817 * A^2$$

$$\boldsymbol{Female\ feed\ consumption} = -49998 + 31,196913 * ME + 219,350257 * A - 0,004999 * ME^2 + 0,034783 * A * ME - 0,749763 * A^2$$

$$\boldsymbol{Male\ feed\ consumption} = -37547 + 24,056064 * ME + 257,506049 * A - 0,00381 * ME^2 + 0,042241 * A * ME - 0,792996 * A^2$$

[1] ME and A represent the Metabolizable Energy and the Age, respectively.

The objective functions for profit margin (PM) for males (PMm) and females (PMf) were obtained[1]:

PMm = -0.879527 + 0.090166 × A-0.019683 × PM-0.000576 × A ^ 2 + 0.001738 × PM × A

PMf = -0.613252 + 0.075129 × A-0.012823 × PM-0.000615 × A ^ 2 + 0.00135 × PM × A

[1] *A represent the Age.*

The broilers were evaluated through their body weight gain, feed intake and feed conversion index.

Weight gain (g / broiler / period), feed intake (g / broiler / period) and feed conversion were verified at 21°, 42° and 56° days of age.

From these data, the bioeconomic index (IBE), adapted from [6], Economic efficiency (EFE) adapted by [7] and Bioeconomic Energy Conversion (BEC), was calculated in order to reduce the distortions made by the indices.

As they do not consider energy in the evaluation of economic efficiency, IBE and EFE would not be appropriate, due to the fact that in the nonlinear model diets with different energy levels are formulated in the same creation phase, which does not occur in the linear model, which formulates diets with defined energy requirements, that is why in this work the BEC (Bioeconomic Energy Conversion) index was proposed in order to evaluate this new formulation principle.

The BEC Eq formula (1) integrates the total energy intake (TEI) in Megacalories (Mcal), the weighted cost of the feed (WCF) in (R$/kg), the weight gain (WG) in (kg) and the price of live chicken (PC)(R$/kg).

$$\boldsymbol{BEC} = \frac{TEI \times WCF}{WG \times PC}\ (Mcal/kg) \qquad \text{Eq (1)}$$

It is observed that the cost per kg of the feed should be the weighted (WCF) Eq (2), because this way an average value of the feed cost is obtained with greater accuracy. Therefore the weighted cost for the experiment was:

$$\boldsymbol{WCF} = \frac{\mathrm{IFC} \times 21 + \mathrm{GFC} \times 21 + \mathrm{TFC} \times 14}{56} \qquad \text{Eq(2)}$$

Where: IFC = initial feed cost; GFC = growth feed cost; TFC = termination feed cost.

In relation to the other indexes, EFE [7], it was calculated in relation to the income obtained by weight gain and the cost invested in food in each period Eq (3), thus allowing an economic view of productivity in our market [7] through the currency of the Federal Republic of Brazil (R$) and the IBE [6] [12], used it to perform the calculation the average weight gain in the period, the relationship between the price of 1kg of feed (PF) and the sale price of 1kg of live chicken (PC) and the average feed consumption (FC), in each treatment Eq (4) .

$$\boldsymbol{EFE} = \frac{Weight\ gain\ income}{feed\ cost}\ (R\$/R\$) \qquad \text{Eq (3)}$$

$$\boldsymbol{IBE} = \text{weight gain} - \left\lfloor \left(\frac{PF}{PC}\right) \times \mathrm{FC} \right\rfloor\ (\text{kg}) \qquad \text{Eq(4)}$$

Table 1 - Composition of the feed ingredients (%) and the calculated nutrient content of the diet (%), according to the stages and requirements for females.

Ingredients	Starter (1 a 21 days of age)						Grower (22 a 42 days of age)						Finisher (43 a 56 days of age)					
	Nonlinear spreadsheet					Linear spreadsheet	Nonlinear spreadsheet					Linear spreadsheet	Nonlinear spreadsheet					Linear spreadsheet
	Price per kilogram of Broiler						Price per kilogram of Broiler						Price per kilogram of Broiler					
	0.82	1.23	1.64	2.05	2.46		0.82	1.23	1.64	2.05	2.46		0.82	1.23	1.64	2.05	2.46	
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Feed cost	0.582	0.624	0.657	0.671	0.678	0.662	0.511	0.531	0.531	0.535	0.535	0.614	0.464	0.495	0.501	0.506	0.506	0.000
Inert	0.000	0.000	0.000	0.000	0.000	0.000	1.890	0.000	0.000	0.000	0.000	0.000	6.227	0.000	0.000	0.000	0.000	66.737
Corn	61.881	62.135	58.692	57.258	56.507	56.893	67.259	72.664	72.664	73.556	73.534	65.413	66.041	70.427	72.777	74.816	74.816	4.733
Soy oil	0.000	1.398	3.096	3.803	4.173	3.566	0.000	0.000	0.000	0.000	0.012	4.225	0.000	0.000	0.000	0.000	0.000	25.076
Soybean mean -45%	34.293	32.277	33.930	34.618	34.978	35.313	27.909	24.047	24.047	23.074	23.085	26.814	25.036	26.699	24.184	22.003	22.003	1.359
Dicalcium phosphate	1.581	1.670	1.722	1.744	1.755	1.724	1.240	1.318	1.318	1.330	1.330	1.440	1.101	1.174	1.204	1.230	1.230	0.415
Common salt	0.447	0.458	0.471	0.476	0.479	0.472	0.382	0.397	0.397	0.398	0.398	0.427	0.351	0.375	0.378	0.382	0.382	0.000
L-Lysine HCl	0.109	0.225	0.214	0.209	0.206	0.176	0.000	0.158	0.158	0.193	0.192	0.158	0.000	0.000	0.090	0.167	0.167	0.165
DL-Methionine	0.189	0.237	0.249	0.254	0.257	0.242	0.084	0.132	0.132	0.142	0.142	0.166	0.065	0.069	0.095	0.118	0.118	0.153
L Threonine	0.000	0.055	0.056	0.056	0.056	0.041	0.000	0.000	0.000	0.015	0.015	0.013	0.000	0.000	0.000	0.000	0.000	0.012
Calcitic limestone	0.824	0.847	0.858	0.862	0.864	0.856	0.721	0.753	0.753	0.756	0.756	0.777	0.662	0.706	0.716	0.725	0.725	0.749
Polimax F-pre initial (Fatec)	0.676	0.698	0.714	0.721	0.725	0.716	0.515	0.533	0.533	0.535	0.535	0.567	0.000	0.000	0.000	0.000	0.000	0.000
Polimax F-3 finishing (Fatec)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.517	0.551	0.556	0.561	0.561	0.600
Calculated composition																		
Metabolizable Energy (Kcal kg-1)	2.877	2.970	3.040	3.070	3.085	3.050	2.907	3.010	3.010	3.020	3.021	3.200	2.800	2.986	3.013	3.036	3.036	3.250
Crude protein (%)	20.865	20.152	20.613	20.805	20.906	21.041	18.252	17.125	17.125	16.808	16.811	17.810	16.839	17.957	17.111	16.377	16.377	17.130
Calcium (%)	0.805	0.831	0.850	0.858	0.863	0.853	0.668	0.691	0.691	0.694	0.694	0.735	0.604	0.644	0.650	0.655	0.655	0.701
Available phosphorus (%)	0.404	0.417	0.427	0.431	0.433	0.428	0.333	0.345	0.345	0.346	0.346	0.367	0.302	0.322	0.324	0.327	0.327	0.350
Potassium (%)	0.801	0.765	0.785	0.794	0.798	0.806	0.699	0.644	0.644	0.628	0.628	0.674	0.643	0.686	0.646	0.612	0.612	0.646
Sodium(%)	0.197	0.201	0.205	0.207	0.208	0.206	0.171	0.177	0.177	0.177	0.177	0.188	0.158	0.168	0.170	0.171	0.171	0.183
Chlorine (%)	0.336	0.364	0.368	0.370	0.371	0.362	0.275	0.315	0.315	0.323	0.323	0.331	0.255	0.272	0.291	0.308	0.308	0.325
Linoleic acid	1.362	2.107	2.971	3.331	3.519	3.201	1.418	1.491	1.491	1.501	1.507	3.655	1.376	1.468	1.494	1.517	1.517	3.942
Dig. Lysine	1.086	1.121	1.147	1.158	1.164	1.151	0.853	0.883	0.883	0.886	0.886	0.939	0.777	0.829	0.836	0.843	0.843	0.902
Dig. Methionine	0.484	0.519	0.535	0.541	0.545	0.533	0.352	0.385	0.385	0.391	0.391	0.423	0.314	0.335	0.350	0.362	0.362	0.403
Dig. Methionine + Cystine	0.771	0.796	0.814	0.822	0.826	0.817	0.614	0.636	0.636	0.638	0.638	0.676	0.559	0.596	0.602	0.606	0.606	0.649
Dig. Tryptophan	0.229	0.218	0.225	0.228	0.230	0.232	0.197	0.178	0.178	0.173	0.173	0.189	0.180	0.192	0.179	0.168	0.168	0.180
Dig. Threonine	0.705	0.728	0.746	0.753	0.757	0.748	0.620	0.574	0.574	0.576	0.576	0.610	0.571	0.609	0.576	0.547	0.547	0.586
Dig. Arginine	1.320	1.257	1.297	1.314	1.323	1.335	1.135	1.031	1.031	1.003	1.003	1.094	1.039	1.108	1.036	0.973	0.973	1.043
Dig. Valine	0.878	0.840	0.860	0.869	0.873	0.881	0.774	0.718	0.718	0.703	0.703	0.746	0.714	0.762	0.721	0.687	0.687	0.718
Dig. Isoleucine	0.819	0.781	0.804	0.814	0.819	0.826	0.711	0.651	0.651	0.634	0.634	0.685	0.652	0.696	0.654	0.617	0.617	0.655
Dig. Leucine	1.704	1.642	1.662	1.670	1.674	1.689	1.551	1.479	1.479	1.456	1.457	1.498	1.447	1.543	1.485	1.434	1.434	1.455
Dig. Histidine	0.529	0.507	0.517	0.522	0.524	0.529	0.471	0.441	0.441	0.433	0.433	0.455	0.436	0.465	0.443	0.424	0.424	0.439
Dig. Phenylalanine	0.959	0.917	0.940	0.949	0.954	0.963	0.843	0.781	0.781	0.764	0.764	0.813	0.778	0.829	0.784	0.745	0.745	0.781
Dig. Phenylalanine+Tyrosine	1.618	1.547	1.584	1.600	1.608	1.623	1.423	1.319	1.319	1.289	1.290	1.372	1.312	1.399	1.324	1.259	1.259	1.318
Energy:Protein Ratio	137.869	147.391	147.495	147.538	147.559	144.958	159.250	175.753	175.753	179.674	179.674	179.674	166.285	166.285	176.079	185.394	185.394	189.726

Vitamin-mineral supplements used in diets in three rearing stages (quantity / kg of product) included: pre Initial: vit. A - 1,835,000 I.U. vit. D3 - 335,000 I.U. vit. E - 2,835 mg; vit. K3 - 417 mg; vit. B1 - 335 mg; vit. B2 - 1,000 mg; vit. B6 - 335 mg; vit. B12 - 2,500 mcg; folic acid - 135 mg; biotin - 17 mg; niacin - 6,670 mg; calcium pantothenate - 1,870 mg; Cu - 1,000 mg; Co - 35 mg; I - 170 mg; Fe - 8,335 mg; Mn - 10,835mg; Zn - 8,335 mg; Se - 35 mg; Choline Chloride 50% - 135,000 mg; Methionine - 267,000 mg; Coccidiostatic - 13,335 mg; Growth Promoter - 16,670 mg; Antioxidant - 2,000 mg. Termination: vit. A - 1,670,000 I.U. vit. D3 - 335,000 I.U. vit. E - 2,335 mg; vit. K3 - 400 mg; vit. B1 - 100 mg;

vit. B2 - 800 mg; vit. B6 - 200 mg; vit. B12 - 2,000 mcg; folic acid - 67 mg; biotin - 7 mg; niacin - 5,670 mg; calcium pantothenate - 2,000 mg; Cu - 2,000 mg; Co - 27 mg; I - 270 mg; Fe - 16,670 mg; Mn - 17,335 mg; Zn - 12,000 mg; Se - 70 mg; Choline Chloride 50% - 100,000mg; Methionine - 235,000mg; Antioxidant - 2,000 mg.

Table 2 - Composition of feed ingredients (%) and calculated nutrient content of the diet (%), according to the stages and requirements for males.

Ingredients	Starter (1 a 21 days of age)						Growero (22 a 42 days of age)						Finisher (43 a 56 days of age)					
	Nonlinear spreadsheet					Linear spreadsheet	Nonlinear spreadsheet					Linear spreadsheet	Nonlinear spreadsheet					Linear spreadsheet
	Price per kilogram of Broiler						Price per kilogram of Broiler						Price per kilogram of Broiler					
	0.82	1.23	1.64	2.05	2.46		0.82	1.23	1.64	2.05	2.46		0.82	1.23	1.64	2.05	2.46	
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Feed cost	0.599	0.659	0.686	0.696	0.702	0.677	0.511	0.542	0.544	0.556	0.586	0.648	0.507	0.517	0.517	0.525	0.534	0.631
Inert	0.000	0.000	0.000	0.000	0.000	0.000	0.312	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corn	63.092	57.260	54.458	53.392	52.852	54.196	62.110	68.270	68.867	69.663	66.603	60.152	66.476	70.242	70.242	72.193	71.275	61.183
Soy oil	0.000	3.004	4.371	4.891	5.155	4.091	0.000	0.000	0.000	0.293	1.859	5.161	0.000	0.000	0.000	0.000	0.476	5.717
Soybean mean -45%	32.679	35.304	36.662	37.179	37.441	37.301	30.846	28.368	27.716	26.489	27.910	30.905	30.535	26.512	26.512	24.387	24.806	29.423
Dicalcium phosphate	1.707	1.808	1.852	1.868	1.877	1.830	1.257	1.358	1.366	1.393	1.436	1.526	1.215	1.264	1.264	1.291	1.303	1.438
Common salt	0.472	0.496	0.507	0.511	0.513	0.503	0.398	0.412	0.414	0.418	0.429	0.453	0.400	0.395	0.395	0.399	0.402	0.438
L-Lysine HCl	0.215	0.208	0.199	0.195	0.194	0.167	0.000	0.137	0.161	0.213	0.202	0.180	0.000	0.145	0.145	0.222	0.219	0.183
DL-Methionine	0.233	0.259	0.269	0.272	0.274	0.256	0.116	0.161	0.168	0.186	0.196	0.218	0.105	0.148	0.148	0.171	0.174	0.207
L Threonine	0.049	0.056	0.057	0.057	0.057	0.042	0.000	0.000	0.010	0.034	0.034	0.034	0.000	0.000	0.000	0.033	0.033	0.034
Calcitic limestone	0.874	0.895	0.904	0.908	0.909	0.898	0.723	0.769	0.772	0.779	0.788	0.805	0.725	0.742	0.742	0.750	0.753	0.778
Polimax F-pre initial (Fatec)	0.678	0.708	0.721	0.726	0.729	0.716	0.496	0.524	0.526	0.531	0.542	0.567	0.000	0.000	0.000	0.000	0.000	0.000
Polimax F-3 finishing (Fatec)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.543	0.551	0.551	0.555	0.559	0.600
Calculated composition																		
Metabolizable Energy (Kcal kg-1)	2.888	3.015	3.071	3.092	3.103	3.050	2.800	2.959	2.966	2.994	3.060	3.200	2.940	2.984	2.984	3.006	3.027	3.250
Crude protein (%)	20.397	21.119	21.500	21.645	21.719	21.719	19.176	18.718	18.506	18.094	18.481	19.296	19.390	18.040	18.040	17.349	17.462	18.706
Calcium (%)	0.851	0.889	0.905	0.912	0.915	0.899	0.678	0.717	0.718	0.725	0.741	0.775	0.669	0.679	0.679	0.684	0.689	0.740
Available phosphorus (%)	0.425	0.444	0.452	0.455	0.457	0.449	0.338	0.357	0.358	0.361	0.369	0.386	0.333	0.338	0.338	0.340	0.343	0.368
Potassium (%)	0.775	0.806	0.823	0.830	0.833	0.834	0.738	0.710	0.700	0.680	0.697	0.734	0.745	0.682	0.682	0.648	0.654	0.710
Sodium(%)	0.206	0.216	0.220	0.221	0.222	0.218	0.177	0.183	0.184	0.185	0.189	0.198	0.178	0.176	0.176	0.178	0.179	0.192
Chlorine (%)	0.371	0.382	0.386	0.388	0.389	0.378	0.284	0.321	0.326	0.339	0.342	0.350	0.287	0.312	0.312	0.329	0.330	0.342
Linoleic acid	1.374	2.905	3.599	3.864	3.998	3.448	1.343	1.439	1.446	1.610	2.408	4.091	1.421	1.463	1.463	1.485	1.727	4.400
Dig. Lysine	1.126	1.175	1.197	1.206	1.210	1.189	0.917	0.969	0.971	0.981	1.002	1.048	0.918	0.932	0.932	0.939	0.945	1.015
Dig. Methionine	0.519	0.550	0.563	0.568	0.570	0.554	0.392	0.432	0.436	0.448	0.461	0.489	0.386	0.411	0.411	0.424	0.428	0.471
Dig. Methionine + Cystine	0.799	0.834	0.850	0.856	0.859	0.844	0.661	0.698	0.700	0.706	0.722	0.755	0.661	0.671	0.671	0.676	0.681	0.731
Dig. Tryptophan	0.221	0.232	0.238	0.240	0.241	0.241	0.210	0.200	0.197	0.190	0.196	0.209	0.211	0.191	0.191	0.180	0.182	0.201
Dig. Threonine	0.732	0.764	0.778	0.784	0.787	0.773	0.652	0.630	0.631	0.637	0.651	0.681	0.659	0.606	0.606	0.610	0.615	0.660
Dig. Arginine	1.273	1.336	1.369	1.382	1.388	1.389	1.211	1.154	1.135	1.098	1.133	1.206	1.216	1.101	1.101	1.040	1.050	1.162
Dig. Valine	0.852	0.882	0.898	0.904	0.908	0.910	0.813	0.786	0.776	0.755	0.772	0.807	0.822	0.758	0.758	0.723	0.728	0.782
Dig. Isoleucine	0.791	0.827	0.846	0.853	0.856	0.857	0.754	0.722	0.711	0.690	0.709	0.750	0.759	0.692	0.692	0.656	0.662	0.724
Dig. Leucine	1.664	1.692	1.709	1.715	1.718	1.727	1.596	1.576	1.560	1.529	1.545	1.579	1.628	1.535	1.535	1.486	1.490	1.541
Dig. Histidine	0.514	0.529	0.538	0.541	0.542	0.544	0.491	0.479	0.473	0.461	0.470	0.487	0.498	0.463	0.463	0.444	0.446	0.473
Dig. Phenylalanine	0.930	0.964	0.982	0.989	0.993	0.995	0.887	0.857	0.845	0.822	0.841	0.881	0.896	0.825	0.825	0.787	0.792	0.853
Dig. Phenylalanine+Tyrosine	1.567	1.625	1.656	1.667	1.673	1.677	1.496	1.446	1.426	1.387	1.419	1.485	1.512	1.392	1.392	1.328	1.337	1.439
Energy:Protein Ratio	141.590	142.767	142.843	142.872	142.886	140.432	146.015	158.082	160.261	165.472	165.594	165.837	151.636	165.389	165.389	173.276	173.318	173.742

Vitamin-mineral supplements used in diets in three rearing stages (quantity / kg of product) included: pre Initial: vit. A - 1,835,000 I.U. vit. D3 - 335,000 I.U. vit. E - 2,835 mg; vit. K3 - 417 mg; vit. B1 - 335 mg; vit. B2 - 1,000 mg; vit. B6 - 335 mg; vit. B12 - 2,500 mcg; folic acid - 135 mg; biotin - 17 mg; niacin - 6,670 mg; calcium pantothenate - 1,870 mg; Cu - 1,000 mg; Co - 35 mg; I - 170 mg; Fe - 8,335 mg; Mn - 10,835mg; Zn - 8,335 mg; Se - 35 mg; Choline Chloride 50% - 135,000 mg; Methionine - 267,000 mg; Coccidiostatic - 13,335 mg; Growth Promoter - 16,670 mg; Antioxidant - 2,000 mg. Termination: vit. A - 1,670,000 I.U. vit. D3 - 335,000 I.U. vit. E - 2,335 mg; vit. K3 - 400 mg; vit. B1 - 100 mg; vit. B2 - 800 mg; vit. B6 - 200 mg; vit. B12 - 2,000 mcg; folic acid - 67 mg; biotin - 7 mg; niacin - 5,670 mg; calcium pantothenate - 2,000 mg; Cu - 2,000 mg; Co - 27 mg; I - 270 mg; Fe - 16,670 mg; Mn - 17,335 mg; Zn - 12,000 mg; Se - 70 mg; Choline Chloride 50% - 100,000mg; Methionine - 235,000mg; Antioxidant - 2,000 mg.

3. RESULTS AND DISCUSSION

Regarding the formulation principle (Linear and Nonlinear), the performance (Tables 3 and 4) was very similar in relation to the studied parameters. However, when simulated values of 50% below the historical average, performance was significantly impaired in this specific condition.

If all essential nutrients are maintained in an adequate proportion to the energy density of the diet, body weight and feed conversion are favored by increasing the energy density of the feed.

This condition makes it possible to apply models for maximum profit (nonlinear formulation), aiming to estimate the most appropriate proportion of weight gain according to the price paid by the market, producing quality carcasses.

This worsening in live weight, weight gain, feed consumption and feed conversion is mainly due to the lower energy : nutrient content offered in this diet (-50%), which was inherent to the formulation principle (nonlinear), which does not aim at the best broiler performance, but at the economic optimization of production.

As for the profit margin (Table 5), it was demonstrated that the principle of nonlinear formulation allows to significantly reduce losses (P <0.05), mainly under unfavorable conditions in the market price of chicken.

Table 3 - Live weight, weight gain, feed intake and feed conversion for female broilers, according to age and the linear model (LM) and nonlinear model (NLM) formulation principle.

	Live weight (kg)			Weight gain (kg)			Feed consuption (kg)			Food conversion (kg/kg)		
Trataments	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days
Normal LM	0.93 **a**	2.71 **a**	3.81 **a**	0.89 **a**	2.7 **a**	3.8 **a**	1.3 **a**	4.8 **b**	7.4 **b**	1.4 **b**	1.8 **c**	2.0 **c**
NLM+25%	0.94 **a**	2.63 **ab**	3.67 **ab**	0.89 **a**	2.6 **ab**	3.6 **ab**	1.3 **a**	4.9 **ab**	7.9 **ab**	1.4 **b**	1.9 **ab**	2.2 **ab**
NLM+50%	0.93 **a**	2.63 **ab**	3.64 **ab**	0.88 **a**	2.6 **ab**	3.6 **ab**	1.3 **a**	4.9 **ab**	7.6 **ab**	1.4 **b**	1.9 **b**	2.1 **b**
NLM-25%	0.88 **bc**	2.59 **ab**	3.60 **b**	0.84 **bc**	2.5 **ab**	3.6 **b**	1.3 **a**	4.9 **ab**	7.7 **ab**	1.5 **b**	1.9 **b**	2.2 **b**
NLM-50%	0.85 **c**	2.56 **b**	3.60 **b**	0.80 **c**	2.5 **b**	3.6 **b**	1.3 **a**	5.0 **a**	8.0 **a**	1.6 **a**	2.0 **a**	2.3 **a**
Normal NLM	0.91 **ab**	2.61 **ab**	3.63 **ab**	0.87 **ab**	2.6 **ab**	3.6 **ab**	1.3 **a**	4.9 **ab**	7.8 **ab**	1.5 **b**	1.9 **ab**	2.2 **ab**
P	0.0004	0.2437	0.2524	0.0004	0.2437	0.2524	0.3038	0.3534	0.2938	0.0027	0.0024	0.0010
CV (%)	2.82	3.16	3.54	0.69	3.22	3.58	3.44	3.25	5.09	4.87	2.95	3.42

[a-b] Mean values with same letter within a column are not significantly different (P<0.05); * kg of paid chicken (normal, + 25%, + 50%, -25% and -50%), according to the historical price from 2009 to 2010.

Table 4 - Live weight, weight gain, feed intake and feed conversion for male broilers, according to age and the linear model (LM) and nonlinear model (NLM) formulation principle.

	Live weight (kg)			Weight gain (kg)			Feed consuption (kg)			Food conversion (kg/kg)		
Tratamens	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days	1 - 21 days	1 - 42 days	1 - 56 days
Normal LM	1.03 **ab**	3.25 **a**	4.74 **a**	0.98 **ab**	3.20 **a**	4.69 **a**	1.4 **ab**	5.2 **c**	8.4 **c**	1.4 **b**	1.6 **c**	1.8 **c**
NLM+25%	1.05 **a**	3.06 **b**	4.38 **b**	1.00 **a**	3.01 **b**	4.34 **b**	1.3 **ab**	5.3 **bc**	8.4 **c**	1.3 **b**	1.8 **b**	1.9 **b**
NLM+50%	1.04 **a**	3.22 **a**	4.53 **ab**	0.99 **a**	3.18 **a**	4.48 **ab**	1.3 **b**	5.4 **bc**	8.7 **bc**	1.3 **b**	1.7 **c**	1.9 **b**
NLM-25%	0.99 **b**	3.12 **ab**	4.55 **ab**	0.95 **b**	3.08 **ab**	4.50 **ab**	1.4 **a**	5.6 **ab**	8.9 **bc**	1.5 **a**	1.8 **b**	2.0 **b**
NLM-50%	0.95 **c**	3.13 **ab**	4.60 **ab**	0.90 **c**	3.09 **ab**	4.56 **ab**	1.4 **a**	5.8 **a**	9.5 **a**	1.6 **a**	1.9 **a**	2.1 **a**
Normal NLM	1.01 **ab**	3.13 **ab**	4.61 **ab**	0.97 **ab**	3.09 **ab**	4.56 **ab**	1.4 **ab**	5.5 **b**	9.0 **b**	1.4 **b**	1.8 **b**	2.0 **b**
P	0.0004	0.0800	0.1503	0.0004	0.0800	0.1506	0.1703	0.0022	0.0020	0.0002	<.0001	0.0002
CV (%)	0.69	2.83	3.78	0.69	2.88	3.81	0.33	3.19	3.91	4.86	2.41	3.40

[a-c] Mean values with same letter within a column are not significantly different (P<0.05); * kg of paid chicken (normal, + 25%, + 50%, -25% and -50%), according to the historical price from 2009 to 2010

Table 5 - Absolute profit margin for female and male broilers, according to the relative price of the chicken and the principle of linear and nonlinear formulation.

	Profit margin (R$) Female						**Profit margin (R$) Male**					
Relative price	Nonlinear 1-21 days	Linear 1-21 days	Nonlinear 1-42 days	Linear 1-42 days	Nonlinear 1-56 days	Linear 1-56 days	Nonlinear 1-21 days	Linear 1-21 days	Nonlinear 1-42 days	Linear 1-42 days	Nonlinear 1-56 days	Linear 1-56 days
N +50%	1.42 **a**	1.46 **a**	3.68 **a**	3.68 **a**	4.80 **a**	4.79 **a**	1.63 **a**	1.60 **a**	4.63 **a**	4.55 **a**	6.06 **a**	6.25 **a**
N +25%	1.07 **b**	1.08 **b**	2.57 **b**	2.57 **b**	3.20 **b**	3.23 **b**	1.21 **b**	1.18 **b**	3.11 **b**	3.22 **b**	4.20 **b**	4.31 **b**
Normal (N)[1]	0.64 **c**	0.69 **c**	1.50 **c**	1.46 **c**	1.75 **c**	1.67 **c**	0.74 **c**	0.76 **c**	1.94 **c**	1.89 **c**	2.58 **c**	2.36 **c**
N -25%	0.30 **d**	0.31 **d**	0.49 **d**	0.35 **d**	0.35 **d**	0.11 **d***	0.28 **d**	0.34 **d**	0.65 **d**	0.56 **d**	0.70 **d**	0.42 **d**
N -50%	-0.07 **e**	-0.07 **e**	-0.56 **e**	-0.76 **e***	-1.11 **e**	-1.46 **e***	-0.08 **e**	-0.08 **e**	-0.53 **e**	-0.77 **e***	-1.20 **e**	-1.52 **e**
P	<.0001		<.0001		<.0001		<.0001		<.0001		<.0001	
CV (%)	7.82		8.96		8.78		6.24		6.22		10.49	

Statistically different means (*) on the line by the T test (P<0.05); 1 Historical average price from 2009 to 2010 (kg of broiler paid to the producer); a-e Mean values with same letter within a column are not significantly different (P<0.05).

Evaluating the EFE, IBE and BEC indices in the analysis of the bioeconomic profit margin (Tables 6 to 8). The data suggest that the bioeconomic energy conversion (BEC), proved to be more adequate to differentiate the evaluated formulation principles (Linear and Nonlinear), regardless of sex and period (Table 6). In relation to the bioeconomic indices evaluated (EFE, IBE and BEC / Tables 8 to 10), BEC differs by incorporating the most expensive item in a diet (energy), by measuring energy consumption according to bioeconomic conversion, that is, the best performance was analyzed in relation to the energy level of the diet. It follows that the lower the index, the better the cost/benefit ratio.

Table 6 - Absolute Bioeconomic Energy Conversion (BEC) for female and male broilers, according to the relative price of the chicken and the principle of linear and nonlinear formulation.

	Bioeconomic Energy Conversion (Female)						**Bioeconomic Energy Conversion (Male)**					
Relative price	Nonlinear 1-21 days	Linear 1-21 days	Nonlinear 1-42 days	Linear 1-42 days	Nonlinear 1-56 days	Linear 1-56 days	Nonlinear 1-21 days	Linear 1-21 days	Nonlinear 1-42 days	Linear 1-42 days	Nonlinear 1-56 days	Linear 1-56 days
N +50%	1.22 **e**	1.17 **e**	1.41 **e**	1.47 **e**	1.51 **e**	1.61 **e**	1.17 **e**	1.17 **e**	1.36 **e**	1.39 **e**	1.49 **e**	1.52 **e**
N +25%	1.43 **d**	1.40 **d**	1.71 **d**	1.76 **d**	1.87 **d**	1.93 **d**	1.41 **d**	1.40 **d**	1.63 **d**	1.67 **d**	1.72 **d**	1.82 **d**
Normal (N)[1]	1.84 **c**	1.76 **c**	2.1 **c**	2.20 **c***	2.27 **c**	2.41 **c***	1.79 **c**	1.75 **c**	2.01 **c**	2.09 **c**	2.12 **c**	2.27 **c***
N -25%	2.26 **b**	2.34 **b**	2.69 **b**	2.93 **b***	2.92 **b**	3.22 **b***	2.43 **b**	2.34 **b**	2.63 **b**	2.79 **b***	2.77 **b**	3.03 **b***
N -50%	3.37 **a**	3.51 **a***	3.86 **a**	4.40 **a***	4.15 **a**	4.83 **a***	3.36 **a**	3.51 **a***	3.60 **a**	4.18 **a***	3.97 **a**	4.55 **a***
P	<.0001		<.0001		<.0001		<.0001		<.0001		<.0001	
CV (%)	4.46		2.33		3.05		4.49		2.49		3.55	

Statistically different means (*) on the line by the T test (P<0.05); [1] Relative price of the kg of the broiler paid to the producer. BEC =(total energy consumption×weighted feed cost/kg):(weight gain kg×live chicken cost); a-e Mean values with same letter within a column are not significantly different (P<0.05).

Through this strategy, and with the evolution from linear to nonlinear formulation, economic optimization by energy density becomes dependent, mainly, on the energy and protein prices of feed ingredients and the value of chicken/kg. This procedure, since it complies with the law of decreasing returns [2], admits through nonlinear programming the most adequate condition for energy density, which is not possible due to linear formulation [1] [13].

Therefore, to improve the energy density of a feed, it is necessary to use the nonlinear formulation.

Among the indexes evaluated (BEC, IBE and EFE), IBE presented the highest variation coefficient, with values between 9.48 to 20.27, demonstrating a great instability (Table 7). For EFE, the values were intermediate for CV, with values ranging from 2.96 to 4.67% (Table 8). As for BEC, the CV varied from 2.33 to 4.49%, thus demonstrating greater reliability for the evaluation of the averages of the current formulation principles (Table 6).

Table 7 - Absolute Bioeconomic Index (IBE) for female and male broilers, according to the relative price of the chicken and the principle of linear and nonlinear formulation.

	Bioeconomic Index (Female)						Bioeconomic Index (Male)					
	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear
Relative price	1-21 days	1-21 days	1-42 days	1-42 days	1-56 days	1-56 days	1-21 days	1-21 days	1-42 days	1-42 days	1-56 days	1-56 days
N +50%	0.53 **a**	0.55 **a**	1.38 **a**	1.43 **a**	1.81 **a**	1.87 **a**	0.62 **a**	0.61 **a**	1.77 **a**	1.79 **a**	2.30 **a**	2.47 **a**
N +25%	0.48 **b**	0.48 **b**	1.13 **b**	1.18 **b**	1.39 **b**	1.49 **b**	0.54 **b**	0.53 **b**	1.38 **b**	1.51 **b***	1.87 **b**	2.02 **b**
Normal (N)[1]	0.34 **c**	0.38 **c**	0.78 **c**	0.81 **c**	0.88 **c**	0.92 **c**	0.40 **c**	0.42 **c**	1.01 **c**	1.09 **c**	1.33 **c**	1.35 **c***
N -25%	0.20 **d**	0.21 **d**	0.26 **d**	0.19 **d**	0.09 **d**	-0.03 **d**	0.18 **d**	0.23 **d***	0.36 **d**	0.38 **d**	0.32 **d**	0.24 **d***
N -50%	-0.14 **e**	-0.13 **e**	-0.83 **e**	-1.04 **e***	-1.70 **e**	-1.93 **e***	-0.15 **e**	-0.15 **e**	-0.85 **e**	-1.03 **e***	-1.74 **e**	-1.99 **e***
P	<.0001		<.0001		<.0001		<.0001		<.0001		<.0001	
CV (%)	10.76		12.61		20.27		9.78		9.48		18.92	

Statistically different means (*) on the line by the T test (P<0.05); [1] Relative price of the kg of the broiler paid to the producer. IBE=weight gain – (A×CR), a being the ratio between the price of one kg of feed and the selling price of one kg of whole chicken (Guidoni, 1994; Meinerz et al., 2001); a-e Mean values with same letter within a column are not significantly different (P<0.05).

Table 8 - Absolute Bioeconomic Efficiency (EFE) for female and male broilers, according to the relative price of the chicken and the principle of linear and nonlinear formulation.

	Bioeconomic Efficiency (Female)						Bioeconomic Efficiency (Male)					
	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear	Nonlinear	Linear
Relative price	1-21 days	1-21 days	1-42 days	1-42 days	1-56 days	1-56 days	1-21 days	1-21 days	1-42 days	1-42 days	1-56 days	1-56 days
N +50%	2.53 **a**	2.61 **a**	2.28 **a**	2.20 **a***	2.13 **a**	2.02 **a***	2.65 **a**	2.61 **a**	2.37 **a**	2.29 **a***	2.17 **a**	2.14 **a**
N +25%	2.16 **b**	2.17 **b**	1.88 **b**	1.83 **b**	1.72 **b**	1.69 **b**	2.19 **b**	2.18 **b**	1.96 **b**	1.91 **b**	1.86 **b**	1.78 **b***
Normal (N)[1]	1.66 **c**	1.74 **c**	1.52 **c**	1.46 **c**	1.40 **c**	1.35 **c**	1.72 **c**	1.74 **c**	1.58 **c**	1.53 **c**	1.50 **c**	1.42 **c***
N -25%	1.31 **d**	1.30 **d**	1.16 **d**	1.10 **d**	1.07 **d**	1.01 **d***	1.25 **d**	1.31 **d**	1.19 **d**	1.15 **d**	1.13 **d**	1.07 **d**
N -50%	0.86 **e**	0.87 **e**	0.78 **e**	0.73 **e**	0.72 **e**	0.67 **e**	0.86 **e**	0.87 **e**	0.82 **e**	0.76 **e**	0.75 **e**	0.71 **e**
P	<.0001		<.0001		<.0001		<.0001		<.0001		<.0001	
CV (%)	4.67		3.00		2.96		3.87		2.53		3.66	

Statistically different means (*) on the line by the T test (P<0.05); [1] Relative price of the kg of the broiler paid to the producer. EFE = (weight gain income : feed cost)); a-e Mean values with same letter within a column are not significantly different (P<0.05).

According to the present experiment, it is evident that all the indexes evaluated (BEC, IBE and EFE) made it possible to measure the variations imposed on the normal market price (with ranges of 25 to 50%, for or less). In other words, what was already expected, due to the high magnitude imposed for price variation (increases or decreases of 25%).

However, in relation to the main objective of the present proposal, regarding the comparison between formulation principles (linear and nonlinear), the differences were extremely distinct, evidencing very well that there was much more quality and sensitivity of measurement by the BEC index.

Then, all indexes presented a significant (P) probability (P <0.0001). Despite this extremely favorable P, the different behavior between the different indices must be highlighted. While the EFE presented its values differentiated between the principles of formulation tending towards the higher relative prices, the IBE presented a trend towards the lower values of the relative price of the broiler. However, both rates were fluctuating.

The BEC, on the other hand, showed a more consistent behavior, with the statistical significance of the differences between the averages associated with the lower ranges of relative price of the broiler, showing less oscillation of the trend and greater coherence of the index.

It was observed that for both females and males, the amount of abdominal fat is related to the formulation principle, being significantly favorable (P <0.05) for nonlinear. Because there is a worse use of energy (deviated to fat deposition) for the principle of linear formulation (Tables 9 to 12).

The average values for the absolute weight and the weight of the body components of the broilers, in grams, are presented in Tables 9 to 12. However, the body composition for abdominal fat, feet, head and neck, feathers and blood, were significantly affected (P <0.05) by the formulation principle adopted (Linear vs NonLinear).

Table 9 - Average values for absolute weight (grams) of carcass and body components of female broilers at 42 days of slaughter, according with the linear model (LM) and nonlinear model (NLM) formulation principle.

42 days of age							
Trataments	Carcass	Abdominal fat weight	Feet	Head + neck	Viscera	Feathers	Blood
Normal LM	1930[a]	45[ab]	78.8[a]	141.3[a]	211.3[a]	105[a]	70[a]
NLM +25%	1770[a]	61.3[a]	66.3[ab]	133.8[ab]	225[a]	97.5[a]	62.5[a]
NLM +50%	1796[a]	45[ab]	62.5[b]	135[ab]	220[a]	115[a]	90[a]
NLM -25%	1759[a]	47.5[ab]	66.3[ab]	126.3[ab]	198.8[a]	117.5[a]	65[a]
NLM -50%	1895[a]	36.3[b]	66.3[ab]	123.8[ab]	211.3[a]	112.5[a]	63.8[a]
Normal NLM	1785[a]	41.3[b]	60[b]	120[b]	208.8[a]	106.3[a]	63.3[a]
P	0.6350	0.1697	0.1600	0.2780	0.4224	0.8060	0.3882
CV (%)	9.45	27.48	14.36	10.45	8.43	20.28	28.65

[a-b] Mean values with same letter within a column are not significantly different (P<0.05).

Table 10 - Average values for absolute weight (grams) of carcass and body components of male broilers at 42 days of slaughter, according with the linear model (LM) and nonlinear model (NLM) formulation principle.

42 days of age							
Trataments	Carcass	Abdominal	Feet	Head + neck	Viscera	Feathers	Blood
Normal LM	2339[a]	41.3[a]	98.8[a]	163.8[a]	247.5[a]	120[a]	105[a]
NLM +25%	2243[a]	36.3[a]	96.3[a]	162.5[a]	233.8[a]	155[a]	66.3[b]
NLM +50%	2146[a]	33.8[a]	91.3[a]	140[a]	232.5[a]	107.5[a]	107.5[a]
NLM -25%	2345[a]	31.3[a]	98.8[a]	166.3[a]	256.3[a]	142.5[a]	105[a]
NLM -50%	2270[a]	31.3[a]	97.5[a]	146.3[a]	263.8[a]	150[a]	77.5[ab]
Normal NLM	2119[a]	35[a]	87.5[a]	152.5[a]	228.8[a]	137.5[a]	77.5[ab]
P	0.6936	0.9760	0.6495	0.6723	0.5930	0.3463	0.1285
CV (%)	10.84	54.80	11.83	17.15	13.49	24.57	28.51

[a-b] Mean values with same letter within a column are not significantly different (P<0.05).

Thus, abdominal fat, when expressed in absolute value (g), was significantly reduced (P <0.05) for females by 56.29% (from 120.1 g to 67.6 g, respectively for the Normal LM and Normal NLM), at 56 days of age (Table 11).

Table 11- Average values for absolute weight (grams) of carcass and body components of female broilers at 56 days of slaughter, according with the linear model (LM) and nonlinear model (NLM) formulation principle.

56 days of age							
Trataments	Carcass	Abdominal	Feet	Head + neck	Viscera	Feathers	Blood
Normal LM	2901[a]	120.1[a]	90[a]	217.5[a]	310[a]	185[a]	87.5[a]
NLM +25%	2692[a]	98.3[ab]	82.5[a]	186.3[ab]	275[a]	180[ab]	90[a]
NLM +50%	2749[a]	73.9[bc]	91.3[a]	187.5[ab]	253.8[a]	135[b]	92.5[a]
NLM -25%	2673[a]	81.1[bc]	74.5[a]	166.3[b]	276.3[a]	157.5[ab]	97.5[a]
NLM -50%	2673[a]	97.1[abc]	90[a]	182.5[ab]	305[a]	172.5[ab]	82.5[a]
Normal NLM	2723[a]	67.6[c]	82.5[a]	180[ab]	277.5[a]	160[ab]	82.5[a]
P	0.3967	0.0116	0.7844	0.2696	0.4296	0.3274	0.8788
CV (%)	8.67	33.09	21.99	15.29	14.64	19.77	22.49

[a-c] Mean values with same letter within a column are not significantly different (P<0.05).

Table 12- Average values for absolute weight (grams) of carcass and body components of male broilers at 56 days of slaughter, according with the linear model (LM) and nonlinear model (NLM) formulation principle.

56 days of age							
Tratamens	Carcass	Abdominal fat weight	Feet	Head + neck	Viscera	Feathers	Blood
Normal LP	3455.5[a]	67.5[a]	135[ab]	211.3[b]	295[a]	190[a]	150[a]
NLM +25%	3442[a]	58.4[a]	123.8[b]	217.5[ab]	321.3[a]	185[a]	135[a]
NLM +50%	3551.5[a]	46.9[a]	135[ab]	226.3[ab]	336.3[a]	192.5[a]	127.5[a]
NLM -25%	3494.8[a]	55.3[a]	132.5[ab]	207.5[b]	336.3[a]	187.5[a]	152.5[a]
NLM -50%	3721.4[a]	63.4[a]	143.8[a]	270[a]	400[a]	212.5[a]	152.5[a]
Normal NLM	3456.8[a]	64.6[a]	127.5[ab]	223.8[ab]	323.8[a]	200[a]	125[a]
P	0.4496	0.5318	0.3233	0.2565	0.5353	0.9323	0.8685
CV (%)	8.68	39.28	9.27	16.70	22.73	23.96	30.32

[a-b] Mean values with same letter within a column are not significantly different (P<0.05).

There was a clear influence of the concentration of nutrients offered in normal price diets on body composition. In this way, it is directly related to the formulation principle adopted (Linear and NonLinear) and, also, the body composition is conditioned to variations in energy concentration : nutrients [9], inherent to the nonlinear principle, which because it is adopted by the spreadsheet PPFR, maintains energy density with adjustments concomitant with other nutrients [5].

The results also showed that the effects of the formulation principles were more characterized in females, mainly for the deposition of abdominal fat. Thus, the greater deposition of abdominal fat was already expected for females, due to their lower growth rate (genetic potential). Thus, excess energy is deposited as lipids in the body.

From the above, it is evident the importance of studying mathematical models and new principles of formulation that integrate the current knowledge of the use and deposition of nutrients in the body tissues of the modern broiler, mainly in protein and fat, aiming at the optimization of its deposition in the housing [11]. And in this way, to produce better quality carcasses, for increasingly demanding customers, who want a lower fat content in the products consumed [12].

4. CONCLUSION

In this study, it was observed that the ration formulation, based on the nonlinear model, corrects the distortions of the traditional system (minimum / linear cost ration), resulting in an optimal solution in terms of the energy content of the diet.

The nonlinear concept proves to be a great tool to be applied in diet formulations in order to increase the profitability of a broiler breeding.

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Issues on the optimization of bioreactors of microalgae and cyanobacteria crops for hydrogen and bioproduct productions

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Abstract

Optimizing the design and operating parameters for optimum production of hydrogen and other bioproducts is a necessary step to address the rate of production of this energy input. Optimization is basically based on the appropriate choice of microalgae strain along with the available growth conditions. This paper presents a simplified review of the possible monitoring variables for microalgae and cyanobacteria crops. In addition, the design of open pond bioreactors and photobioreactors (PBR) that allow greater control of monitoring and crop parameters were presented. The physicochemical bioproduct characterization, such as fatty acids constituent and gases, is an aspect to be considered. The use of the optimization of the physical-chemical properties for their subsequent processing may improve the production of biofuels and biomass. In addition, the generation of hydrogen in the photosynthetic cycle of bioreactors based on microalgae cultures is presented as a solution to energy demand. And finally, we comment on some findings obtained from Multiphysics computational modeling carried out in PBRs.

Keywords: Microalgae; cyanobacteria; bioproducts; hydrogen; PBR; biofuels.

1. Introduction

The world is facing challenges associated with high demands of energy and rising fossil fuel prices, due to the growing world population and rapid industrialization. Fossil fuels linked to environmental pollution, global warming and are non-renewable. Therefore, it is necessary to expand the processes of generating energy from renewable sources, mainly in sustainable, ecological, renewable, low cost and decentralized methods (AZWAR; HUSSAIN; ABDUL-WAHAB, 2014; MALLICK, 2002).

At present, governments are proactive in securing energy supply and limiting climate change. Many potential fuels were assessed early in this century (CHAUMONT, 1993; SAIFUDDIN; PRIATHARSINI, 2016). Biomass is one of the most promising renewable resources used to produce various types of biofuels, including biodiesel, bioethanol, biogas and biohydrogen. Energy from biomass contributes to a stable supply of energy and to society, maintaining the growth of market activities (SHERIF; BARBIR; VEZIROGLU, 2003). Biomass can be derived, for example, from harvesting specific crops; using raw materials from forestry and other plant residues (CHANG; LIN, 2004). So far, saccharose and starch crops, for example, sugarcane and maize, as well as lignocellulosic materials, such as rice straw, have being used as feedstock for biofuel. Sugars come in various forms, containing about four calories per gram, such as monosaccharides like glucose, fructose and galactose. However, the high cost of hydrolysis lignocellulosic materials is a limiting factor.

In turn, hydrogen is considered a clean and environmentally safe fuel, with renewable resources and a great substitute for fossil fuels. Hydrogen retains high energy density potential, 143 GJ per ton, with many technical, socioeconomic and environmental benefits that guarantee its credibility among all other fuels. Hydrogen is the only recognized fuel that does not produce carbon dioxide as a by-product when it is used in fuel cells to produce electricity (AZWAR; HUSSAIN; ABDUL-WAHAB, 2014; CHANG; LIN, 2004). The largest users of hydrogen are the fertilizer and petroleum industries, at approximately 50% and 37% respectively (CHANG; LIN, 2004).

The production of biohydrogen offers a sustainable alternative and the use of renewable carbon sources can be considered as offsetting the production of carbon dioxide. The hydrogen production process can consume multiple sources of carbon, including organic material from wastewater. Glucose and sucrose are easily degradable and are therefore preferred as model substrates for the hydrogen production. Because of the complexity of the chemical composition and polymeric structure of these carbon sources, the carbon present must be released or transformed to simple sugars. Complex carbon polymers consist of tightly bonded lignin, cellulose and hemicellulose. Cellulose and hemicelluloses may be degraded under the same conditions and add to the cost factor, which is also restrictive (AZWAR; HUSSAIN; ABDUL-WAHAB, 2014; BEHERA; SINGH; ARORA; SHARMA *et al.*, 2015).

Many microorganisms participate in the production of biofuels like hydrogen, but the most accepted are cyanobacteria and green microalgae. These micro-organisms are recently considered as a third-generation raw material, being more effective in converting sunlight into chemical energy and requiring less footprint and less water for cultivation. (KOTAY; DAS, 2007; MANISH; BANERJEE, 2008). In such a case, it is said that the fuel is biohydrogen.

The production of biohydrogen using algae was determined only at the laboratory level, with a consistently

low yield for commercial application. Therefore, optimizing the design and operating parameters for maximum hydrogen production is a necessary step to process the production rate of this energy input. Optimization is primarily based on the microalgae strain with the available growing conditions (MORENO-GARRIDO, 2008). For biofuels to be widely authorized in the energy markets, emphasis should be placed on acclimatization and improvement photosynthetic organisms for the biofuel production (DINCER, 2012). Several physical-chemical pretreatments have been revised to produce hydrogen, biooils and biomass as supplementary nutrients. It requires a step to pierce the algal cell wall with the complex carbohydrate to release simple sugars. Pretreatment methods such as physical (sonication, grinding, and pyrolysis), chemical (acid, alkali, and thermal) and biological (enzymatic) methods are used to break up the algal cell wall, to hydrolyze complex carbohydrates and release fermentable sugars, or merely oil (KAPARAPU; GEDDADA, 2016).

A immobilised cell means that a cell through natural or artificial pathways is prevented from moving independently of the surrounding environment to all parts of the system that are under consideration (BROUERS; SHI; HALL, 1988). Basically, there are six different types of cell immobilization methods. There is covalent coupling, affinity immobilization, adsorption, liquid-liquid emulsion containment, trapping behind a semi-permeable membrane. The use of the immobilization technique contributes to greater resiliency when designing a reactor comparing conventional suspension systems. Additionally, increased cell density and permeability of cell wall, lack of cell washing, and improved system stability are some additional benefits of the cell immobilization technique. Above all, cell trapping in polymeric matrices and self-adhesive cell binding on solid support surfaces are generally more common. The algae cells within its partition are important criteria for a successful trap, while the pores within the gel matrix allow the diffusion of substrates and metabolic products to and from cells (BROUERS; SHI; HALL, 1988). In this case, there is a lot of experience in growing algae in bioreactors. Cell immobilization techniques for the exploration of products expressed by green algae have not yet been studied and could be a reason for the future to improve the processes of extraction of bioproducts from live matrices. In turn, bioreactors are considered a means of producing hydrogen from algae biomass.

The production of bio-hydrogen by micro-organisms has attracted growing worldwide attention, with the potential to be an inexhaustible, inexpensive, and renewable energy source. The development of bioreactors or microalgae immobilizers is a sine qua non condition for large-scale hydrogen production. Bioreactors are closed or open or hybrids systems ranging in size from the small scale (5 to 10 mL) to the larger scale or more than 500,000 L on an industrial scale. Photobioreactors (PBRs) are composed of a series of tubes, tank bags, in which photosynthetic micro-organisms, including algae, are grown and then monitored because light is the critical component for the growth of photosynthetic microorganisms. These bioreactors are PBRs, called continuous wave tank reactor (CSTR), fixed bed bioreactors, membrane bioreactors, multistage bioreactors or hybrid bioreactors.

2. Mechanisms for biofuel production

Biofuels can be solids, liquids or gases to the extent that they are derived directly from biological sources. The most common solid biofuel is lignified (wood based) cellulose, which can be burned for energy

proposes. Liquid and gaseous biofuels generally require more refining and include bio-ethanol, biodiesel and hydrocarbons for engines, as well as methane from anaerobic digestion. The liquid biofuels mentioned above have significant potential to increase or substitute petroleum fuel for transportation purposes. Currently, ethanol dominates the biofuels market and can be produced through various of methods, primarily heterotrophic fermentation of purified sugars from biomass (CHIARAMONTI, 2007). Biodiesel and other hydrogen-treated biofuels are primarily derived from vegetable oils (lipids) raw materials (VAN GERPEN, 2007).

Lipids used for biofuels have important physiological roles in plants, including energy storage, structural support such as membranes and cell signaling (MURPHY, 2001). Storage lipids differ from structural and signaling lipids in that they are composed primarily of glycerol esters of fatty acids, also known as triacylglycerol (TAG). These lipids are generally stored in a specialized lipid storage compartment, the lipid body. This compartment is found in most oil seed cells and is used to store a variety of TAG molecules, depending on the species (MURPHY, 2001). Vascular plants store large amounts of lipids in the seeds and provide energy for growth during germination. The lipid content and fatty acid composition of oilseeds vary. Environmental changes or human manipulations, such as reproductive or genetic engineering, have been used to alter lipid content and composition (GUSCHINA; HARWOOD, 2007). Although less common, some species such as Simmondsia chinensis accumulate stored lipids in the form of waxes, not as TAG. Regardless of the type of final storage, fatty acid biosynthesis again at the plants occurs only in the plastid stroma. While, with the exception of plastid desaturation and some complex lipid biosynthesis, most changes in the fatty acyl residues and TAG synthesis of the acyclic chains are located in the lumen of the endoplasmic reticulum (ER) (GUSCHINA; HARWOOD, 2007). In addition to TAGs, plants also contain membranous lipids. These, unlike TAGs, remain highly preserved in identity and quantity to maintain the normal plant physiology.

Ethanol and biodiesel are mainly derived from plant sources, often food crops, because the established scale of food crops has become a convenient source of biomass required to produce biofuel on a commercially. However, a growing demand for biofuel feedstock has a negative impact on food markets and has led to global controversy over "food versus fuel". Furthermore, land and fresh water for cultivation and long growing-to-harvest periods limit the expansion of the biofuel industries to the amount of arable land. In contrast, unicellular algae require small quantities of land which do not need to be cultivated, have faster growth cycles, have a higher percentage of oil and have been proposed as a better solution to the food and fuel debate. Therefore, particular attention has been paid to algae as the next generation raw material for the biofuel production (CHISTI, 2007). It was proposed that a fuel-only approach for biodiesel production from algae is unlikely given current yields based on economic modeling of production facilities. As a result, attention needs to be paid to genetic manipulation to take advantage of algae's ability to produce high quality fuel, but also potentially to be used as a factory for the production of other value-added products, such as protein therapy (GREENWELL; LAURENS; SHIELDS; LOVITT *et al.*, 2009; WILLIAMS; LAURENS, 2010). In light of this and studies of the selection pressure for photosynthetic efficiency in native environments versus bioreactor environments, it seems that genetic modification is likely to provide the key to unlocking the viability of algal production lines (FLYNN; GREENWELL;

LOVITT; SHIELDS, 2010).

3. Biohydrogen production and extraction

3.1 History

The ability of unicellular algae to produce H_2 gas under lighting was discovered six decades ago (GAFFRON, 1939; GAFFRON; RUBIN, 1942). The hydrogen production activity in green algae was induced following previous anaerobic incubation of cells placed in the dark (GREENBAUM, 1982; HAPPE; NABER, 1993; ROESSLER; LIEN, 1984; SCHULZ, 1996). A hydrogenase enzyme has been expressed in such incubation and catalyzed, with high specific activity, generating H_2 mediated by light. The reported monomeric form of the enzyme belongs to the Ferrous hydrogenase class (ADAMS, 1990; HAPPE; MOSLER; NABER, 1994; MEYER; GAGNON, 1991; VOORDOUW; STRANG; WILSON, 1989). This functional protein is encoded in the nucleus of unicellular green algae and locates and operates in the chloroplast stroma (HAPPE; MOSLER; NABER, 1994).

3.2 Biochemical mechanism

The absorption of light by the photosynthetic apparatus is essential for the generation of gaseous hydrogen, because the light energy facilitates the oxidation of water molecules, the release of electrons and protons and the transport of metals from these electrons to ferredoxin. Photosynthetic ferredoxin (PetF) is used as a physiological electron donor for Fe-hydrogenase and thus connects Fe-hydrogenase to the electron transport chain in the green algae chloroplast (TAMAGNINI; LEITÃO; OLIVEIRA; FERREIRA *et al.*, 2007).

3.3 Inhibitory process for oxygen (O_2)

Under these conditions, the hydrogenase activity is only transient for a few seconds to minutes, since, in addition to protons and electrons, the light-dependent oxidation of the water molecule involves the release of molecular O_2. However, oxygen itself is a potent inhibitor of Fe-hydrogenase (GHIRARDI; ZHANG; LEE; FLYNN *et al.*, 2000).

3.4 Questions

Current technological developments in this field have not yet succeeded in overcoming this mutually exclusive nature of O_2 and H_2 photoproduction reactions. Thus, the physiological meaning and role of Fe-hydrogenase in green algae, which normally grow under photosynthetic aerobic conditions, has been a mystery. Given the sensitivity of Fe-hydrogenase to O_2 and the oxidative conditions in the soil, questions were arise whether hydrogenase is anything more than a relic of a chloroplast´s evolutionary past in green algae, producing cellular energy in non-oxygenated environments. It is questionable whether this enzyme and the photosynthesis process can at present be used to produce H_2 gas for commercial purposes (ZHANG; HAPPE, 2001). However, the ability of green algae to generate H_2 gas has been a challenge despite the fundamental and practical importance of the process. A diagram of the cycle in biohydrogen production is shown in Fig. 1.

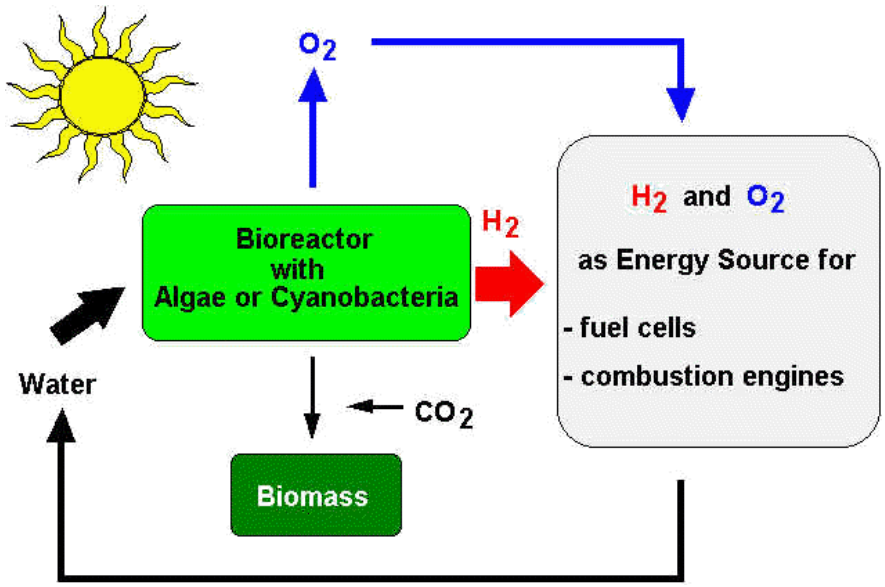

Figure 1. Hydrogen production cycle in bioreactors.

4. Microalgae Production

Growing microalgae as a raw material for biofuels can be the solution for burning fossil fuels. This sounds like a viable resource for biodiesel and biogas. Some microalgae have up to 70% lipid in their structure and are capable of producing more than 30 times the amount of oil (per year and per unit soil area) compared to oilseed crops (CHISTI, 2007). This is because the fact that they have the doubling of biomass in a very short time, the use of a smaller physical space, the ability of being grown in areas not suitable for agriculture and the lower generation of waste (LOURENÇO, 2006). Algae constitute a highly diverse group of microorganisms. Thus, microalgae can be found in virtually all aquatic systems, including places with a wide range of physicalchemical development parameters. The biodiversity of these organisms represents an important technological feature, allowing the cultivation of various genera and species in a wide range of operational (THAJUDDIN; SUBRAMANIAN, 2005; XU; MIAO; WU, 2006). Another benefit is that microalgae use CO_2 as a carbon source to grow, being able to capture carbon dioxide from emissions from power plants or any other CO_2-emitting process. Microalgae may be grown in closed photobioreactors (PBRs) as shown in Fig. 2, or in open systems (open ponds, swimming pools or small lakes), as shown in Fig. 3 (a) and (b). Since racing ponds are less productive and require a large amount of land, PBRs appear to be better candidates for industrial production of microalgae biofuels in the future.

Figure 2. Compact conduits-array Photobioreactor (PBR). Source: Núcleo de Pesquisa e Desenvolvimento em Energia Autossustentável NPDEAS - UFPR (2016)

A number of research groups have already recognized the demand for algae and biofuel. The Center for Research and Development of Self-Sustainable Energy (NPDEAS/UFPR) selected high-fat microalgae strains, improved the culture medium, and investigated the use of degraded water for culture and reuse of the culture medium. New compact geometries for driven PBRs and growth kinetics analysis on the pilot and industrial scale (RIBEIRO; MARIANO; VARGAS, 2016). The design and mathematical modeling of the PBR is very important for the development of a microalgal biomass oil extraction process and the biodiesel production from microalgae oil.

(a) (b)

Figure 3. Hybrid open ponds. (a) Open ponds for controlling microorganism and nutrients (b) closed system type swimming pool.

The various research approaches required to make any process possible with microalgae, the need for a crooping system with high productivity per occupied area, low cost of installation and operation, stands out. To develop such a system, it is necessary to understand the parameters of the microalgae growing process and the systems that have already been used.

Factors such as temperature, sunlight, pH and the nutrient composition of the growing medium directly influence the cellular composition of the microalgae. Where these condition can be controlled by PBR engineering and architecture, the microalgae biomass can be increased. The pH and nutrient composition in medium can be controlled by devices installed in the PBR, but solar radiation and room temperature are variables that depend on the location of the system.

5. Some relevant control factors in monitoring microalgae crops

5.1 Temperature

Optimal temperature plays an important role in the growth of microalgae. An increase in temperature can lead an increase in biomass to a certain level, where growth can be inhibited due to inactivation of proteins by heat shock (MAHBOOB; RAUF; ASHRAF; SULTANA *et al.*, 2012). Studies carried out on biomass production at temperatures of 30, 40 and 50 ºC, and found that, for high growth, the optimal temperature for the microalgae Chlorella vulgaris is 30ºC (CHINNASAMY; RAMAKRISHNAN; BHATNAGAR; DAS, 2009). Kerby and Stewart (1988) reported that the ideal temperature for rapid growth, especially for Chlorella species, should be between 20 and 32ºC (KERBY; STEWART, 1988).

However, there is the possibility of preadaptation of crops to temperature values outside the range considered ideal. Isolation of species tolerant to high temperatures (40 - 60 °C) has been considered an important criterion in the selection of the microorganism because it would allow the direct injection of carbon dioxide from thermal processes (ONO; CUELLO, 2007).

Microalgae cultures in the PBRs, at excessive or reduced temperatures, show a decrease in growth. However, it is possible to try to control the temperature in the values defined as ideal for a given crop by installing systems that use heat exchange to reach the ideal temperature. While these systems increase microalgal productivity, their main disadvantage is the high cost and energy expenditure. It is possible to determine the effect of temperature on the specific growth rate of microalgae by keeping all other variables constant. Indeed, the growth rate reaches a maximum at a specific temperature.

5.2 pH

The ideal pH range for most algae species is 5 to 9. However, it found that, at pH 5, the productivity of the microalgae Chlorella vulgaris increases considerably. After 9 days, the concentration at pH 5 was $9.5x10^7$ cell/mL, at pH 7 it was $4.5x10^7$ cell/mL, and $1.5x10^7$ cell/mL at pH 9, under the following conditions: initial density of $100x10^4$ cell/mL, temperature of 24 ºC, photoperiod of 24:0 (light/dark) and brightness 97 µmol·photon/m^2·s. According to Becker (2004), pH influences the solubility of CO_2 and minerals, interfering directly or indirectly in the metabolism of algae (BECKER, 2007). According to Esteves (1998), in aqueous media, inorganic carbon can be in the form of CO_2, H_2CO_3, HCO_3^- (bicarbonate) or CO_3^- (carbonate) and their proportions depend on the pH. At high (basic) pHs, the proportions of HCO_3^- or CO_3^- increase. Thus, the availability of CO_2 increases in a culture with acid pH, since it is the carbon source used by algae. The gradual increase in pH in the culture medium is an indicative of microalgae growth (ESTEVES, 1998). The increase in pH occurs because the biological cellular activity, which produces a reduction in the dissolved inorganic carbon by the consumption needed for cell growth, forcing a shift of

the carbonate-bicarbonate balance in the buffer system (BERENGUEL; RODRIGUEZ; ACIÉN; GARCIA, 2004). Due to the low solubility of CO_2 in aqueous solutions, it is necessary to supply it throughout the process (KLASSON; ACKERSON; CLAUSEN; GADDY, 1991). Another study assesses the effect of the hydrogen ion concentration on the growth of Chlorella vulgaris between pH 3.0 and 11.5 and showed increased growth in the pH range 5.5 to 8.0 (MAYO; NOIKE, 1994).

5.3 Oxygen concentration [O_2]

Another factor to consider, according to Oswald (1988), is the concentration of O_2 in the microalgae culture medium. High levels of dissolved O_2 may generate photo-oxidative damage in cells with a parallel reduction in growth efficiency (OSWALD, 1988). However, since oxygen is a product of photosynthetic metabolism, its formation and solubilization in PBRs are indicative of high rates of inorganic carbon consumption (MUÑOZ; KÖLLNER; GUIEYSSE; MATTIASSON, 2004).

5.4 Stirring and flow dynamics

Stirring is an important variable for providing more homogeneous exposure to light; increase nutrient availability, so that in constant agitation, no deposition to avoid microalgae sedimentation which would lead to excessive exposure of the upper layers and underexposure of the lower layers (COUTTEAU; SORGELOOS, 1992; MONTEIRO; LUCHESE; ABSHER, 2010).

5.5 Radiative transfer at light-dark cycle

Light is the most important factor that influences the growth of photosynthetic organisms, representing the main source of energy (SOLETTO; BINAGHI; LODI; CARVALHO *et al.*, 2005). However, exposure to high photosynthetic photon flux density (PPFD) can increase the production of harmful reactive oxygen species, such as H_2O_2, damaging the cellular structure, or inducing the phenomenon of photoinhibition, that is, the reduction of microalgae photosynthesis capability causing bleaching and death (MEHLITZ, 2009; MÜLLER; LI; NIYOGI, 2001; SOLETTO; BINAGHI; LODI; CARVALHO *et al.*, 2005). Soletto et al evaluated the luminous intensity in the growth of microalgae, using different densities of photosynthetic photon flux in Spirulina platensis based on a reactor with a volume of 4 L. The authors obtained maximum photosynthetic efficiency with 125 $\mu mol \cdot photon \cdot m^{-2} \cdot s^{-1}$ (SOLETTO; BINAGHI; LODI; CARVALHO *et al.*, 2005). The photoinhibition phenomenon for low PPFD and excess CO_2 inhibited growth. Redaelli et al. (2011) also studied the influence of light intensity (2200, 10000, 17000, 24500 lux) on carbon bio fixation in very short Chlorella, using a 2.2 L by PBR, and observed that the best results were obtained for intensity 17000 lux, reaching a biomass of 0.38 g/L and a specific growth rate of 0.61 day^{-1} (REDAELLI; KOCHEM; DIERINGS; JARENKOW *et al.*, 2011).

5.5 Influence of UV and oxidative stress

Oxidative stress is defined as the increase in the production of species in excess of cellular antioxidant defenses (MOSKAUG; CARLSEN; MYHRSTAD; BLOMHOFF, 2005). The consequence of oxidative stress can cause damage to lipids, proteins and DNA, with the development of pathologies and subsequent aging (FINKEL; HOLBROOK, 2000). Vegetables synthesize bioactive compounds with antioxidant

characteristics, containing multiple phytochemical structures, the majority fraction of which are polyphenols (SCALBERT; WILLIAMSON, 2000), tannins, lignans and flavonoids (KUSKOSKI; ASUERO; GARCÍA-PARILLA; TRONCOSO *et al.*, 2004). Many polyphenols have antioxidant features (for example, reducing agents) and can react directly with reactive species, forming less reactive products (MOSKAUG; CARLSEN; MYHRSTAD; BLOMHOFF, 2005). Plants produce these phytochemicals as a defense mechanism for several factors that can cause stress. Relevant factors are ultraviolet radiation (UV) (CANTOS; GARCÍA-VIGUERA; DE PASCUAL-TERESA; TOMÁS-BARBERÁN, 2000; DUVAL; SHETTY; THOMAS, 1999; HERNANDO; MALANGA; FERREYRA, 2005; JANKNEGT; DE GRAAFF; VAN DE POLL; VISSER *et al.*, 2009; MALANGA; CALMANOVICI; PUNTARULO, 1997; ZUDAIRE; ROY, 2001) and temperature variations (WONG; CHU; MARCHANT; PHANG, 2007). Many organisms produce different substances capable of absorbing ultraviolet light (COCKELL; KNOWLAND, 1999; ROZEMA; BJÖRN; BORNMAN; GABERŠČIK *et al.*, 2002). Among these chemical compounds there are the so-called "screens", such as MAAs (mycosporin-type amino acids), produced by many algae and some cyanobacteria (BJÖRN; PAPAGEORGIOU; BLANKENSHIP, 2009). Studies in vascular plants have shown that RUV-B (280-315 nm) stimulates the production pathways of some metabolites, including polyphenols and flavonols that have proven to be UV radiation absorber compounds, minimizing damage to the normal physiological functions of their tissues (REUBER; BORNMAN; WEISSENBÖCK, 1996). In addition, there are studies that show the presence of photoprotective compounds against UV radiation in algae (GARCIA - PICHEL, 1994; GÓMEZ; PÉREZ-RODRÍGUEZ; VIÑEGLA; FIGUEROA *et al.*, 1998; HOYER; KARSTEN; SAWALL; WIENCKE, 2001).

Several studies have been carried out in the following macro and microalgae: Chlamydomona nivalis strain (DUVAL; SHETTY; THOMAS, 1999), C. augustae, Naviculla uncertain (WONG; CHU; MARCHANT; PHANG, 2007), Chlorella sp. (VIMALABAI; KULANDAIVELU, 2002; WONG; CHU; MARCHANT; PHANG, 2007), Isochrysis galbana (VIMALABAI; KULANDAIVELU, 2002), Ascophyllum nodosum (PAVIA; CERVIN; LINDGREN; ÅBERG, 1997) and Ulva fasciata (SHIU; LEE, 2005), among others, to assess resistance and the effect of exposure to UV radiation. There is evidence that organisms such as microalgae may have adaptive responses to exposure to UV radiation, increasing levels of polyphenols as photoprotectors (DUVAL; SHETTY; THOMAS, 1999). This process can be used as a very useful mechanism for the production of antioxidants of natural origin, the selection of more adapted plant organisms and their exposure to controlled UV radiation to increase the production of phytocomposites (polyphenols) through the photoprotective response of these algae. The importance of microalgae in aquatic ecosystems in primary production and in trophic plots is to understand how sensitive these organism are to UV-B (radiation UV-B). This research evaluated the adaptation strategy to the effect of ultraviolet B radiation on marine microalgae Chlorella sp. through the capacity of production of polyphenols and total antioxidant.

6. Physical-chemistry techniques for characterizing bioproducts and crop medium

The production of substances within the life cycles of microalgae crops makes easier to understand and adjust certain control factors to produce fatty acids, esters and other substances that form the basis of lipids

and biofuels. The balance of the biophysical parameters for crop optimization is analyzed wit the aid of the capacity factors in the production of these raw materials. The definition of the capacity factors requires an understanding of the physicochemical properties of the culture media and the strains used. Chemical analysis techniques such as gas chromatography, magnetic resonance imaging, Fourier transform infrared spectroscopy, and other thermal and rheological analysis techniques, expanded the compression on the bioproduct compositions of a limited number of strains of cyanobacteria. The photosynthetic efficiency to produce monounsaturated fatty acids (double bond at the carbon chain) is related to a high morphological complexity that are identified in the raw materials of lipids present in crops. The feature of unsaturation in the fatty acid and the basis of the lipid production were identified in a complementary way with FT-IR as well as the hydrogen coupling factors at the carbon positions of the chain studied by ^{1}H-NMR technique. Other rheological studies carried out showed viscosity parameters of non-Newtonian fluids susceptible to a strain rate like the base lipids of biodiesel such as beef tallow. Studies in thermal stability based on thermogravimetric analysis (TGA) found degradation of lipid materials, presented a maximum mass loss of 380 and 497 °C. The following table summarizes some physicochemical features of the fatty acids made in three strains of cyanobacteria (RÓS; DA; SILVA; SILVA-STENICO *et al.*, 2013).

In other thermal characterization studies based on differential scanning calorimetry (DSC) established the degree of randomness of residues by analyzing crystallization and fusion in microalgae ethylic biodiesel (BATISTA; LUCCHESI; CARARETO; COSTA *et al.*, 2018). Those studies are a base of knowledge in the characterization of the bioproducts of algae crops.

Table 1. Physicochemical properties of lipids at three cyanobacteria for biodiesel production

Analysis Technique	M. aeruginosa NPCD-1	Trichormus sp. CENA77	Synechococcus sp. PCC7942
Long chain satured factor (gas chromatography)	5.7	5.0	5.2
Viscosity (Rheology) [cP]	52.7	59.1	62.3
Set points by maximum mass lose (TGA analyzer) [°C]	200 - 321	321 - 442	210 - 560
Formation ethyl esters (^{1}H-NMR) 4 – 4.2 ppm	100%	50%	94%

7. Modeling computational for PBRs optimal design

The production of microalgae in pond models and in PBRs requires an in-depth analysis of other variables associated with the light transfer, both on close or open systems in a controlled matter. Furthermore, the understanding about hydrodynamic parameters in which the culture medium are mixed with the captured gases in the CO_2 fixation process as an integral part of the photochemistry developed by the various microalgae trains.

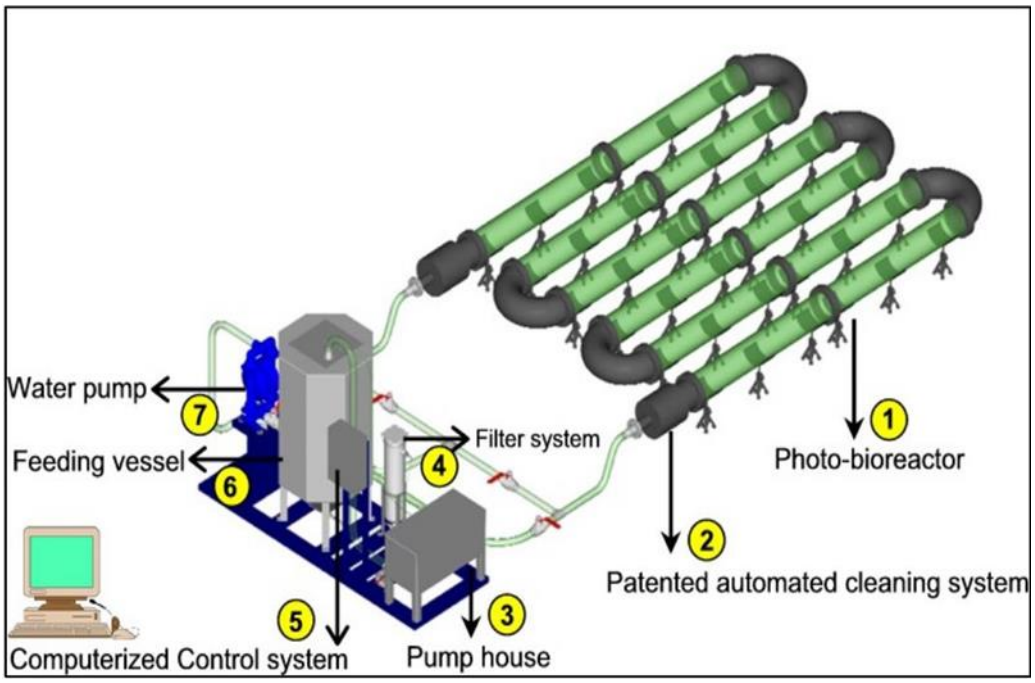

Figure 5. Compact conduits-array Photobioreactor System Design. Source: Algaelink 2007.

PBRs, like presented on Fig.5, are the most suitable design to measure and monitor the mass transfer, and the amount of gases in the culture medium, and the wall surface deposition of microalgae that limit the penetration and the scattering of light throughout the system. The close and compact PBR model, depicted on Fig 5, developed over a decade ago shows the parts of the microalgae cultures process in a general fashion. Nany determining factors in the growth and life cycle of microalgae cultures have been modeling computationally based on these revolutionary designs. A computational model was developed at ANSYS FLUENT whose PBR held a cylindrical tube with an internal radius of 7.5 cm and 40 cm height, the light emitted at solid angles by irradiating light sources with wavelength among 400 and 700 nm. The simulation results were able to establish relationships among the intensity of incident radiation the radial tube distance, the number of cells in the column, the scattering effect of the rays, the size of the gas bubbles, and the air-mass flow rates (WHEATON; KRISHNAMOORTHY, 2012). The findings were the greater efficiency in radiative transfer for bubbles between 10 and 100 micrometers. Many other characteristics can be analyzed in these controlled bioreactor designs (NAUHA; ALOPAEUS, 2013).

8. Conclusion

The problems that the world is currently facing regarding climate change and energy demand have forced governments to strengthen policies regarding alternative energy resources, clean, sustainable, and renewable energy sources. Microalgae cultivation has been positioned as a strategy that builds on these new challenges and becomes an important solution in the transition to the gradual reduction in dependence on fossil fuels.

Despite the importance and interest that this energy resource has reached, its production at an industrial level is still very low and therefore requires great efforts to channel studies that lead to optimizing and improving its efficiency with a view to raising its energy capacity factor and the production of feedstock

as the basis of industrial activity. The monitoring of physicochemical variables as well as the characterization of substances harvested in crops will allow the necessary readjustment to make government and private investors in this energy sector much more attractive. The development of new PBRs based on new designs will allow optimizing the culture media of microalgae and cyanobacteria that are part of the spectrum of almost 100 species among the more than 10 thousand that have not yet been investigated. Without a doubt, photosynthetic efficiency based on photochemical and radiative processes should continue to be the target of many studies for the selection of new strains of natural or genetically manipulated origin. Computational modeling using Multiphysics software code offers great advantage for controlled farming systems, and great strides have been made in understanding ideas about hydrodynamics, as well as radiation and mass transfer in a predictable fashion.

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The Innovative Capacity of Incubated Companies in Brazilian Technology-Based Business Incubators

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Abstract

TBCs are ventures formed by entrepreneurs whose core is technical knowledge and which are sometimes accompanied by business incubators. It is estimated that the earnings of TBCs incubated in Brazil are more than R$550 million and that they generate around 14 thousand jobs. Thus, given the importance of TBCs for a country's social and economic development, this research is justified, which aims to measure the innovative capacity of TBCs linked to incubators of Brazilian technology-based companies. The chosen methodology was a descriptive research, of quantitative nature, whose data collection technique uses the Innovation Radar questionnaire. The sample of this study had the participation of 62 incubated in the incubation stage in 22 incubators located in the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, and Distrito Federal. Among other results, the study showed that, in a sectorial analysis, mining companies in the service sector are not very innovative and the other occasional innovators, as well as that the industries of Mato Grosso do Sul are not very innovative and the other occasional innovators. Finally, in comparison, all TBCs that participated in the research are occasional innovators, that is, in general, the entire sample was characterized as an occasional innovator.

Palavras-chave: innovation; Innovation Radar; innovation capacity; Technology-Based Companies; incubated companies.

1. Introduction

When a hamburger launches a new sandwich on the market it is innovating (product innovation). The vehicle manufacturer that optimizes its production time from 08 to 06 minutes per vehicle is innovating (process innovation). When Havaianas Company repositioned its products on the market, changing its image before consumers, it innovated (position innovation). The introduction of low-cost airlines by airlines is also an innovation (paradigm innovation) (Tidd, Bessant, & Pavitt, 2008).

From the examples, it is observed that innovation is something fundamental and common in organizations, being simple or complex, given its different dimensions. One of them refers to the types of innovation; it can be the product, process, marketing and organizational (Organization for Economic

Cooperation and Development [OECD], 2006) or, in the view of Tidd et al. (2008), of product, process, position and paradigm (the "4 Ps" of innovation). From another perspective, there is a dimension related to the degree of novelty involved, which can be radical or incremental (OECD, 2006; Tidd et al., 2008). Finally, there is a dimension that shows the extent of innovation: something new for the company, new for the market, or new for the world (Tidd et al., 2008).

Innovation, in general, brings numerous benefits to those who practice and/or use it. In this sense, technological innovation stands out, considered an indispensable resource for the economic and social development of a country (Carayannis & Zedtwitz, 2005; M. Mcadam & R. Mcadam, 2008), since its applicability is of great relevance for any sector of the economy (Stal, 2010) and, above all, for Technology-Based Companies - TBCs (Sanches & Machado, 2014).

TBCs are enterprises formed by entrepreneurs whose core is technical knowledge, coming from the area of science in which they operate (Barbalho, Amaral, Kernbichler, Richter, & Torres, 2009; Perussi Filho & Escrivão Filho, 2012; Silva & Reis, 2015). In general, these companies present certain difficulties in the initial and business development phases, with emphasis on shortage of financial resources (Antolín-López, Céspedes-Lorente, García-de-Frutos, Martínez-del-Río, & Pérez-Valls, 2015; Costa & Torkomian, 2008) and difficulties in accessing these resources (Hueske, Endrikat, & Guenther, 2015); entrepreneurs with little management knowledge (Barbalho et al., 2009; Perussi Filho & Escrivão Filho, 2012) and an inefficient network of contacts (Carayannis & Zedtwitz, 2005).

Aiming at the development of these ventures, Innovation Support Agents (ISAs) were created, such as Technology-Based Business Incubators - TBBIs and, recently, Business Accelerators (BAs), whose mission is to support the development of TBCs (Silva, Gonçalves, Silva, & Venâncio, 2018).

The support provided to TBCs by ASIs generally comprises the provision of the physical structure and basic services (Iacono, Almeida, & Nagano, 2011; J. M. Silva, C. E. S. Silva, Batista, & Bitencourt, 2012); access to a relevant network of contacts (Bollingtoft, 2012; M. Mcadam & R. Mcadam, 2008); acculturation offer (Bollingtoft, 2012), which concerns participation in managerial training and business plan development (Bollingtoft, 2012; Silva & Reis, 2015) and; access to subsidized financing (Iacono et al., 2011).

Given the importance of TBCs for a country's social and economic development, the discussion on the trajectory and direction of these companies about their innovation processes becomes relevant (Iacono et al., 2011). Therefore, the general objective of this study is to measure the innovative capacity of companies linked to Brazilian TBBIs.

1.1. Business Incubators

Innovation Areas are the Innovation Areas and the Mechanisms for the Generation of Enterprises, which act with a high degree of interaction (Aranha, 2016). The Innovation Areas are spaces strategically created with the function of attracting human talents and knowledge-intensive businesses, for the sustainable economic development of the region where they are installed (National Association of Entities Promoting Innovative Enterprises [ANPROTEC], 2019). Examples of Innovation Areas are Science and Technology Parks, Smart Cities, and Innovation Communities. The Enterprise Generation Mechanisms, in

turn, support the creation, development, and consolidation of new businesses (ANPROTEC, 2019), such as accelerators and incubators (Aranha, 2016).

Concerning incubators, it has its origin in the mid-twentieth century, in the United States and England, as a result of adverse economic phenomena (economic crises) or as initiatives of large companies. Initially, the objective of these environments was to provide physical space and infrastructure for the development of nascent businesses (ANPROTEC, 2019).

In the current concept, incubators offer, in addition to the aforementioned benefits, a range of advantages for incubated companies, such as management support, acculturation, networks of contacts, among others; with the mission of transforming innovative ideas into successful businesses (ANPROTEC, 2019).

In Brazil, the emergence of incubators is recent, with reports from the 1980s, in cities such as São Carlos (SP), Campina Grande (PB), Florianópolis (SC), and Rio de Janeiro (RJ) (ANPROTEC, 2019). From there, several economic and legal factors contributed to the expansion of these environments (ANPROTEC, 2019).

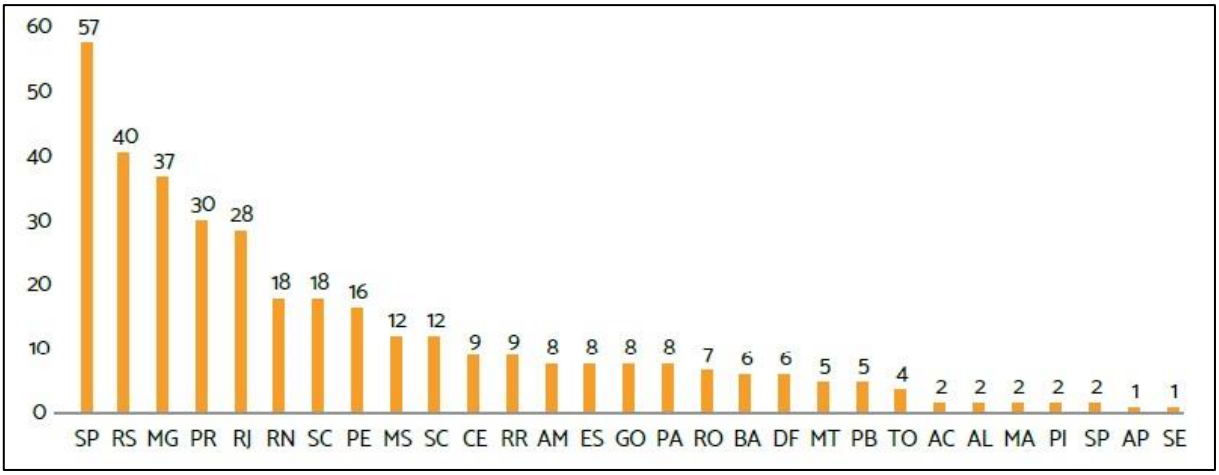
Among the economic factors, the opening of the Brazilian market in 1990, the fall and stabilization of inflation in 1994, and advances in the area of information and communication technology stand out. This situation was favorable for the emergence of new businesses and, consequently, for the development of Brazilian incubators (ANPROTEC, 2019).

At the same time, the legal apparatus related to innovation began to be thought about, created, and improved. Composing this regulatory structure, there are: the creation of the National Support Program for Business Incubators - PNI in 1998; the creation of the Innovation Law in 2004; the creation of the Lei do Bem in 2005; the establishment of Constitutional Amendment 85, in 2015; of Law No. 13,343, in 2016 (BRASIL, 2016), known as the Science, Technology and Innovation Code and the New Legal Framework for Science, Technology, and Innovation, with Decree 9,283, in 2018 (ANPROTEC, 2019; BRASIL, 2018).

Commonly, the incubation process comprises the stages of pre-incubation, incubation, and post-incubation. The pre-incubation, or project hotel, consists of the period before the company enters into the incubator when the enterprise is in the design and constitution phase (Tumelero, 2012). In the incubation, the company uses the physical facilities and other services provided by the incubator. It is a critical step in terms of adding value. Therefore, the incubator focuses too much on the orientation, monitoring, and evaluation of the incubated company. Post-incubation is made up of companies that have gone through the incubation period and that have already reached maturity. In this phase, the company is called a graduate but continues to have a link with the incubator, with access to its services. The objective of this step is to mitigate the impact of untying the incubator (Iacono et al., 2011).

Between 2017-2019, 405 incubators were accounted for in Brazil, of which 363 were active and the remainder without operation. In the geographical distribution shown in Graph 1, it can be seen that there were 08 TBBIs in Goiás (GO), in Mato Grosso (MT) 5, in Mato Grosso do Sul (MS) 12, in the Distrito Federal (DF) 6 and Minas Gerais (MG) 37 (ANPROTEC, 2019).

Graph 1 - Number of TBBIs by Brazilian State



Source: ANPROTEC (2019)

Regarding TBCs linked to incubators, the study conducted by ANPROTEC (2019) pointed out, in 2017, the number of 3,694 companies, which generated 14 thousand direct jobs, revenues of R$550 million, and payment of R$110 million in taxes.

According to Autio (1994), the international literature points out that TBCs, in addition to boosting the economy with the launch of new products and services of greater added value in the market, also play an essential role in the transfer of technology by absorbing scientific production. of Science and Technology Institutions - ICT, and transform it into technologies that will be offered to the market, accelerating their commercialization.

Other positive aspects of TBCs are market orientation; flexibility; ability to respond quickly to market opportunities and demands (Santos apud Inácio Júnior, Carvalho, & Gariva, 2012) and performance in high-risk market nests, in which large organizations are unable to operate (Marcovitch, Santos, & Dutra apud Inácio Júnior et al., 2012).

2. Methodology

This is a descriptive study - in which the facts (variables) are observed, analyzed, and correlated, without the interference of the researcher (Rampazzo, 2011) - with a quantitative nature, which was approved by the Ethics Committee, through the Plataforma Brasil, on 04/01/2019.

The population - set of beings that have at least one characteristic in common (Marconi & Lakatos, 2016) - in this study was made up of TBC owners in the incubation stage in Brazilian TBBIs, more specifically in the states of GO, MT, MS, MG, and DF.

To identify the population of this study, the following step-by-step was performed:

1) Request and access to the database of TBBIs existing in the states of GO, MT, MS, MG, and DF with ANPROTEC;
2) Manual validation of this database through online searches with the names of TBBIs or through state incubator networks and, subsequently, making calls to the identified telephone contacts to obtain the following information:

i) If the incubator exists;
ii) If it meets the previous criterion, if it is characterized as technological or mixed, provided that one of the aspects is technological;
iii) If it meets the previous criteria, if it is in operation;
iv) If it meets the previous criteria, if it has TBCs in the incubation stage (resident or non-resistant);
v) If it meets the previous criteria, how many are these TBCs, and who they are (name, entrepreneur, contact)?

After this process, 42 TBBIs were identified in the states that comprise the scope of this study, as shown in Table 1. However, the number of active TBBIs (in operation) is 39 and the number of TBBIs that have enterprises in the incubation phase is 28. From these data, it was identified that the total number of TBCs that make up the population of this study is 153.

Table 1 - Quantity of TBBIS and TBCs accounted for

	Number of TBBIs found	Number of TBBIs in operation	Number of TBBIs with TBCs in the incubation	**Number of TBCs found**
Goiás	11	10	6	**23**
Distrito Federal	3	3	1	**3**
Mato Grosso	2	2	1	**3**
Mato Grosso do Sul	6	5	4	**12**
Minas Gerais	20	19	16	**112**
TOTAL	**42**	**39**	**28**	**153**

Source: Prepared by the authors (2020)

The sample – the portion of the population selected for the study (Marconi & Lakatos, 2016) - was calculated on the website OpenEpi® version 3.0.1 (2013), from 50% anticipated frequency, 95% confidence level, 10% absolute precision, and sample design effect by clusters (DEFF) de 1.0. The result consisted of a sample of 60 companies. Considering a possible loss of data, there was an increase of 5% in the sample, resulting in 63 companies in the incubation stage.

The type of sampling chosen was non-probabilistic for convenience. Therefore, of the 153 TBCs found, 64 participated in the survey. However, 02 entries were excluded, due to incorrect questionnaire filling. Therefore, 62 companies participated in the survey. It is important to note that participation in the research was carried out with one of the company's owners voluntarily, with consent and guidance through the Free and Informed Consent Form.

As a data collection technique, the Innovation Radar questionnaire, proposed by Sawhney, Wolcott, and Arroniz (2006), and adapted by Bachmann and Destefani (2008), was used; chosen due to its use in scientific studies published in national and international journals that aimed, as well as this research, to analyze the Innovation Index (II) of companies through the Innovation Radar. Among these studies are that

of Chen and Sawhney (2010); Néto and Teixeira (2014); Oliveira, Cavalcanti, Paiva Júnior, and Marques (2014) and Carvalho, Silva, Póvoa and Carvalho (2015).

The Innovation Radar consists of 03 (three) questionnaires, 01 for companies in the trade sector (comprising 35 questions), 01 for the industrial sector (with 40 questions), and 01 for the services sector (with 39 questions) (Zanirato, 2017). This Innovation Radar seeks to analyze 13 constructs, namely: Offer, Platform, Brand, Client, Solution, Relationship, Value-Adding, Processes, Organization, Supply Chain, Presence, Network, and Innovative Ambience. It is noteworthy that in addition to the issues mentioned, another 26 sociodemographic questions were elaborated.

Cross-sectional data collection took place from 9/2/2019 to 3/5/2020. Initially, calls were made to the owners of the identified TBCs explaining the survey and, subsequently, sending the questionnaires through the Google Forms tool to their e-mails or WhatsApp.

The data collected were systematized in Microsoft's Excel software, version 2013; being that the quantitative variables were analyzed in measures of central tendency, more specifically in averages, to calculate the average II of the surveyed companies.

All questions in the Innovation Radar questionnaire have 03 closed answer options, in decreasing order. Therefore, each answer was assigned a score ranging from 1 to 5. Always, the first answer option is equivalent to 5, the second to 3, and the third to 1.

After calculating the mean of the constructs, companies that scored between 1 and 2.9 (II <3 and II ≥ 1) are considered to be little innovative, occasionally innovative to those that scored between 3.0 and 3.9 (II <4 and II ≥ 3) and systemic innovators TBCs that scored 4.0 or higher (II ≥ 4), demonstrating that they have a systematic culture of innovation management. Visually, the farther the centerline is from the center of the graph, the greater the company's innovative capacity concerning the analyzed dimension and vice versa (Néto & Teixeira, 2014).

3. Results

Initially, the sample profile is demonstrated. The participants, predominantly, are between 20 and 39 years old, since 46.8% are between 30 and 39 years old and 27.4% between 20 and 29 years old. A portion of the sample (about 13%) is between 40 and 49 years old. The rest (12.9%) are aged between 50 and 72 years.

79% of individuals are male and most respondents are married (59.7%). Singles represent 29% of the sample, 8.1% are dating and 3.2% are divorced.

The level of education of these entrepreneurs is diversified: about 13% are taking an undergraduate course and 24.2% have completed it; approximately 34% are specialists; 3.2% (02 people) are studying for a master's degree and 8.1% (05 individuals) are already masters. There are also respondents with PhDs (11.3%) and other Ph.D. students (6.5%).

When asked about the number of hours per day they dedicate to the company, about 31% said they dedicate themselves from 9 to 12 hours; 29% of the sample from 05 to 08 hours daily; 27.4% from 01 to 04 hours and 4.8% from 13 to 16 hours. It is noteworthy that 01 respondents said he did not dedicate himself

to TBC - as a result of being an investing partner - and 04 (6.5%) affirm that they spend 20 to 24 hours a day in the business, showing that all their time is spent in the company.

About 77.4% of respondents have some partner. Of these, 45.8% have only one partner and the remaining 02 or more. Another important fact is that 22.6% of the sample in this study has other companies.

As for the number of employees, about 40% of the sample said they did not have them; another 34% have 1 to 2 employees; 11.3% have 3 to 4; 9.7% from 5 to 8, and the rest have 10 to 15 employees.

Another question was about the monthly billing obtained in 2018. For 3.2% of the sample, monthly billing was below R$1,000.00; for 17.7% it ranged from R$1,001.00 to 10 thousand reais; 21% answered that it was from R$ 10,001.00 to 100 thousand reais; 4.8% obtained from R$100,001.00 to 200 thousand reais and 01 (1.6%) company said to have obtained revenue greater than R$200,000.00, this being an industry located in the municipality of Itajubá (MG), which has a link with the INCIT incubator. Another 40% stated that they had no revenue in the aforementioned time - partly due to formalizing the deal only in 2019 - and 11.3% did not inform.

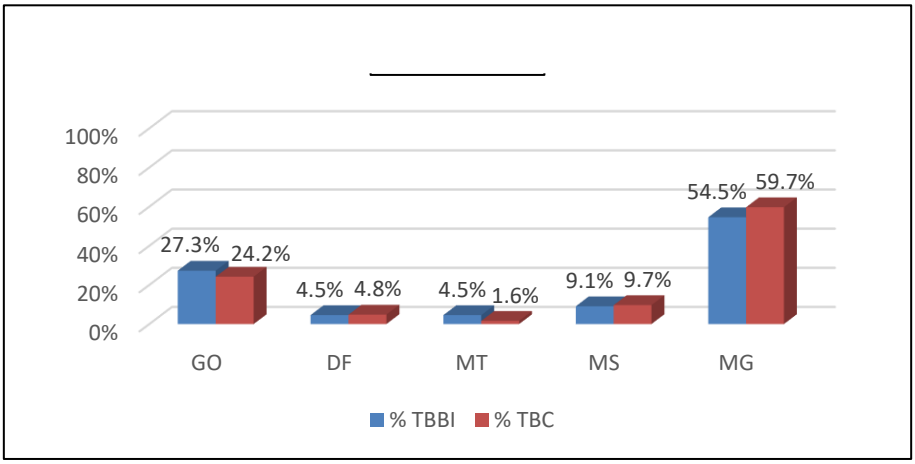
Also analyzing the profile of the sample, the relationship between researched TBCs and TBBIs was investigated. Thus, it was found that the majority of the incubated established links with the TBBIs in the years 2019, 2018, and 2017, with 38.7%, 27.4%, and 21%, respectively. The 6.5% link between TBCs and incubators was agreed upon in 2015 and the rest (6.5%) entered into a partnership in 2011, 2012, 2014, and 2016, in a 1:1 ratio. That said, it became clear that 79% of these links were established as incubated resident companies and the remainder, 21%, as non-residents.

The values of the incubation fees paid by the TBCs to the TBBIs ranged from R$0.00 to about 1.2 thousand, being: 9.7% do not pay; 3.2% pay from R$100.00 to R$199.00; 58% pay from R$200.00 to R$499.00; 9.7% from R$500.00 to R$599.00; 8.1% from R$600.00 to R$799.00; 8.1% from R$800.00 to R$899.00 and a company pays R$1,168.00. It should be noted that one company did not reveal the amount paid.

Among the reasons that led the incubated to establish a link with the incubators is the infrastructure of the TBBI (about 32%), followed by the specialized services (29%), the notoriety of the incubator and its maintainer (16.1%), and network of contacts (about 13%). Other reasons, unknown, were the response of 9.7% of respondents.

The study consisted of 62 TBCs in the incubation phase, which were linked to a total of 22 incubators, according to the geographical distribution shown in Graph 2. It is observed that the largest portion of the sample (approximately 60%) is contained in the state of MG and that about 24.2% in GO. There was low participation of TBCs in the other states that make up the analyzed territorial range, such as MT, with only 1.6%.

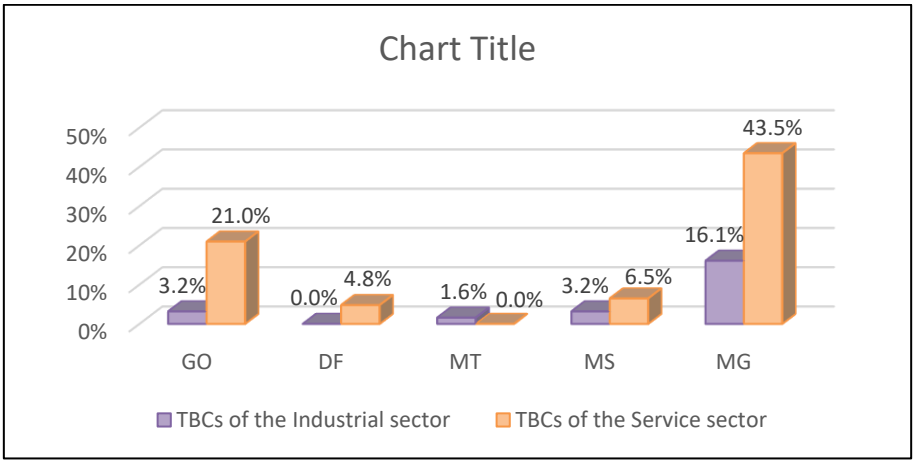
Graph 2 - Percentage of TBBIs and TBCs by State



Source: Prepared by the authors (2020)

As shown in Graph 3, the largest portion of the companies analyzed belongs to the services sector (47 companies) and there were no participants in the trade sector. It is also noted that 100% of the TM sample belongs to the industrial sector and that, in the DF, 100% of the respondents are from the services sector. However, these results do not show a great impact, since the relative number of respondents in each of these states is very small.

Graph 3 - Percentage of TBCs by economic sector



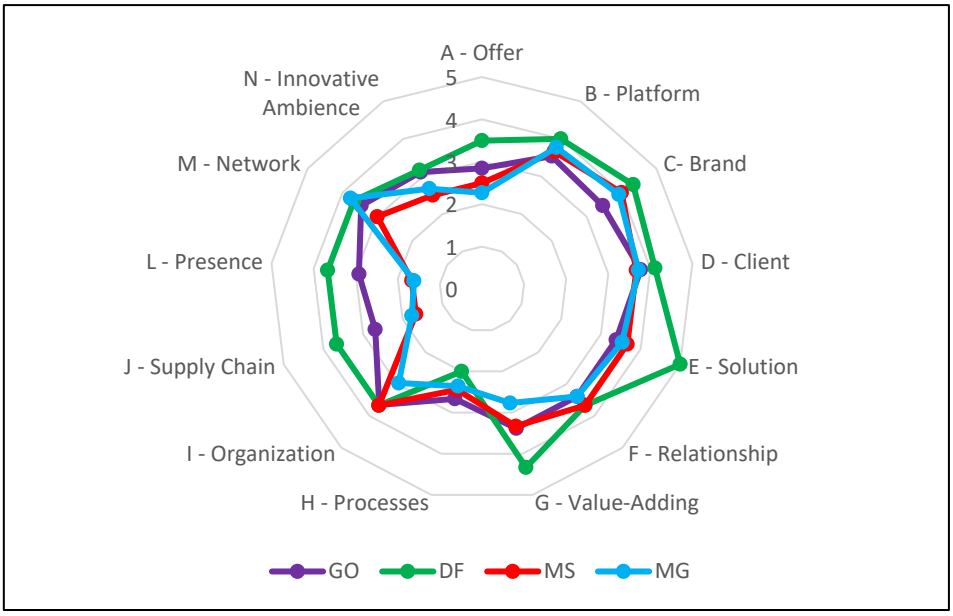
Source: Prepared by the authors (2020)

Regarding issues related to the Innovation Radar, the results were combined in two aspects: by sector of the economy and by state.

47 companies comprised the sample of the service sector, being 13 companies from Goiás, 3 from Brasília, and 27 from Minas Gerais. Thus, analyzing the Innovation Radar presented in Graph 4, it can be seen that in Goiás none of the dimensions scored above 4 points, however, most of them (9 of 13 dimensions) had a good score: Platform, Brand, Customers, Solution, Relationship, Value-Adding, Organization, Network, and Innovative Ambience. The others (Supply, Processes, Supply Chain, and Presence) had a low score, pointing out that these constructs are the most conducive to the emergence of bottlenecks and, therefore, should be the first to be analyzed and worked on, to overcome barriers existing

(Néto & Teixeira, 2014). Such data, together with the Average II, of 3.25, indicate that the service companies from Goiás analyzed are occasional innovators.

Graph 4 - II of the TBCs of the Service sector



Source: Prepared by the authors (2020)

The Brasilia service providers that were analyzed make up the entire population of TBCs in DF, which are linked to the CDT incubator (the only incubator in the Distrito Federal in operation and with incubated companies). About them, it can be seen that the dimensions of the Innovation Radar are well developed - except the Processes dimension - and that their Average II was 3.75, characterizing them as occasional innovators, close to reaching the level of systemic innovators.

Analyzing the service companies in Mato Grosso do Sul, through Graph 4, it was identified that there are constructs with a very low score, such as Presence and Supply Chain. However, the dimensions with a good score are the majority, with emphasis on Brand, with 4 points. As their Average II was 3.03, they were defined as occasional innovators.

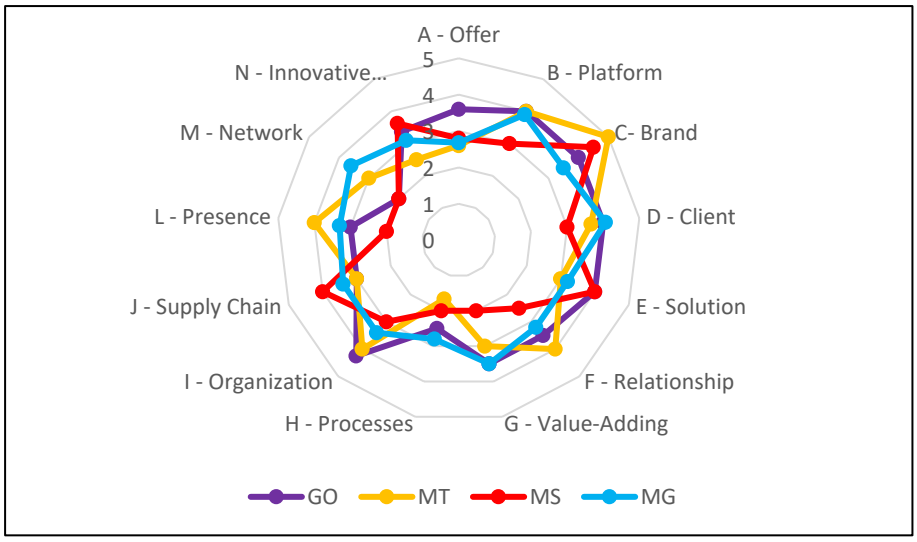
In MG, the ability to innovate TBCs in the service segment is very similar to the state of MS, since there is a contrast between the scores, that is, some with very low scores and others with scores close to 4. Including, the similarity was also about the dimensions because as in MS, the lowest scores were Supply Chain and Presence and the highest was Brand. The average II of the companies was also similar, with a difference of only 0.07 between MG (with 2.96) and MS (with 3.03). Therefore, the conclusion is that these companies are not very innovative.

In a macro analysis of Graph 4, it was observed that the dimensions of the service providers that stood out were Solution (5.0), followed by Value-Adding (4.33) and Customers (4.11). The areas that received the lowest score were Presence (1.62), Supply Chain (1.77), and Processes (2.0), all with scores below or equal to 2 points. The average II of the service companies was 3.25, showing that, in general, they are occasional innovators.

Regarding the trade segment, it is important to note that no participants were representing it. Next, follow the results of the industrial sector.

The companies that make up the industrial sector had, except for Minas (10 companies), low participation in the research. In GO, for example, there were only 02 respondents, as well as in MS. In MT there was one participant.

Graph 5 - II of the TBCs of the Industrial sector



Source: Prepared by the authors (2020)

The industries in Goiás, according to Graph 5, presented 10 dimensions with scores between 3 and 4 points, showing a good result. The maximum score was for Organization, with 4.25 points. The lowest score was in the Network area, with 2 points. With these data in mind and analyzing the Average II (3.44), it can be seen that GoT's TBC in the industrial sector are occasional innovators.

In MS, there was heterogeneity in the results of the dimensions of the industries, that is, a significant variation in the scores. The best results were obtained in the dimensions Brand (4.5), Solution (4.0), and Supply Chain (4.0), while the dimensions Value-Adding, Processes, Presence, and Network - all with 2.0 points - obtained the lowest averages. At the same time, the average II of these companies was 2.96, showing that these companies are not very innovative.

MT, in turn, had the participation of only 01 TBC, which is from the industrial sector, and presented disparate scores in the analyzed constructs, as well as MS. The highest score was obtained in the Brand dimension, which reached the ceiling (5 points). The lowest score was in Processes, with 1.7 points. Concomitantly, the average II of this company was 3.34, that is, an occasional innovator (see Graph 5).

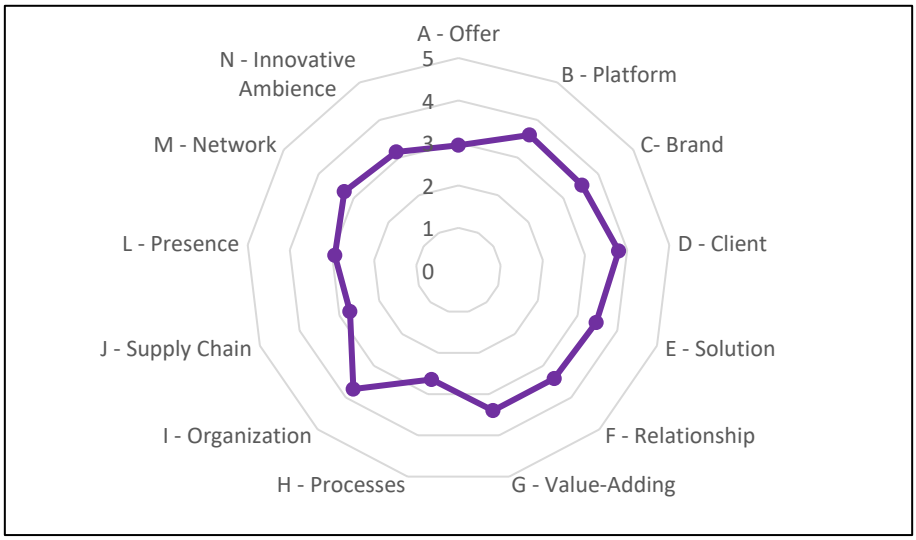
The industrial mining TBCs had only 02 dimensions (Supply and Processes) with a score lower than 03 points. All other dimensions were scored with 03 or more points, with a notoriety for Customers, who obtained the highest score, with 4.1 points. Allied to this information, there is the Average II of these TBCs, which was 3.4, demonstrating that these companies are occasional innovators.

In a comparison of the industry segment, as shown in Graph 5, it was observed that only the state of MT had an industry with a dimension - Brand - equal to 5, demonstrating that the company uses this construct in a very positive way. Simultaneously, the lowest score obtained in a given dimension is also

MT, which obtained 1.7 points in Processes. The average II of companies in the industrial sector was 3.27, showing that they are also occasional innovators.

Once the analysis by sector of the economy is finished, TBCs capacity for innovation by the state is demonstrated. Graph 6 shows that TBCs that have links with incubators in Goiás had, in general, a good score (between 3 and 4 points) in dimensions, except 04 areas (Supply, Processes, Supply Chain and Presence), which scored below 3 points. The Average II was 3.28, showing that the TBCs in Goiás are occasional innovators.

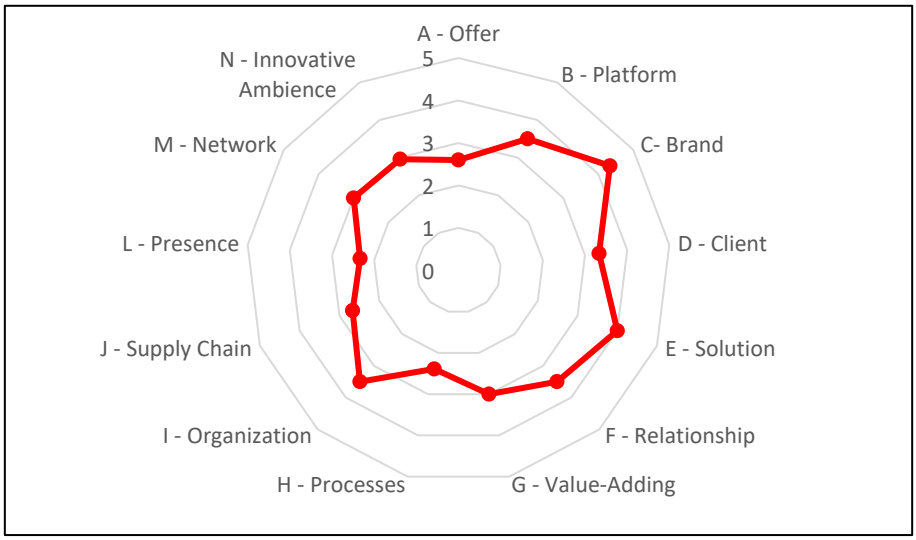
Graph 6 - Goiás II



Source: Prepared by the authors (2020)

Graph 7 shows that the TBCs participating in the state of MS stood out in the dimensions Brand (4.33) and Solution (4.0). Some dimensions scored below 3 points, but none below 2 points. By consulting the Average II of these TBCs (3.16), it appears that they are occasional innovators.

Graph 7 - MS II

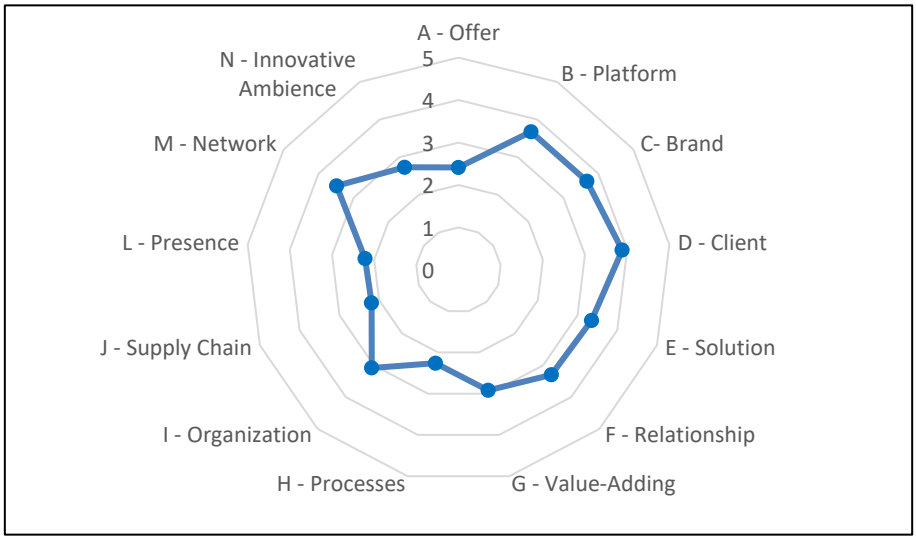


Source: Prepared by the authors (2020)

The analysis of the Distrito Federal will not be demonstrated here because it was presented in Graph 4 since the population and sample of DF are composed only of companies in the service sector. It is worth mentioning that the IG was 3.75 points. The same occurs with MT analysis, which has already been presented in Graph 5 since only 01 companies in the industry sector made up the sample.

Analyzing Graph 8, which shows the Innovation Radar of the TBCs of Minas, it is clear that none of the constructs obtained a score greater than or equal to 4. A good portion of the dimensions analyzed reached scores between 3 and 4 points. At the same time, another portion - formed by the dimensions of Offer, Value-Adding, Processes, Supply Chain, Presence, and Innovative Ambience - scored between 2 and 3 points. Such market positioning, together with the Average II of 3.01, demonstrated that these companies are occasional innovators.

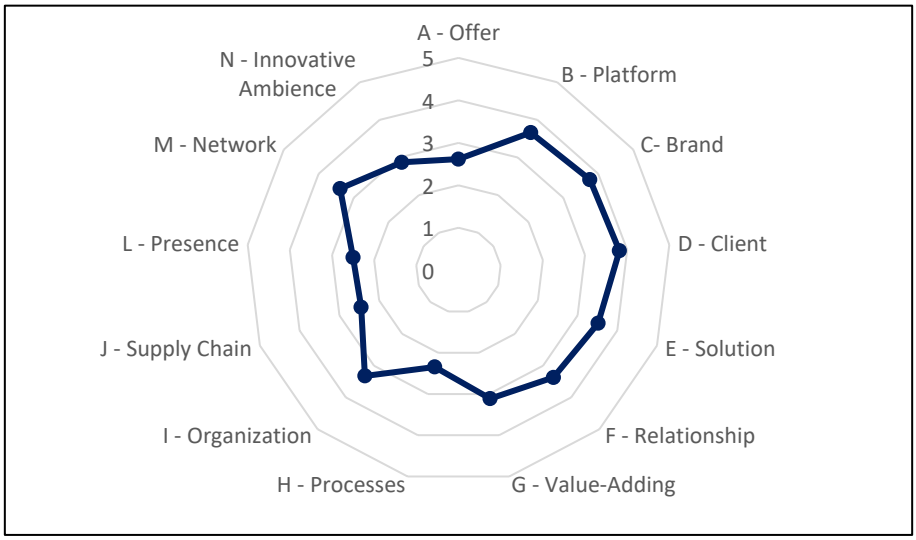
Graph 8 – MG II



Source: Prepared by the authors (2020)

Graph 9 presents the scores obtained by the 62 companies that constituted the sample of this study in each of the thirteen dimensions. It appears that there were no dimensions with a score equal to or greater than 04.

Graph 9 - II of the entire sample



Source: Prepared by the authors (2020)

The Customers, Brand, Platform, Solution, Network, Relationship, Organization, and Value-Adding dimensions, respectively, had a good score (equal to above 3 and below 4). The others had a low score (below metric 3). The average II of all companies was 3.13, showing that, systemically, the analyzed TBCs are characterized as occasional innovators.

4. Final Considerations

Altogether, 62 TBCs were researched, in the incubation phase, linked to 22 incubators installed in the states of GO, DF, MT, MS, and MG. Of those surveyed, about 60% is contained in the state of MG and about 24% in GO. The other states had low participation. Also, the majority of companies belong to the service sector (76%).

From this study, it was possible to identify that those surveyed are predominantly adults (aged between 20 and 39 years old) and male. Most of them are married (about 60%) and the level of education is diverse, from undergraduates to doctors.

Most respondents dedicate 5 to 12 hours a day to their businesses, have partners to manage them, and have no other companies on their behalf.

A portion (40%) of the TBCs surveyed do not have employees and those that usually have 1 to 2 employees. In all, the TBCs surveyed generate 134 jobs.

Regarding the monthly invoicing obtained by these companies in 2018, it was found that 40% had no invoicing and that, for the rest, the revenue was quite diversified (from R$300.00 to R$200,000.00). Analyzing the data provided by the companies, it was found that the monthly revenue obtained by these companies in 2018 was 1.2 million reais.

The study in question also sought to analyze the relationship between TBCs and incubators. Therefore, it was identified that most of the companies surveyed are resident companies, which pay, in most cases, from R$200.00 to R$499.00 of incubation fee.

Among the reasons that led the incubated to establish a link with the incubators is the infrastructure of the TBBI, the specialized services, the notoriety of the incubator and its maintainer, network of contacts, among others.

Regarding the innovation capacity of the analyzed TBCs, 3 types of analysis were carried out, namely: i) analysis by sector of the economy (service and industry); ii) analysis by state; iii) analysis of the entire sample. Such analyzes are condensed in the table below.

Table 1 - Analysis of the Innovation Capacity of TBCs

Service Sector Analysis					
State	**Number of TBCs**	**Highest Innovation Index**	**Lower Innovation Index**	**Average Innovation Index**	**Innovation capacity**
GO	13	Client (3,77)	Processes (2,67)	3,25	Occasional Innovator
DF	3	Solution (5,0)	Processes (2,0)	3,75	Occasional Innovator
MS	4	Brand (4,0)	Supply Chain, and Presence (with 1,7)	3,03	Occasional Innovator
MG	27	Brand (3,9)	Presence (1,6)	2,96	Little Innovator
Industry Sector Analysis					
State	**Number of TBCs**	**Highest Innovation Index**	**Lower Innovation Index**	**Average Innovation Index**	**Innovation capacity**
GO	2	Organization (4,25)	Network (2,0)	3,44	Occasional Innovator
MT	1	Brand (5,0)	Processes (1,7)	3,34	Occasional Innovator
MS	2	Brand (4,5)	Value-Adding, and Processes (2,0)	2,96	Little Innovator
MG	10	Client (4,1)	Offer (2,7)	3,4	Occasional Innovator
State Analysis					
State	**Number of TBCs**	**Highest Innovation Index**	**Lower Innovation Index**	**Average Innovation Index**	**Innovation capacity**
GO	15	Client (3,8)	Processes (2,64)	3,28	Occasional Innovator
DF	3	Solution (5,0)	Processes (2,0)	3,75	Occasional Innovator
MT	1	Brand (5,0)	Processes (1,7)	3,34	Occasional Innovator

MS	6	Brand (4,33)	Processes (2,39)	3,16	Occasional Innovator
MG	37	Client (3,88)	Processes (2,26)	3,01	Occasional Innovator
Analysis of the Entire Sample					
State	**Number of TBCs**	**Highest Innovation Index**	**Lower Innovation Index**	**Average Innovation Index**	**Innovation capacity**
GO, DF, MT, MS, MG	62	Client (3,82)	Processes (2,34)	3,13	Occasional Innovator

Source: Elaborated by the authors (2020)

Analyzing Table 1, which represents a synthesis of the results obtained in this research, it appears that about the service sector, the TBCs of DF was the most innovative, with 3.75 points, and those of Minas Gerais was the least innovative, with 2.96, which are characterized as not very innovative. Based on the industrial sector, the result was different, with the incubated companies in Goiás being the most innovative, with 3.44 points, and the least innovative MS companies (also classified as not very innovative).

In an analysis by state, it was observed that, unlike analyzes by sector of the economy, all states were characterized as occasional innovators, with the TBCs of DF with the highest score and Minas with the lowest. From a more comprehensive perspective, it was found that the entire sample was, in general, identified as an occasional innovator, with II of 3.13 points.

Regarding the dimensions, it was found that the Process dimension was, in general, the one that received the lowest score, demonstrating that TBCs have some difficulty in developing actions related to this construct. This dimension encompasses the most varied types of changes in the company's internal environment, aiming at gains in competitiveness.

Still, about dimensions, Brand and Client were, in general, the most cited as those that obtained the highest scores, demonstrating that the companies have acted more present in these constructs.

The limitations of this work include the difficulty and slowness in accessing the population defined for the present study, which made it impossible to conduct a study with a wider geographical scope, as well as the use of stratified sampling. Therefore, suggestions for future work include similar studies with stratified sampling; with other Brazilian states or regions; at Brazil and, perhaps, international level.

Other suggestions include conducting similar surveys with TBCs at time "0" when the company enters into a bond with the incubator and at the time "1", which can be months or years, to assess the development of this incubated business over time.

6. Acknowledgement

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Women, Education and Science

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SUMMARY

The study presented discusses the insertion of women in the sciences and starts from the assumption that Western epistemology is based on the dualism that is hierarchical, since it privileges mind or reason, said to be proper to masculinity, to the detriment of prejudice against the body and matter, which represents femininity. The objective is to analyze gender relations, whose differences have deepened social and, in particular, educational inequality, especially in relation to the insertion of women in the sciences. To fulfill the proposed objective, the methodology used will be the combination of analysis-synthesis and historical-logic methods, conceived in its dialectic unit. Research techniques such as bibliographic and documentary were used, through data provided by international organizations, censuses and national research institutes. The study of this theme is justified for considering it relevant in the current context where much is discussed from the perspective of building a plural society, with gender justice and less inequality. It is worth mentioning that the study proposed here was presented at the meeting of ANPEd - North, in 2016, at the Federal University of Pará. Thus, it is understandable that education for gender relations has been a relevant theme regarding practices oriented to the discussion of prejudice and discrimination against women.

Keywords: Women. Gender. Education. Science.

INTRODUCTION

Education for gender relations, inscribed in the transversal perspective of the organization of pedagogical work, has been a relevant theme regarding practices oriented to the discussion of prejudice and discrimination against women.

Gender relations are imbricated in the trinomial, sociedade-culture-socialization, and move according to the dynamics and social transformations that operate there. Society is an indispensable component of human social life, the culture emerges as an expression of that life in the social context and, finally, socialization develops as learning the cultural patterns for life in society.

Thus, there is no human behavior outside of culture since it is a distinctive feature of human societies and collective life is made up of representations. It can be said that the logic that determines these social representations is based on a duality, which hierarchizes and defines social relations, making them unequal.

Societies are full of norms and values that are established in order to organize the social life of their members, making men and women have certain roles, assume certain functions, defining hierarchies. If, on the one hand, aspects perceived culturally as masculine are valued, on the other hand, those taken as feminine are dulled.

For women, in particular, the collection is even more rigorous, since a series of stereotypes is still launched that compete so that they, since their birth, find values that delimit their behavior, thus establishing which postures should be adopted. The various stereotypes about men and women can be observed: "aggressive, militaristic, rational for them; docile, relational, affective for them". (VIANNA, 2002, p.93).

These expressions mark social representations that are inscribed in the bodies that carry the mark of their time. A time inscribed either under religious ideology, whose dominant power was present in the Church, or under scientific ideology, whose power is still present in the Modern State. The focus of the dominant institution is changed in a determined historical moment; however, not much is changed in terms of the power relations that are established in each highlighted period. In other words, unlike the ideological focus present in each historical moment, there are aspects that still remain, and here the issue of the social condition of women is highlighted, although resistance has been a constant presence in these power relations.

This social condition is implied, among other aspects, in their devaluation as human beings endowed with intelligence and practical knowledge, which has always been a strong weapon of men, holders of privileges, who sought ideological mechanisms, based sometimes on religion, as in the period of the Middle Ages, sometimes on science, as in the period of the Modern State, to silence their voices and social practices.

Physical reasons were sought to justify their alienation in the most different spaces other than the domestic (CLARKE apud MORENO, 1999). And by not reaching a direct rupture, like their insertion in formal education, other artifices were created, in an attempt to introject ideas that would make them believe that their abilities are more focused on certain areas of knowledge than others, like the exact sciences.

The image built for men and women at the end of the 19th century and the beginning of the 20th, attributed to these physical, psychological, intellectual and emotional characteristics that were superiorly differentiated. About women, it was said that "excessive education could harm their natural focus more on emotion than on intelligence skills. Destined for motherhood, they should be spared so as not to harm the health of their future children, and this included cognitive parsimony. (ALMEIDA, 2007, p.177).

The 18th century can be seen as a dividing line when it comes to women's social roles, because at the same time we have, in a period before it and up to its half, women with scientific knowledge, even if empirical, through chemical and pharmacological studies, for example, after this period, and with the consolidation of formal scientific knowledge, based on rationality and control, these women have been usurped from this knowledge and unable to access the newly constituted knowledge (TOSI, 1998).

The usurpation of these knowledges is associated with a series of factors, among them, the constitution of formal scientific knowledge, the consolidation of industrial capitalism, and the rise of the bourgeoisie. In relation to the former, there is a whole construction that brings the characteristics of this knowledge, as rational and objective, closer to men and excludes women because they are considered emotional and subjective. In relation to the last two, there is a significant change in values in relation to social roles and, in this particular, those attributed to women, since manpower was needed for insertion into the productive system and reproduction of the labor force.

It is not surprising that the access to formal education and the consequent professionalization of women, occurs, especially in the areas of care, like nursing, and teacher training, mainly directed to the initial grades of basic education.

The basis of Western epistemology, or in other words, the Western philosophical and scientific tradition, is based on the dualism that is hierarchical, since it privileges the mind or reason, that is, masculinity, to the detriment of prejudice against the body and matter, which represents femininity. This means that, at the time when it values one side, associated to the masculine, it lowers the other, associated to the feminine. Donna Wilshire exemplifies this issue by taking up a classic of philosophy:

> Aristotle's world is characterized by polarized opposites in which one side has dominion over the other; for him, the Soul has dominion over the body, Reason over emotion, the Masculine over the feminine, and so on. The Pure Mind relates to the 'divine' Soul, which is superior to all earthly things. [...] surely the masculine Mind and Reason dominate and are 'more divine' than the feminine body, because the woman (being dominated by emotions and bodily functions) is not so capable of Mind and Reason, etc. (WILSHIRE, 1997, p.102-103).

This construction of the perception that men are more active and prone to the area of rational knowledge is introjected in such a way that, when a woman stands out, the direct association that is made is that she resembles a man and not that she is as capable as he is of developing skills in this area.

Women, however, along the history, have not accepted in a passive way these stereotypes. For centuries they have opposed the idea of natural inferiority and have argued that the differences in aptitude and capacity between men and women depend, in reality, on unequal access to education.

The discrimination in access to education that thinkers denounced took on a different dimension in the periods in which they each wrote. This discontent can be expressed in many ways. From literature, following the example of Cristhine de Pizan, when she wrote about the need for recognition of women as subjects, to the example of the work "The City of Women" at the beginning of the fifteenth century (SERRANO, 2006), to the "Preciosas" (GARCIA, 2011) in the seventeenth century, owners of French salons who fled from superficiality and discussed issues such as rational thinking, education and freedom.

It can also be expressed in the contested texts, of a political nature, such as that of Mary

Wollstonecraft of England on the Demand for Women's Rights of 1793 and of Olympe de Gouges of France, who wrote the "Universal Declaration of the Rights of Women and Citizens" in 1791, for not being represented in the "Universal Declaration of the Rights of Man and of the Citizen" of the same year written during the French Revolution. Or, for example, in the writings of the Brazilian Nísia Floresta who wrote in 1832 on the "Rights of Women and Injustice of Men.

Added to this are the women's movements for education, universal suffrage, equal employment opportunities, and legal rights within marriage, among others, which extended from the 19th to the 20th century, beginning the waves of feminist movements, whether liberal or socialist in nature.

The situation was different in the middle of the 19th century, because since the 18th century educational opportunities in the West were changing as a result of the progress of science, the capitalist development of production and the need for skilled labor for industry and services.

It was only at the end of the 19th century that women progressively acquired the right of access to universities. To this end, "they are asked to use their knowledge for altruistic and unselfish purposes. To please their husbands, to be better teachers to their children, but never for personal purposes". (BADINTER, 2003, p.68). This observation made by Badinter leads us to reflect on the unequal insertion of women in the different areas of knowledge, where the most inclined to women are those that involve care, both in the field of health and education.

The study of this topic is justified for considering it relevant in the current context where a lot is discussed in the perspective of building a plural society, with gender justice and less inequality, and school is a privileged space to develop practices oriented to overcome prejudice and gender discrimination.

2 METHODOLOGICAL PATH

Based on the foregoing, the objective of this article is to analyze the gender relations that reproduce in a historically determined society, whose differences have deepened social and, in particular, educational inequality, especially with regard to the insertion of women in the sciences.

For this purpose, the methodology used will be the combination of analysis-synthesis and historical-logical methods. Initially the analysis of the elements of the situation raised will be made, relating them among themselves allowing the synthesis that is produced based on the results obtained previously through the analysis. Two essential components developed in this process of analysis-synthesis will be historicity and logicality, conceived in its dialectic unit.

Research techniques such as bibliographic and documentary were used, through data provided by international organizations, censuses and national research institutes.

This theme has often been approached by education, however, the indicators show us that advances have occurred, but much remains to be done concerning school practices and changes in attitudes towards gender justice.

It is worth noting that the original text of this article was presented at the ANPED/Norte event in 2016, at the Federal University of Pará. After that, some reflections were made to improve the text.

3 WOMEN, EDUCATION AND SCIENCE

It is necessary to understand how these gender relations occur and reproduce in a historically determined society and, therefore, it seems appropriate to develop the study of these relations, based on the analysis of gender and habits, as durable provisions that reiterate behaviors, without making them permanent.

Differences such as race and sex have historically contributed to the deepening of social inequality of subjects inserted in these categories, such as blacks and women, thus concluding that gender and race inequalities are structuring for social inequality in Brazil. According to Nancy Fraser:

> Gender, for example, has economic-political dimensions because it is a basic structural principle of political economy. On the one hand, gender structures the fundamental division between 'productive' paid work and 'reproductive' and unpaid domestic work, giving women primary responsibility for the latter. On the other hand, gender also structures the internal division of paid work between higher-paid professional and manufacturing occupations where men predominate, and low-paid 'pink collar' and domestic services occupations where women predominate. (FRASER, 2006, p.232-233).

To reinforce this issue Cláudia Vianna and Sandra Ridenti claim that in our society, inequalities between men and women are strongly attributed to sex distinctions, with evident biological connotations. Thus, sex refers to the physical differences between men and women, and these distinct characteristics are used by individuals in the construction of a "set of social and cultural representations, values and social attributions that we call gender, which in turn refers to an attempt to incorporate aspects that are socially constructed, noting that each culture defines what is male and female". (VIANNA; RIDENTI, 1998, p.96-97). Therefore, these are procedural and changeable definitions.

In this way, we start from the unnatural and non-essentialist character to analyze the relationships that are established between men and women in a given society. Therefore, nothing is more appropriate than referring to the concept of gender "developed to contest the naturalization of sexual difference in multiple arenas of struggle". (HARAWAY apud CARVALHO, 2011, p.101). In this sense, it gives us subsidies for a better understanding of the different and varied forms of interaction between human beings.

Thus, the optics is directed to a process, to "a construction, and not to something that existed a priori. The concept now demands that we think in a plural way, emphasizing that the projects and representations about women and men are diverse". (LOURO, 2012, p.27). For Joan Scott the concept of gender is "anchored in an integral connection between two propositions: it is a constitutive element of social relationships based on perceived differences between the sexes; and it is a primary way of giving meaning to power relationships". (SCOTT, 1995, p.86).

Based on the above, it is understood that there are objective structures in the social world, such as social institutions, the family, the church and the school, which can direct the action and representation of individuals. From this perspective, the school reproduces the power relations present in society, in addition to reiterating discourses full of prejudice and discrimination.

Prejudice is understood as "a negative attitude, unfavorable to a group or its individual

components. It is characterized by stereotyped beliefs" (SILVA apud CANDAU, 2003, p.16).

To better elucidate this concept, Edison Borges et al. state that:

> Prejudices are part of our socialization process and it is extremely difficult to eradicate them from thinking, because the critical perspective requires more effort than the simple acceptance of false ideas, but which we are used to and which favor us. Furthermore, prejudices are rooted in all cultures, marking the relationships that each one establishes with the others and often justifying unequal treatment and discrimination of individuals and groups. (BORGES et al. apud CANDAU, 2003, p.17-18).

There is a close relationship between prejudice and discrimination, while the first refers to attitude, the second to concrete social practices, meaning,

> [...] the unfavorable treatment usually given to certain categories of people and/or groups. It refers to social control processes that serve to maintain the social distance between certain groups, through a set of more or less institutionalized practices that favor the arbitrary attribution of traits of inferiority for reasons, in general, independent of the actual behavior of the people who are the object of discrimination. (CANDAU, 2003, p.18).

This is maintained because societies are full of norms and values that aim at the adjustment of individuals and, consequently, the maintenance of the current societal model. For women, above all, all these values are much more rigorous, because stereotypes are still launched that compete so that they, from their birth, find values that delimit their behavior, thus establishing the postures they should adopt.

Being specifically about the school institution, according to Fúlvia Rosemberg et al. the feminine and masculine values present in these spaces can be used for the propagation of stereotypes, as well as to interfere in the production and reproduction of gender prejudices, since this kind of prejudice - which affects boys and girls in classrooms or school space - is based on an educational system that reproduces the structures of power, of privileges of one sex over the other in our society and even appears in textbooks and school relations. (ROSEMBERG et al. apud VIANNA; RIDENTI, 1998, p.100).

This implies that formal education reflects the values culturally developed by the society in which it is inserted, passed on through socio-educational conceptions present at a given historical moment, as well as the school curriculum, teaching contents and shared knowledge.

According to Vera Candau (2003), the educational institution is the stage for manifestations of prejudice and discrimination of various kinds. However, school culture tends not to recognize them, since it is impregnated by a standardized representation of equality. The author comments on this:

> The school, in most cases, deals badly with differences and tends to silence and neutralize them. Prejudices and different forms of discrimination are present in school daily life and need to be problematized, unveiled, denatured; otherwise, the school will be at the service of reproducing standards of conduct that reinforce the processes of discrimination underway in society. (CANDAU, 2003, p.92).

This reproduction of patterns of conduct still tends to determine careers that are sexualized, hierarchizing them and valuing them in different ways. The result of this is the insertion of women in productive activities of a relational, affective and caring nature, often moving away from those that require logical reasoning and greater power of abstraction, conceiving this issue as natural and not as a social and

historical construction.

When observing the data from the Higher Education Census (2010, 2013), for example, the courses with the highest percentage of female students are Social Service, Speech Therapy, Nutrition, Secretariat. In this sense, the reproduction of the sexualization of careers is a fact that is observed when we analyze the distribution of enrollment in higher education by sex and course.

Even the dominant positions in which women occupy an increasing number, in Pierre Bourdieu's evaluation, are essentially in the dominated regions of the area of power, i.e., in the production and circulation of symbolic goods such as publishing, journalism, teaching. (BOURDIEU, 2011, p.111). The teaching function, for example, particularly in the initial grades of basic education in several countries, is made up significantly of women, when such an activity is conceived as an extension of that carried out in the domestic space with regard to the care of the offspring.

Women currently study harder and are financially responsible for an increasing number of homes. Nevertheless, the country's research institutes prove that they still occupy fewer formal jobs than men and have lower salaries, even when they perform the same function, that is, they have conquered more space, but still haven't managed to overcome the inequalities regarding salaries and positions.

For Pierre Bourdieu, all knowledge rests on a fundamental division operation, that is, the opposition between the feminine and the masculine. The way people learn this division is through the daily activities imbued with symbolic meaning, that is, through practice. The quotidian concepts about the feminine and the masculine structure the perception and the concrete and symbolic organization of the whole social life. (BOURDIEU apud LAMAS, 2000, p.18).

These quotidian concepts polarize the feminine and the masculine, establishing distinct patterns of behavior that are reiterated by the social institutions, as the family and the school, that is, since the primary socialization; reaching, in the youth or in the adult phase, the choice of the profession to be followed.

In this way, there is a whole discourse of representation of the feminine that brings an affinity for the social area and care, for example, whose justification is in the characteristics closest to affectivity, sentimentalism, emotion. The interest in science and technology, on the other hand, has always been viewed with mistrust when it comes to women's skills and abilities for the most rational and abstract field, placed as characteristics more proper to men. The female cognitive parsimony was used as one of the reasons that led to the absence of women from these areas.

Thus, there are models that reproduce traditional and conservative patterns, which tend to direct men and women to certain professions that carry within themselves social representations of the male and female.

Moreover, in the classroom, there is a whole discourse of reiteration of skills and abilities differentiated for both sexes, with a male inclination to disciplines that require logical reasoning, precision, technique, that is, the so-called hard sciences. On the other hand, there is a feminine inclination towards those more relational, focused on the humanities. This has a decisive effect when, in the final stage of basic education, young people need to define which profession they will follow, at a technical level or in higher education, in a technological course, bachelor's degree or diploma.

This definition of the profession brings with it a load of social meanings that tend to determine

the career paths of men and women. For them, male careers that presuppose greater power of abstraction, logical reasoning. For them, women's careers, focused on the care of others and the humanization of social relations.

These issues are problematized, starting from the unnatural and non-essentialist character of being in the world, and education for gender relations has become a relevant issue in terms of practices oriented to the discussion of prejudice and discrimination against women.

Since the 1990s, Brazil has been undergoing educational reform processes, whose normative documents have addressed gender issues from the perspective of overcoming prejudice and discrimination against women, following the example of National Curriculum Parameters.

The 1990 World Declaration on Education for All, which addressed the satisfaction of basic learning needs, states in its Article 3: "Universalize access to education and promote equity, guaranteeing access to education for girls and women, and overcome all obstacles that prevent their active participation in the educational process. Prejudices and stereotypes of any nature must be eliminated from education". (UNESCO, 1990).

Since then, the discussion on the new directions of education and the exclusion of minorities, like prejudice and gender discrimination, has been one of the problems that are necessary for reflection and implementation of policies aimed at overcoming them. In this regard, it is worth mentioning that the UN held five international conferences in the 1990s on issues related to women, development and education.

There is a whole discourse of the Brazilian State focused on gender equality, considered as transversal in federal policy planning. In this direction, the National Plans on Policies for Women, linked to the Special Secretariat on Policies for Women, reaffirm the above.

In addition to these projects, there is also the Women and Science Program, created in 2005, whose objective is "to valorize the field of studies on gender, women and feminism relations, and promote reflection on gender relations among high school students, undergraduate students and graduates through the Building Gender Equality Award. (Women and Science Program, 2005).

As far as the object of analysis of this article is concerned, the path is long and permeated by prejudice and discrimination, which leads to unequal access, permanence and recognition of women in the scientific field.

According to Maria del Pilar Sancho (2006, p. 129), statistics of Nobel Prize winners show that physical women appear in an unfavorable position in relation to chemical or medical women. According to a survey she made in the early 2000s, of the 174 Physics winners, only two were women: Marie Curie in 1903 and Maria Goeppert-Mayer in 1963. Of the 146 Chemistry winners, three were for women: Marie Curie in 1911, Irene Joliot-Curie in 1935 and Dorothy Crowfoot Hoodgkin in 1964. Of the 182 medalists, seven were women: Getty Cory in 1947, Rosalyn Yalow in 1977, Barbara Mcklington in 1983, Rita Levy Montachini in 1986, Gertrude Elion in 1988, Christiane Nüsslein-Volhard in 1995 and Linda B. Buck in 2004.

The representation of women until 2011 was 5.2%, which is the most representative area, in the decreasing area of nomination, we have the Nobel Peace Prize, Literature and Medicine. In the case of the Nobel Prize in Physics, beyond the two women mentioned in the previous paragraph, we had two more, one in 2018 and one in 2020, that is, four in total, since the creation of this prize in 1901. In the case of

the Nobel Prize in Chemistry, in addition to the three women mentioned in the previous paragraph, we had four more, one in 2009, one in 2018 and two in 2020, that is, seven in total.

4 FINAL CONSIDERATIONS

The analysis presented here has made us reflect on the insertion of women in the sciences and is based on the assumption that Western epistemology or Western scientific tradition is based on the dualism that is hierarchical, since it privileges mind or reason, said to be proper to masculinity, to the detriment of prejudice against the body and matter, which represents femininity.

Women, however, throughout history, have not passively accepted these stereotypes. For centuries they have opposed the idea of natural inferiority and maintain that the differences in aptitude and capacity between men and women depend, in reality, on unequal access to education. An education that must be understood as an important instrument that influences personal and professional training, that is, the full development of people.

However, this broader dimension placed on education is far from being realized, and what is observed is that it acts as a reproducer of gender relations, since it reflects pre-established cultural patterns, leading to differentiated education and the consequent sexualization of careers.

The lack of gender equality in the academic, scientific and technological fields is not a particularity of science. It is in consonance with the lack of equality between women and men in other spheres of social life. However, when observing a certain area, such as engineering, and according to the data presented, the inequality is even greater, because there is a whole socio-cultural construction that distances women from this field.

Although cultural barriers have been broken down and women have been included in careers historically considered male, subtle and complex processes of prejudice and discrimination persist. In addition to breaking down barriers and breaking down careers, world consciousness becomes essential for building new relationships based on social justice, respect and human dignity.

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Manufacture of a non-woven using bamboo cellulose base *(angustifolia)* as a filter medium for the manufacture of masks

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Abstract

The purpose of this study was to produce a non-woven, using a base of bamboo cellulose (angustifolia) with a particle size of 1mm, and it begins with the weighing of 100 g bamboo cellulose, which is mixed with a bath ratio bamboo / water 1:10 in a mixer grinder, placing 1 liter of water mixes and forms a viscous solution, this solution is placed on a frame stretched with polyester woven mesh and another frame without mesh, once the layer is formed, it is remove the upper frame without mesh and compress it manually with a sponge, removing excess water and drying in the room at a temperature of 20 ^{0}C for 8 hours, evaporated the moisture from the bamboo cellulose (angustifolia) and dried, separated from the frame and a laminated nonwoven (filter) was obtained. Finding that the breaking strength and its elongation in thickness of 0.3mm is 2.73 N and 0.895 mm respectively and thickness of 5mm is 31.2 N and 1.01 mm. The resistance and extension is very low in the two cases, and there are no statistically significant differences between their sample medians (p> 0.05). It can be concluded that when using bamboo cellulose base with a particle size of 1mm, and forming the non-woven with thickness of 0.5mm and 3mm, it has low resistance and extension, finding that if the raw material has an influence on the conformation of the non-woven.

Keywords: Bamboo, non-woven, filter

1. Introduction

The research focuses on the elaboration of a filter based on bamboo cellulose *(angustifolia)* intertwined between its fibers known as non-woven, taking advantage of the fact that bamboo is a cellulosic non-timber forest resource found in nature, since 1990 The need for the environment arises and promotes bamboo research, in conjunction with several international donors, creating the International Network on Bamboo and Rattan (INBAR) with the support of the International Center for Development Research (IDRC), (FAO , 2017). In order to benefit from its properties and characteristics, it can be used from food for human and animal consumption, beverages, clothing, medicine, coal, paper, soaps, cleaning products among others. (BAMBUCYT, 2018), Because it is a grass, it has properties that can be used as a fiber with particular and natural antibacterial, bacteriostatic and deodorizing functions, bamboo has a unique bioagent against bacteria and bacteriostasis called "Bamboo Kun". This molecular substance is hermetically found all the

time during the process of being produced in bamboo fiber. (Bambro textile Co., 2017).

Silman, details that there are in the south west Amazon of Peru large areas of bamboo covering an area of 180,000 km^2 and dominate the largest areas of tropical virgin lands on the planet. (Nelsón 1994 citado en Saatchi et al 2000 citado en Miles R. Silman, 2015). With its different properties according to the cultivation site, as expressed in the Technological University of Pereira on the physical characteristics of Guadua angustifolia fiber bundles in: percentage of moisture content, percentage of water absorption, average apparent density, shape and texture (Universidad Tecnológica de Pereira, 2007). In addition, in the National University of Colombia in 2002, I developed an investigation on the taxonomy of the two classes of bambusoideae existing in America, on the anatomy of the leaf blade and culm, emphasizing preservation methods. (Universidad Nacional de Colombia, 2002).

Until now, the behavior of the material when subjected to mechanical characterization tests is not adequately known. In this work, it was sought to evaluate bamboo (Guadua angustifolia) specimens subjected to the simple compression test (Antonio Ludovico Beraldo, 2007). In addition, the bamboo fiber (cut) guadua angustifolia, at the National University of Colombia conducted the study to determine the resistance to compression parallel to the fiber and the modulus of elasticity. (Universidad Nacional de Colombia, 2007), developing a construction manual for anti-seismic earthen houses, through the use of bamboo as an alternative method, where the vertical reinforcements of the mud wall are placed with 2.5 to 5 cm thick bamboo canes (Universidad de Kassel, Alemania, 2005). Where, through this fiber, the publication of the optimization of the production of activated carbon from bamboo (Bambusa vulgaris striata) was made (Revista Mexicana de Ingeniería Química, 2010), Research was carried out on the characteristics of bamboo fibers (Dendrocalamus giganteus), in their anatomical, chemical, and physical-mechanical compositions, according to the ABNT and EN standards. (Universidad Tecnológica Federal Do Paraná , 2012).

From the analyzes carried out by China Textile Supervision National Testing Center, with the support of Bambrotex, a company related to the production of Bamboo fibers, finding that bamboo has good physical, chemical and biological properties (Bambro textile Co., 2017). Especially applied in new fields due to their resistance, such as the aeronautical industry that replaces carbon fiber, fiberglass, and kevlar, which due to their favorable aspects during the period of use work against the moment of their degradation (Lucena, Suarez, & Zamudio, 2009). Its use has been aimed exclusively at construction, such as the research carried out in the Canton Bucay Ecuador on the benefits of Guadua angustifolia with a scientific analysis on the amount of water in stems and woody tissues of the stems, (Dávila, 2013).

Cellulose is renewable, biodegradable and biocompatible, it can be used as a raw material in packaging materials. Due to its immiscibility, it is usually converted into derivatives to make it more processable such as: cellulose ethers such as methylcellulose (MC), carboxymethylcellulose (CMC), hydroxypropylcellulose (HPC), hydroxypropylmethylcellulose (HPMC) (Camacho et al, 2011). These advantages are taken advantage of in the shaping of medical-sanitary tissues due to its action to prevent allergic phenomena and skin infections, drapery due to its antibacterial and permeability functions (Observatorio Industrial del sector textil/confección, 2015).

Advantages that can be exploited with an analysis of the best option in the fiber production stages, as indicated (Rosero, Rosero, Esparza, & Esparza, 2018), it is necessary to carry out physical and / or chemical

treatments to the bamboo cellulose. The bamboo cellulose is extracted using the alkaline method with sodium hydroxide flakes. This process is carried out at a temperature of 150 ° C, with a time of 6 hours and a 1:10 bath ratio (bamboo / water), the yield is in the order of cellulose 11.39%, 41.61% and 44.8%. In addition, lignin was removed in 88.6, 58.39 and 51.2 percent respectively (Esparza W. , Rosero, Chamorro, & Herrera, 2018). Meanwhile, another procedure for obtaining cellulose was optimized by varying the time, temperature and concentration of sodium hydroxide. In addition, the best cellulose yield was obtained after the entire process and a reaction percentage of 44.05% cellulose was achieved after 5 hours of extraction (Jiménez & et al, 2011) . And applying the study of vulcanized elastomeric mixtures composed of natural rubber NR and styrene butadiene rubber SBR. They are two of the most widely used elastomers on a global scale for different industrial applications (Mansilla, 2012), achieving the formation of a polymer. These compounds are mixed components, they improve the physical and thermal properties of elastomers.

2. Methodology

The nonwoven (filter) elaboration process was using bamboo cellulose (angustifolia), with a particle size of 1 mm. Obtained from the separation process with lignin using the alkaline method as indicated (Esparza W. , Rosero, Chamorro, & Herrera, 2018) at a temperature of 150 0C, 6h and bath ratio (bamboo / water) 1:10 as variables the alkali and the alkali / bath ratio, the cellulose yield 11.39, 41.61 and 44.8%. Furthermore, lignin was eliminated in 88.6, 58.39 and 51.2% respectively.

2.1 Materials

The following materials were used to form the nonwoven:

- Balance
- Tray
- Frame tensioned with mesh
- Frame without mesh
- Mixer crusher
- Canvas
- Sponge

2.2. Process

The particle size of the bamboo cellulose base (angustifolia) used was 1mm, and it begins, with the weighing of the bamboo cellulose 100 g (c) which is mixed with a ratio of bamboo / water bath 1:10 in a mixer grinder (b) placing 1 liter of water, mixing and forming a viscous solution (d), this solution is placed on the frame stretched with mesh and the frame without mesh (e), once the bamboo layer is formed, Remove the upper frame without mesh (f) and compress it manually with a sponge (g), removing excess water to dry at room temperature at 20 °C for 8 hours (i) as shown in graph 1.

Graph 1. Process for obtaining non-woven (filter) from bamboo cellulose

Compressed, the moisture evaporated from the bamboo cellulose (angustifolia) and dried, the non-woven that was on its frame was separated (h), a laminated non-woven (filter) of 0.5 and 3 mm thick (i), with a smooth characteristic on the surface, of a beige and rigid color. Resistance and extension tests were carried out on the elaborated nonwoven, in order to determine the properties acquired in the formation process by means of the Titan 5 universal Strength Tester dynamometer equipment, using the ISO 13934-1: 2013 STANDARD as shown in graph 2.

Graph 2. Bamboo Nonwoven (Filter) Strength and Expansion Test

3. Results

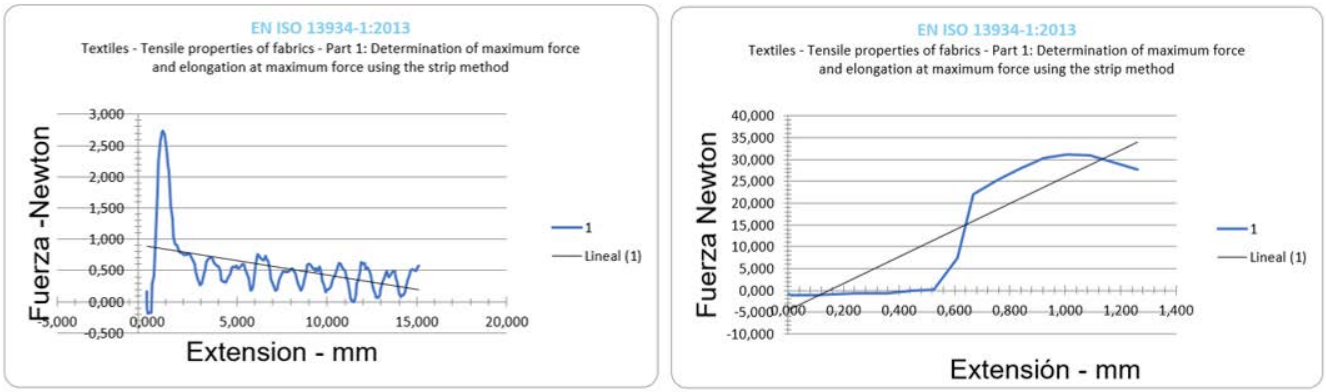
To determine the tensile strength and extension to breakage of paper and others, in the elaborated bamboo nonwoven, the strip method was used according to the ISO 13934-1: 2013 standard, the results and data found with the thicknesses of 0.5 and 3 mm were the following, indicated in table 1.

Table1. Results with 0.5 and 3 mm thick non-woven bamboo

Reading Índex	Extension With thickness 0.5 (mm)	Force (N) With thickness 0.5 (mm)	Extension With thickness 3 (mm)	Force (N) With thickness 3 (mm)
1	-0,001	0,166	0,000	-0,627
2	-0,001	0,066	0,000	-0,797
3	-0,001	-0,076	0,000	-0,962
4	0,058	-0,184	0,012	-1,025
5	0,140	-0,180	0,101	-1,081
6	0,223	-0,173	0,165	-0,954
7	0,306	0,290	0,249	-0,781
8	0,391	0,403	0,360	-0,658
9	0,476	1,064	0,444	-0,173
10	0,559	1,752	0,526	0,041
11	0,644	2,231	0,612	7,443
12	0,727	2,542	0,668	21,957
13	0,811	2,711	0,755	25,177
14	0,895	2,730	0,838	28,006
15	0,978	2,685	0,922	30,314
16	1,062	2,465	1,007	31,197
17	1,146	2,163	1,090	30,926
18	1,228	2,064	1,175	29,250
19	1,313	1,531	1,259	27,622

3.1 Strength and extension with thickness 0.5 and 3 mm

According to graph 3a, with the data found from the dynamometer equipment, the resistance and extension were obtained, showing that the nonwoven (filter) made with bamboo cellulose with a thickness of 0.5 mm resists a maximum breaking force of 2.73 Newton and reached to obtain an extension of 0.895 mm indicating that it does not have a good resistance to breakage, in addition its extension is very low causing it to break with a minimum force with a tendency to decrease, while with a thickness of 3 mm, it was found that it resists a breaking force of 31.02 Newton and an extension of 1.01 mm with a tendency to increase according to figure 3b.

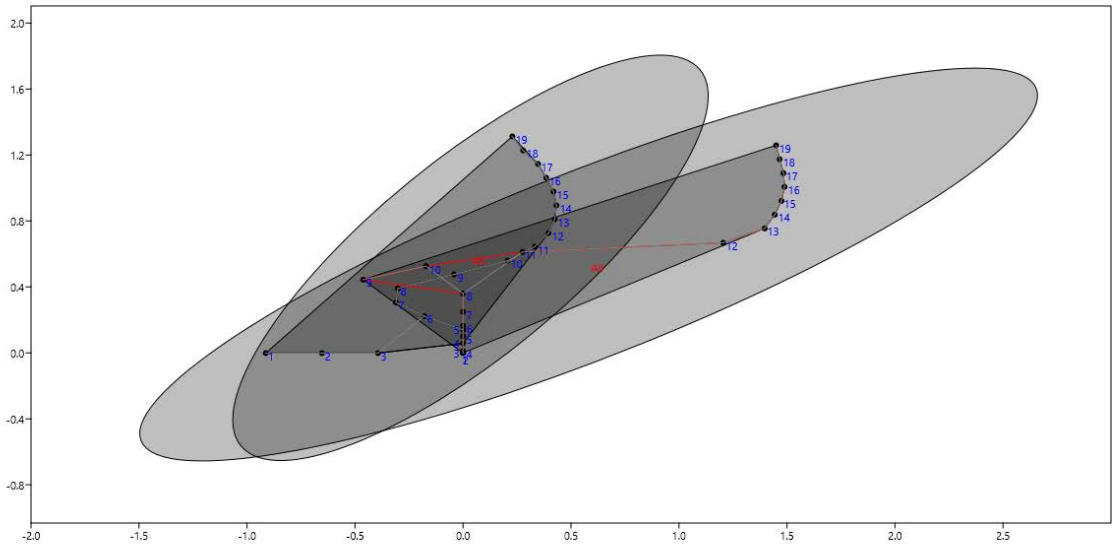


a. Strength and extension thickness 0.5mm b. Strength and extension thickness 3mm

Grph3. Strength and extension thickness 0.5 and 3 mm

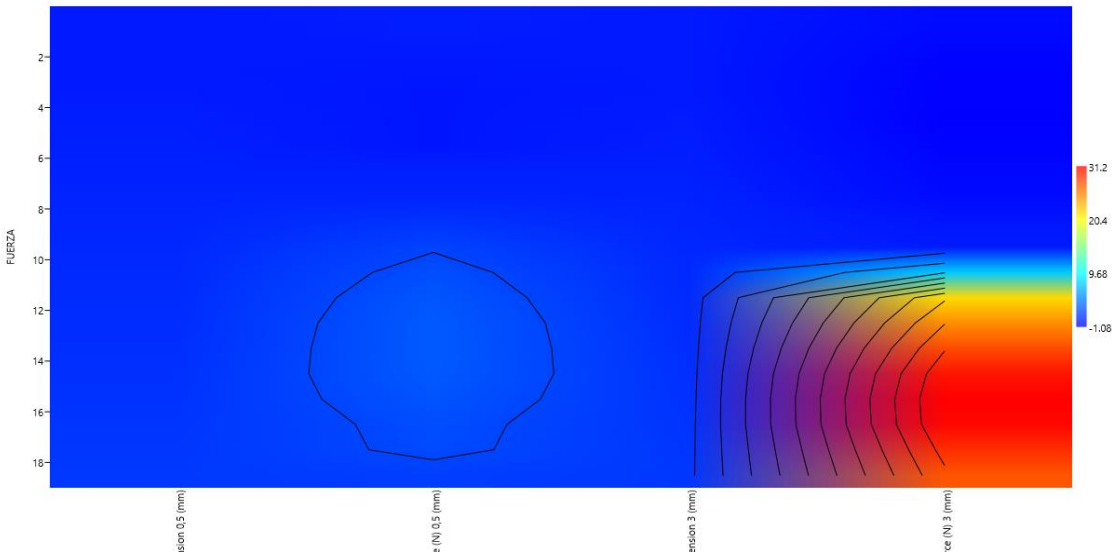
4. Discussion

In the graph in x, y past, it can be observed that all the data are within the eclipse with a reliability of 95%, there are data that are concentrated in the center indicating that they are uniform and have correlation between them and few data are a little distant in group from their correlation, expressing that all the data obtained are reliable as shown in graph 5.



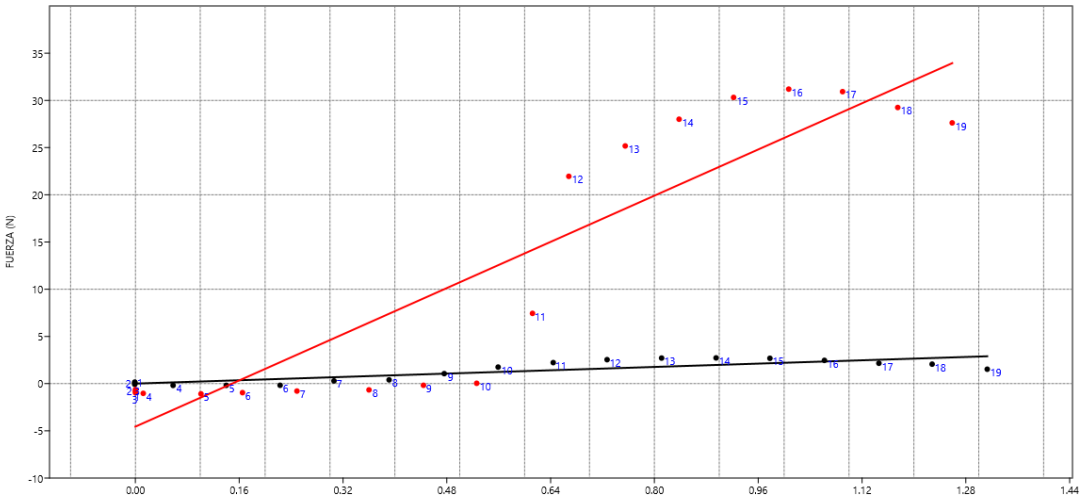
Graph4. Correlation between thicknesses of 0.5 and 3 mmm

While in the Matrix Plot graph, it is possible to distinguish the similarity between strength and extension of the nonwoven with a thickness of 0.5 mm, concentrating little data on its extension, while in the 3mm thickness it is observed that, initially both its strength and extension They are similar to that of 0.5 mm with a tendency to increase in resistance as its extension increases, indicated in graph 6.



Graph 5. Correlation of 0.5 and 3 mm thicknesses

On the other hand, in the One –way Ancova graph, it is shown that using the bamboo cellulose base with a particle size of 1 mm, as we increase the thickness of the bamboo non-woven from 0.5 to 3 mm respectively, the resistance increases. And the extension as detailed in figure 7.



Graph6. Trends according to thickness 0.5 and 3 mmm

When using the raw material with a particle thickness of 1 mm for the elaboration of the bamboo nonwoven, it was found that, with the two thicknesses obtained of 0.5 and 3mm, the resistance and the extension are very low in both cases, and not there are statistically significant differences between their sample medians ($p > 0.05$). Taking into account the bamboo with its culm they are more resistant as indicated (Lucena, Suarez, & Zamudio, 2009) its lightness and high modulus of rupture (from 9000 to 10100 N / mm2) and elasticity (84 to 126 mm) make bamboo an ideal material for construction greater than steel. While the non-woven analyzed, with a thickness of 0.5mm, it was found that the breaking

strength and its elongation is 2.73 N and 0.895 mm respectively and with a thickness of 3mm it increased to 31.2 N and 1.01 mm.

This low resistance and elongation in the analyzed laminated nonwovens is possibly due to the particle size of 1 mm used as raw material, as determined (Esparza , Rosero, Herrera, & Chamorro, 2018) with a particle size between 20 to 0.05 mm. The result found was a cellulose base with a higher yield of 44.845% using an intermediate particle of 15 mm. It was found that the smaller the bamboo particle, the lower the percentage of cellulose base separated from the lignin. That is, if the particle size used in the formation of laminates has an influence, the longer the fiber obtained in the cellulose has more resistance as indicated (Noé, 2016) The pulp mixes bagasse and pulp from Kraft 70-30 bags presents the highest amount of long fiber. This material forms a closed and not very porous structure, which prevents the long fiber fraction from working optimally.

5. Conclusion

It can be concluded that when using bamboo cellulose base with a particle size of 1mm, and forming the nonwoven elaborated with thickness of 0.5mm and 3mm, it has low resistance and extension, finding that if the raw material has an influence on the conformation of the no tissue. With this finding, it is necessary to carry out more studies with different cellulose particle sizes to show that it improves its properties.

6. Recognition

A thanks to the Technical University of the North, Ibarra, Ecuador, for the contribution in providing the necessary support to carry out this study on bamboo

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Assessment of Access of Reading Resources in Bolstering Extensive Reading Habits and Composition Writing Skills in Secondary Schools in Kenya

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ABSTRACT

Reading resources in schools can help in inculcating the reading culture and reading proficiency amongst students. This may help learners develop rational skills that are crucial in dealing with the current unpredictable and dynamic world. There has been a concern from educationist and researchers about the declining reading interest among secondary school learners in Kenya and one of the causes could be unavailability of reading resources amongst other determiners. This study was prompted by the lack of adequate reading resources that can bolster and sustain reading interest among secondary school learners in Laikipia County in Kenya. The study therefore sought to establish whether there existed any relationship between availability and access of extensive reading resources and development of extensive reading habits evidenced in composition writing amongst learners. The study was guided by Piaget's (1952)) Schema Theory. The study used descriptive survey research design. Fifteen secondary schools in Laikipia County were sampled using proportional stratified sampling technique in five sub-counties across the County. Purposive sampling was used to sample 30 out of 80 (37.5%) teachers of English language. A Simple random sampling technique was used to sample 327 students out of approximately 2670 students (12.24%) in form 2 and 3 in the County. The research instruments used for data collection included: questionnaire for students, interview guides for teachers and composition writing test. A pilot study of the instruments was done to ensure their validity and reliability in a co-educational secondary school in the neighbouring county that was not involved in the study. The reliability of the questionnaire and interview guide was estimated using Cronbach's alpha coefficient as 0.871 which met the recommended threshold of 0.7 and above. Analysis of data was done using descriptive statistics such as frequency, tables and percentages. T-test was done at 95% confidence level (F(2) = 80.933, P = .001) to establish whether there was statistically significance difference between availability of reading resources and development of extensive reading habits captured in composition writing mean scores of different categories of school using (SPSS) version 17. Qualitative data were organized according to the study themes and presented descriptively on the basis of the study objective. It was established that learners in secondary schools with adequate extensive reading resources performed better in composition writing than those who did not. Therefore, it was established that inadequate supply of reading resources in schools had a negative impact

on development of reading interest amongst learners. The study recommended that schools should collaborate with various stakeholders to solicit reading resources so as to promote access of reading materials and reading culture in schools and consequently improve learners' composition writing skills.

Keywords: Extensive reading, Reading resources, Assessment, Bolstering

BACKGROUND TO THE STUDY

One of major aspects that influence students' attitudes toward extensive reading is reading resources. Reading resources are very important for encouraging the students to learn. Extensive Reading Foundation (2014) observes that extensive reading is a way of reading for pleasure where learners are allowed to choose reading materials which suit their interest. Materials that are selected should be fun, interesting, enjoyable, and should address students' needs, tastes, and interests because the more the students are interested and enjoy the reading they do, the better. It should not be bound by time, space, or even class. Moreover, the materials also can be taken from many types of texts, books, novels, magazines and newspapers which should be planned and provided with guidelines by the language teachers so that it would be more organized for the students to engage in reading (Extensive Reading Foundation, 2014).

Higginbotham (1999) did a study in Atlanta, Georgia on extensive reading interests by gender. The study was based on a metropolitan public school where he analyzed extensive reading interests of sixth, seventh and eighth grade learners. The results of the study presented differences in reading interest and preference by gender of the learners. It was found that female learners had a fascinating liking in romance, fables, adventure and historical fiction. However, male learners were found to have a stronger liking for reading materials having content to do with sciences and sports. It was also noted that male learners in India preferred non-fiction reading materials than their female colleagues. The gender as a variable influenced reading preference and thus it was important for schools to engage learners in the process of procuring reading materials so as to ensure that their interests are taken care of.

Krashen (2011) observes that when learners are exposed to large quantity reading input inside or outside their classrooms, it helps in improving many types of language skills such as vocabulary recognition, sentence construction, reading speed and listening comprehension. However, Okwany (2014) notes that most learners nowadays lack interest of purchasing and reading books, which are crucial in vocabulary acquisition and language use thus failing to develop a commendable culture of reading.

Day and Bamford (2002) opine that different types of reading materials should be availed to learners considering the different linguistic abilities of the learners. Learners should be free to choose to read what interest them and thus read at a faster pace because the material chosen is within their linguistic ability. The language teachers play the role of being good role models and act as mentors to the learners (Day & Bamford, 2002).

Palani (2012) observed that for educational success to be realized amongst learners, they must be taught effective reading habits because effective reading and good performance are interrelated. Palani believes that a good reader should be able to identify symbols and relate them with appropriate meaning. Palani

(2012) further opined the teacher should be able to guide the learners in developing comprehension skills so that they are able to deduce the meaning of words in contexts and also when words are on their own. Dempsey (2010) opines that children cannot be good readers if teachers and parents that they are expected to emulate as role models do not read at all. He claims that a country cannot succeed in becoming a reading nation if her population does not have a strong craving and passion for books and visiting the library regularly. However, he points out a very big challenge in reaching this ideal in developing countries in Africa and Asia as being weak and unstable book industry, lack of adequate libraries and low economic status of majority of the population that affects their purchasing power.

Krashen (1998) posits that exposure of learners in conducive environment where they can increase the reading input can assist in development of different language skills such as vocabulary, comprehension, writing and reading speed. So if teachers and parents present themselves as good role models in reading and share what they read with the learners, then the learners may be motivated, attach some value in it and the reading behaviour acquired may shape or improve their reading patterns

During The African Union continental conference under the theme 'Promoting a Culture of Reading in Africa' held in Addis Ababa Ethiopia from 18th September to 20th September 2019, Tessema (2019) cited in Xinhua (2019:22) noted that, "the development of the reading culture in Africa is an issue of high importance, but yet unanimously given insufficient regard especially in Africa." In the same forum Njenga (2019) cited in the African Union Commission (2019) noted that, "without wide reading learners cannot develop skills of locating, selecting, organizing, manipulating, analyzing, evaluating and processing information." This shows that poor reading culture was causing great concern in most of the African countries and as such it was an important issue that needed to be addressed.

Purpose of the Study

The purpose of the study was to assess availability of extensive reading resources that bolster extensive reading habits in secondary schools in Laikipia County, Kenya.

THEORETICAL AND CONCEPTUAL FRAMEWORK

The Schema Theory was proposed by Jean Piaget. The theory proposes that knowledge kept in the mind of a person is organized into units called schemata. Language experts and cognitive-psychologist have used the concept of schemata to understand how comprehension takes place in an individual. A schema then can be said to be a conceptual system for comprehending how knowledge is represented in the mind and how it is applied. Paran (1996) notes that reading can be presented as a psycholinguistic process where the reader interacts with a text, makes hypotheses from the text and reads to confirm or reject them as he tries to make new hypotheses. At this point the reader rather than the text is the main determinant of success of the reading process. Rumelhart (1980) states that schema can represent knowledge at several levels from ideologies to knowledge on morphology, syntax and semantics of a text. Finally, schemata are our

knowledge that we possess from various sources and if the learners have limited exposure to reading materials then their schemata will be limited.

This theory was found to be relevant for this study as it recognizes reading as a cognitive process. The theory suggests that weak struggling learners lack the vital schema which is important in providing connections before reading, while engaged in reading and after reading a text. The theory also suggests that schema operates like a filing system of the human mind where all the files of knowledge are stored. It also suggests that the more the reader is exposed to reading and new experiences, the more the thickness of the files grows and the more knowledgeable the reader becomes.

Krashen (1998) posits that exposure of learners in conducive environment where they can increase the reading input can assist in development of different language skills such as vocabulary, comprehension, writing and reading speed. So if teachers and parents present themselves as good role models in reading and share what they read with the learners, then the learners may be motivated, attach some value in it and the reading behaviour acquired may shape or improve their reading patterns. Therefore, teachers should ensure there is access of reading materials and also scaffold the learners on the best reading skills so as to assist learners develop effective reading habits in their schools. The conceptual framework in Figure 1 presents a representation of the relationship among variables and was derived from theoretical framework.

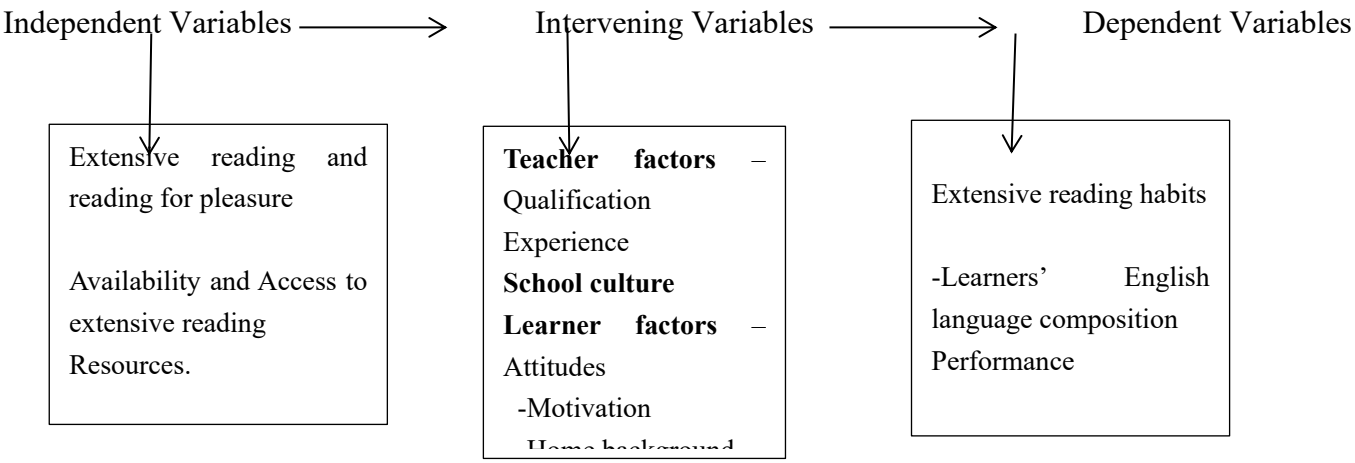

Figure 1: **Relationship between independent, intervening and dependent variables of the study**

The conceptual framework shows the independent variables in this study as extensive reading and availability and access to extensive reading resources. These variables were investigated to establish whether they have any impact on learners' development of desirable reading habits and performance in composition writing. The dependent variable was Learners' performance in composition writing. Intervening variables are variables that may have an influence on the independent variables in explaining the outcome of the study. The intervening variables in this study were teachers' factors that include teachers' qualifications, teachers' attitudes, students' attitudes and school environment. To account for these variables, the teachers who participated in the study were those who were assumed to have pedagogical skills of teaching reading and were in a possession of a degree in education. The selected teachers were also trained to teach English in secondary schools. They must have taught for at least two years.

METHODOLOGY

Research Design

The study utilized a descriptive survey research design. According to Schinder (2003) a research design is a plan, scheme and structure for investigations to obtain answers to questions and may be compared to a blue print for collection, measurement and analysis of data. In addition, the research design includes all procedures selected to answer a particular question. Descriptive research was used to obtain data on availability and access of extensive reading resources that could promote extensive reading habits in secondary schools. The research design helped in collecting a complete and possibly accurate data from the research subjects which was used for detailed analysis and which led to important recommendations that were made. The study was supplemented by views of qualitative data in form of respondents' views, comments and opinions on main themes the study had raised. The study also used descriptive statistical methods to analyze and present quantitative data. The study used qualitative method because it involves analysis and presentation of data in forms of descriptive nature (data obtained are expressed in words). For qualitative data, the researcher used semi-structured interviews with English language teachers. Quantitative method of data collection was employed because the study used descriptive statistical methods to present and analyze study data in frequencies and percentages. For quantitative data, the researcher used structured and an open ended questionnaire and a composition writing test with learners. The use of both qualitative and quantitative methods of data collection helped determine the extent access to reading resources lead to the development of reading habits and performance in composition writing.

Target Population and Sample Size

Secondary school students and teachers in Laikipia County were the target population. About two thousand, six hundred and seventy (2670) learners in form 2 and 3 and eighty (80) teachers of English were the target population. Form 2 and 3 were selected because learners in these classes were assumed to have adequate reading exposure and also had settled down in secondary schools. The two selected forms were also not examination classes. At the time of the study, Laikipia County had sixty seven (67) secondary schools among them were four (4) boys' secondary schools, six (6) girls' secondary schools and fifty seven (57) co-educational secondary schools. A simple random sampling was used to obtain a sample of 20 students in form 2 and 3 in each school totaling 300 students in 15 schools to fill in a questionnaire and also sit a composition writing test. An addition (30) 10% of the questionnaire was added for non-response to bring the total number of student respondents to three hundred and thirty. However, three questionnaires were not responded to making a total sample of 327 learners. A purposive sampling was used to sample 30 out of 80 (37.5%) of the English language teachers. Mugenda and Mugenda (1999) assert that for descriptive studies, a 10% of the target population is representative enough.

Data Collection Instruments

Questionnaires, interview guide and composition writing text were data collection instruments that were used in the study. The questionnaire was administered to the learners to elicit data on availability and access of various extensive reading resources in their schools and how they influence learners' extensive reading

habits. The questionnaire also generated data on learners' reading preferences. In total (99%) 327 questionnaires were responded to with only 3 (1%) registering a non-response. The interview guide was administered to teachers of English to elicit data on how extensive reading was conducted in their schools and the challenges the faced during teaching of reading. This information was corroborated with data available in English language teachers' professional documents that they use for teaching such as lesson plans and schemes of work. Learners also sat a composition writing test to establish aspects of extensive reading habits evidenced in their writing.

Research Results and Discussion

From the data obtained during the study, it was established that there was a mismatch between what the learners wanted to read and the reading resources available in their schools. Extensive reading programmes in schools cannot be successful if reading interest of the learner is not established and addressed appropriately in terms of provision of reading resources. In two national schools studied, their libraries were relatively stocked with reading resources but in most of the sub-county schools libraries were non-existent and scarcity of reading materials for extensive reading worrying. From the study data various reading resources were established to be available in schools. These resources ranged from newspapers, reference materials, novels, pacesetters to magazines as shown in Table 1.

Table 1

Reading Resources Available in Schools

Reading Materials	Responses	
	N	Percent
Newspapers	280	41.8%
Pacesetters	204	30.5%
Novel	118	17.6%
Magazines	45	6.7%
Reference books	22	3.3%
Total	669	100.0%

The study findings obtained from school libraries in the Table 1 indicate that a majority 280 out of 669 (41.8%) of all available reading materials in schools were newspapers. Two hundred and four (30.5%) were pacesetters and 118 (17.6%) were novels. Forty five (6.7%) of the resources in schools were magazines while 22 (3.3%) were reference materials.

From the study data it was deduced that variety and adequate reading materials for promoting extensive reading were missing in secondary schools. This implies that it could be difficult to initiate successful extensive reading programmes with scarcity of reading materials in our secondary schools. The study established that majority of schools had newspapers in the libraries yet majority of the learners preferred reading novels and storybooks as indicated in Table 2.

Table 2

Reading Preference by the Learners

Genre/Reading Material	Frequency	Percent	Rank
Novels & Story books	253	77.4	1
Subject text books	20	6.1	2
Love stories	16	4.9	3
Newspaper	11	3.4	4
Science fiction	9	2.8	5
Magazine	9	2.8	6
Revision Materials	7	2.1	7
Religious books	2	0.6	8
Total	327	100.0	

(n=327)

As indicated in Table 2 a majority of the learners 253 out of 327 (77.4%) reported that they preferred reading novels and short stories. Twenty (6.1%) reported that they enjoyed reading subject text books while 16 (4.9 %) of the learners reported that they enjoyed reading love stories. Eleven (3.4%) reported preferring reading newspapers while 9 (2.8%) reported that they preferred reading science fiction. A similar number preferred reading magazines. Seven (2.1%) of the learners said they preferred reading revision materials. It can be clearly deduced that majority of reading materials in schools are newspapers while majority of the learners liked reading novels and short story. This mismatch in supply of reading materials and learners' preference need to be corrected so as to enable the learners read what they enjoy and also enjoy what they read. Over reliance on classroom text books reading that calls for intensive reading of content was also captured. Learners need exposure to reading materials outside the syllabus so as to widen their world view. The English language teachers reported additional extensive reading resources that they felt were in short supply in their schools. They felt that should the materials be added in the library list, they would assist in providing a variety where learners can choose what they want to read and thus promote a reading culture in schools. These additional materials are shown in Table 3.

Table 3

Recommended Additional Reading Resources for Extensive Reading

Scarce reading resources	Frequency	Percent	Valid Percent
Adventure stories	2	6.7	6.7
Audio-tapes	2	6.7	6.7
Audio-visual materials	2	6.7	6.7
e-books	9	30.0	30.0
Encyclopedias	1	3.3	3.3
Graded readers	3	10.0	10.0
Journals	4	13.3	13.3

Love stories	1	3.3	3.3
Magazines	2	6.7	6.7
Newspapers	2	6.7	6.7
Novels	1	3.3	3.3
Periodicals	1	3.3	3.3
Total	30	100.0	100.0

Data obtained from the English language teachers as indicated in Table 3 suggested additional materials that they felt were scarce and that if availed in schools would motivate learners to engage in independent reading. Two (6.7%) of the teachers suggested adventure stories. A similar number also suggested purchase of audio-tapes and audiovisual materials. Nine (30%) of the English language teachers recommended purchase of e-books (kindle) in their schools. The study also sought to find out whether there existed a relationship between library availability in schools and composition writing scores The study established that schools with libraries had higher mean scores than those that did not as shown in Table 4.

Table 4

Availability of Library in Schools and Composition Writing Scores

Schools	Availability of a library	FORM 2 N	Mean score x/40 %	FORM 3 N	Mean score x/40	%
A	Yes	11	31.1 77.7	11	33.54	83.90
B	Yes	11	24.36 60.9	11	26.40	66.00
C	No	12	21.90 54.7	11	24.48	61.20
D	No	10	16.30 40.8	11	17.50	43.75
E	No	11	14.76 36.9	10	13.45	33.63
F	No	11	18.46 46.15	11	19.55	48.88
G	Yes	11	25.10 62.75	11	24.40	61.00
H	No	11	22.54 56.35	10	23.82	59.55
I	Yes	11	24.64 61.6	11	25.95	64.88
J	No	11	17.18 42.95	11	18.80	47.00

K	No	11	18.18 45.45	11	19.62	49.05
L	No	11	17.82 44.55	10	19.60	49.00
M	Yes	11	28.36 70.9	11	30.50	76.25
N	No	11	17.72 44.3	11	19.67	49.18
P	Yes	11	27.46 68.65	11	28.56	71.40
	Total	165	21.73 54.33	162	24.52	61.30

Data in Table 4 indicate that 7 out of 15 (46.6%) schools A, B, G, I, M, O and P had relatively well stocked libraries and thus they were able to post very impressive mean scores that were above average in their composition writing. The remaining 8 (53.3%) schools C, E, F, H, J, K, L and N their scores were below average which was a good indicator that libraries in schools played a major role in promoting extensive reading and sharpening learners' writing skills. This finding concurs with Wafula (2017) who found that lack of reading materials, time and space were major challenges that hindered learners' engagement in extensive reading.

It was established that learners who reported having a library had higher scores in composition writing than those who did not. This could be due to the availability of variety of reading materials that motivated and encouraged learners to get involved in extensive reading as shown in Table 5.

Table 5

Library Availability in Schools and Composition Writing Scores

Presence of a library in schools	N=327	%	Mean	Std. Deviation	Std. Error mean
Yes	209	63.9	22.9	3.767	.261
No	118	36.1	19.8	3.544	.326

Data in Table 5 show that when learners were asked in a questionnaire whether their school had a library, 209 (63.9%) of the learners agreed they had a library while 118 (36.1%) of the learners responded that they did not have a library. Those learners with a library had a higher mean score of 22.9 than those without a library who had a mean score of 19.8. Further an independent t-test at 95% confidence level was conducted to establish whether the difference was statistically significant as shown in Table 6.

Table 6

T-test Analysis on Presence of Libraries in Schools and Composition Writing Score Independent Sample Test

	Levene's Test for Equality of		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances									
Composition Score assumed	1.438	.231	3.528	325	.000	1.498	.425	.663	
			3.589	255.405	.000	1.498	.418	.676	2.334

It is evident from Table 6 that the difference between presence of libraries in schools and composition writing mean scores was statistically significant (t (325) = 3.528, P = .000). Those who had a library had a higher mean score than those without. From the analysis in Table 6, it is important to establish good libraries in schools as it is the backbone to the success of establishing a reading culture which leads to better performance in examinations. Furthermore, a predictor analysis was generated at 95% confidence level to establish the probability of learners with a school library performing better than those without one as indicated in Table 7.

Table 7

Predictor Analysis on Presence of Libraries in Schools

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Does your school have a library	.587	.366	.943
(Yes / No)	.706	520	958
For cohort Score level = Below Average	1.202	1.011	1.428
For cohort Score level = Average and above	327		
N of Valid Cases			

Variables in the equation

	B	S.E.	Wald	Df	Sig.	Exp (B)	95% C.I.for EXP(B)

							Lower	Upper
Does your school have a library(1)	.377	.532	.242	4.844	1	.028	1.703	1.060	2.736
Constant		.187		4.053	1	.044	1.458		

Data in Table 7 reveal that learners who were in secondary schools that had a relatively well stocked library were 1.703 times more likely to score above average than those who had no library (P=0.028, C.I (1.060-2.736). However, Sindabi (2014) observes that many education experts have blamed the declining reading culture among Kenyan population to be as a result of failure by each successive government to establish libraries especially in public schools and community centers.

CONCLUSION

Data analysis and interpretation of the responses revealed that secondary schools in Kenya had an acute shortage of adequate and updated reading resources and materials to support extensive reading programmes. Learners were not able to access reading materials and resources of their preference. Most the schools that were in dire need of the reading materials were the county and sub-county schools. Ironically, these schools admitted average to below average learners. National schools were relatively well stocked with reading materials. In secondary schools that had reading materials, there was a mismatch between the reading materials in schools and what the learners preferred to read. It was also established that in schools with relatively stocked libraries, learners registered higher composition writing mean scores mostly due to development of better reading habits due to exposure to variety of reading materials.

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Relationships of Body Image and Eating Attitudes with Sociodemographic, Psychologic and Nutritional Factors in University Students Attending First Classes

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Abstract

Senior Seminar students for their research project investigated, "Perceptions of college students on the effects of body image in today's society." In this study, student researchers focused on the way body image was exemplified amongst college students from five factors: 1) their mental development, 2) realistic fashion sense, 3) athletics, 4) nutrition, and 5) the physical wear and tear of its image. The study consisted of 100 individuals on the campus of The University of Arkansas at Pine Bluff who had given time and knowledge to the situation. Through a series of analyses on the surveys administered as well as a graphing, student researchers were able to connect the survey with their general assumptions and theories on the perspectives of body image. While researching, key concepts were identified which provided a better clarification of perspectives on the body's image. Students who experienced the judgment of their body's image were prone to being affected in each of the five brackets mentioned above. The five areas focused on were important in understanding just how a person was affected, and the stages they endured as well. The researchers observed that the image society displays as the perfect body is viewed through different lenses around campuses today. This topic was not only important to research, but also a step forward in building stronger confidence amongst growing individuals in college today.

Introduction

Jess S. Scott, author of multiple novels has described the body as "the best work of art." The human anatomy is one of the most complex builds in the world today. With its ever fascinating and unique designs, it is needless to say that this system is the most well put together of all. The image we display both outside and inside account for a masterpiece. Just think of how different everyone is physically, but how similar we are structurally. The body is a study that will never be taken lightly. Throughout history, people have founded ways to display their body and all of its glory in the best way they know how. Clothing, art, and

many more things account for the outside glory that is displayed. The image that people spend hours perfecting is not only a masterpiece, but a craft that is special to themselves and their pride.

Introducing body image to any person can be both confusing and disappointing. Televisions, magazines, photo shoots, billboards, commercials, and many more sources account for the seemingly endless images that are displayed in references to a body's image. The amount of advertisements that surface to broadcast the diverse human body is what makes things that much more interesting. However, many have found themselves belittled, bashed, and confused on what it truly means to be happy with their body's image. The ability to be self-confident and accepting of the one thing that gives us encouragement is little to none in today's world. Who could think that the unique structure we carry with us day by day could be mistaken as a disappointment. True body image is not the ability to conform to the world's desires and standards of image, but to accept the beauty that is paired with uniqueness in one's self-features.

This capstone research project was an exploratory conductive study of the perceptions of college students on the effects of body image in today's society. The student researchers felt that the most attacked and effected group of individuals in today's society are college students. Through the transitioning time that college students are going through they often find themselves confused on who they are, what they want, and where they are going in their young lives. On top of the weight that is already upon their shoulders, they must be concerned with their outward image that is constantly judged, looked upon, and examined by their peers, elders, and many more. The open study and its effects on young minds will be examined through several key aspects that they believe are a priority in body image.

First, the mental development of college students when affected by body image will be detailed by finding out just how it takes a toll on their everyday thoughts and feelings. Secondly, the researchers want to exemplify just what it means to have a realistic yet fashionably popular body image by discovering the key components in clothing. Next, they would be remise in their abilities to note body image criticisms if they did not take into consideration the hard working student athletes. Of course, there are also the struggles with healthy eating, and day to day practices that many college students encounter. Lastly, the component of true effects may weigh on the physical health of these students in order to display the image they want. Each and every delicate topic is a battle that college students in their time of growth struggle with. It is all important that our study is conducted with the upmost respect and consideration of each unique individual.

Statement of the Problem

The rate of young individuals who face body image insecurities is large in number and constantly at growth. Advertisements highlight the joys of the perfect figure that everyone seeks. Members in society today are told that they are not at their full capacity until they have attained that dreamy body. But, what prices are we truly willing to pay just to add up to what society wants us to be like? The condition of our health and our mental development are at risk just so that we may be granted a body that is beyond expectations.

The true problem that our study is geared towards highlighting is the effects it takes on college students in today's society. The young, fruitful minds, are often hindered by the floods of nature's society. Development, reality, dietary confusion, and physical expectations are negatively impacted because of the

stereotypes that are placed in college students in today's society. The problem is evident in the growth of students and their ability to focus on who they are meant/want to be in life. Not reaching your full potential is a problem alone, but to be disgraced because of your image brings self-confidence down to a zero.

The hindrance of the mind and body's development in fault of society is corrupt to say the least. Entitled "Perceptions of college students on the effects of body image in today's society," the problems listed will be examined for further authentication through our elaborate research study on college campuses today. We want to highlight the ongoing issue that students in their developmental phase face on a daily basis. The problem is not the diversity of body images amongst students, but the unfair image that is pressed upon them at their influential age.

Purpose of Study

Research conducted should never be unnecessary and almost always meaningful in the betterment of the world and the way it works. The purpose of a study is to give a particular topic further knowledge so that it may increase in size and importance. Our study, "Perceptions of college students on the effects of body image in today's society," is not only purposeful but complimentary to the development of self-worth in today's society. The researchers chose this particular study so that they may be able to further investigate just how college students interpret the emotions associated with judgment of their body. It's one thing to administer the judgment of another person, but to receive it is an entire new field of study. If they can pinpoint exactly what it means to college students who undergo such judgment, it is hoped that they just may be able to turn society's perception of self-image around for good. Throughout this investigation, the researchers would like to not only highlight the aspects that make living through this time period difficult for college students but to also provide answers for the situations that they encounter everyday of their busy lives.

Significance of the Study

The study of the perceptions of body image has been detailed by many authors and researchers who want to know similar things that we do. The study conducted is important because it truly pinpoints the effects that individuals encounter at the expense of body image. Not only is the topic significant in the furtherance of understanding mind development, but also towards future concerns as well. As we raise the generations to come, it is important to instill in them the knowledge necessary to be successful in their society as well.

The study does not generalize its research, but narrows it down to college students who are typically in the younger stages of their lives. The importance of focusing on these individuals allows their feelings towards body image to be relevant in discussion. Lastly, they believe that the benefits that come with this study is that of a more open-minded thought process for the ones to come after them. Training the next generation to be happy, confident, and certain of the image they display with their body is all important in determining their future success. The ability to be a quality individual in society stems from the roots that created your persona, not your image.

Research Questions

1. How do the perceptions of body image in today's society effect college students?
2. What are the most important and detailed topics that highlight what college students encounter in relation to body image on and off campus?
3. Why does society limit individuals into believing that there is only one acceptable stereotype that your body must meet?

Review of Literature

The literature review of this research paper is a strong comparison of several articles and their opinions on the topic selected. These sources are believed to be the cornerstone of this study, and the basis of our argument. To begin, they reviewed the topic of the mental development that occurs through body image. In the journal article, "Body Image Concerns and Contingent Self Esteem in Male and Female Students," the author (Grossbard, 2017) studied dissatisfaction in body image with male and female college students. As college students, they understand that there are negative things about themselves that they do not like, which can lead to lack of self-esteem. Throughout this article, the author (Grossbard, 2017) found that "females reported higher levels of contingent self -esteem, and greater concerns about weight, and males have a great drive for muscularity" (p. 1).

Contingent self -esteem is based on the approval of others or social comparison. In the same article it was proven that female college students are affected more than college males when it comes to being accepted with body image. More females experience depression, bad eating or dieting habits, and mental health issues (Grossbard, 2017). "Moreover, a survey of college students had indicated 7.6% of females and 2.8% of males reported vomiting, taking laxatives, or diet pills to lose weight in the previous month (American College Health Association, 2006)" (p. 2). Gaining or losing weight to fit a popular body image is not healthy. Socio-cultural perspectives on body image propose that gender differences in body dissatisfaction likely represent different cultural standards for ideal body types. For most females being thin seems to be more attractive, and for males having muscles resemble power and success. Thoughts of not having a popular body image can cause mental confrontation, making a person feel like they will never fit the standard of having the perfect body.

Throughout their study, 359 first-year college students participated in a study assessing alcohol use and other health risk behaviors during their first-year in college. The participants completed a screening survey assessing alcohol use and completed a baseline survey. It was reported having poor self-esteem and a sense of low self-worth can result in emotional distress, which can prompt young people to seek a 'solution', such as changing/controlling their body image to attempt to feel better about their selves (Grossboard, 2017). "Thus, individuals with greater contingent self-esteem may view their physical appearance as most influential for their self-worth, compared to one who values the importance of academic success, power, or social acceptance" (p. 9). Conversely, an intense focus on body that is encouraged by media exposure can lead to a sense of self overly focused body image resulting in anxiety and depression.

Grossbard (2017) stated, "researchers have suggested utilizing self-determination theory as a framework for the development of interventions aimed at enhancing "true" self-esteem to reduce the

influence of external standards and expectations on one's sense of self-worth" (p. 9). College students face so much in today's society, and they may not always open up about it. It is important to make sure that they have someone in their corner to let them know change is fine, but they are also perfect the way they are.

With social media being at an all-time high, the things college students see and hear have a huge impact on the perspective they have. Mass media uses unrealistic images that send a powerful and explicit message: a message that students must sacrifice their health and even money to be considered attractive. According to the article "Photoshop: The Tool to Being Unrealistically Gorgeous" (Shen, 2015), men and women are held to different body standards. Mediocre images constantly reinforce a discrepancy between most people's actual size and the "ideal "body size. Magazine and beauty campaigns have been a powerful influence on self-satisfaction in appearance. Shen (2015) stated, "In today's commercial world, adjustment and digital manipulation have simply become an expectation, even as the public still continues to believe and demand that photographs represent the real" (p. 2). The people who are portrayed through certain beauty campaigns are referred to as direct representation of what society believes is beautiful.

The social comparison theory explains why images in the media are translated into body dissatisfaction in many women and even men. It examines why/how an individual examines themselves in comparison to others. Moreover, Shen (2015) stated, "It is easy to forget that regular men and women cannot be held to the same standard of maintaining strict diets, workouts, and even surgery" (p. 2). Television, advertisements, movies and other forms of media provide a plethora of references to make comparisons. What is outside the frame of a photo is commonly forgotten in the face of a beautiful image.

Cultivation theory also plays a part on how we may perceive ourselves in today's society. An author from the article "A Critical Analysis of Cultivation Theory" (Otter, 2014), indicated "the repetitive exposure we have to the images we see influence people's inability to recognize that such standards are unrealistic and that media's institutional practices shaped meanings in the mass production of messages that were then widely disseminated and thereby shaped public knowledge and beliefs over the long term" (p. 1016). People who watch television while indulging in other forms of mass media display greater dissatisfaction with their appearance. It is apparent that the true recognition of our beauty is sheltered through images displayed by media.

While the average student can attest to such problems, we would be wrong to neglect the college athlete. The perception of body image among college athletes is to be fit, muscular, and toned. The author of the article, "Dissatisfaction and Body Checking in Sports Scale: A New Measure for Athletes" (Fortes, 2017), explained the purpose of finding a psychological measurement of body image among student athletes. A sample size of over 1,197 athletes participated in an investigation to analyze the psychometric properties of the Dissatisfaction and Body Checking on a Sports Scale (DBCS). Results showed more positive relationship between the DBCS scale and Eating Attitude Test scores.

College athletes maintain their sport performance by training, weight lifting and therapy/yoga. They are consistently working on their craft by having intensive workouts, and lots of weight training. Fortes (2017) reported, "Trainers frequently require that their athletes improve their output during trainings and competitions. To a certain extent, the sports performance depends on the body morphology" (p. 110). These athletes are commonly stereotyped as toned, strong, and in-shape. Some athletes who have concerns about their weight can have issues with their body image. According to Fortes (2017), he explained "In that sense,

one can presuppose that the athletes demonstrate a "double" body image: one associated with the sports context and the other related to the general culture" (p. 111). It is shown that some athletes can struggle with their athletic body image and perceptions of how their bodies should be.

Even famous athletes like Serena Williams have received criticisms for not being built like the rest of her tennis peers. Due to the muscularity of her body, some people feel like she's not the typical women's tennis athlete. Ms. Williams has received countless body shaming comments over the course of her career while also facing obstacles like racism, and sexism. However, not all athletes have to look the same or obtain a certain look based on their sport.

The certain stereotypes college athletes have about themselves has changed the look through social media. General perceptions that we choose to place on athletes are outdated and say a lot about social media. Our author, Fortes (2017), recognizes "One important limitation for the use of these measures in athletes is that they have not been appropriately validated in the athletic population and, therefore, may not be suitable to analyze the body dissatisfaction in that audience" (p. 111). Stereotypes such as: basketball/football players being big and tall, baseball players that are slim and quick, and track athletes having muscles, long legs, and stamina are what narrows mindsets in today's media. Social media can influence an athlete's perception of how to train to mirror the body image in sight.

Nutrition, dietary guidelines, and weight are terms typically associated with the life sustaining substance known to mankind as food. The researchers believe that to live a healthy and encouraging life that one must take into account the food that is ingested as well. Countless sweets, fast-food eateries, alcoholic beverages are more than just a resource for college students, but a necessity. The convenience of these typically unhealthy habits is at an all-time high. The outward image is not taken into consideration until the aftermath of unsatisfactory images are displayed on their body's surface.

The article, "Relationships of Body Image and Eating Attitudes with Sociodemographic, Psychologic and Nutritional Factors in University Students Attending First Classes," by ÖZenoĞLu (2013), explored the true domain of college students and their viewpoints and practices of the ingestion of food. The study takes place on a college campus to get the most recent and knowledgeable student's opinions on the subject matter at hand. ÖZenoĞLu (2013) stated, "In recent years, especially with the influence of media, eating disorders in young people, health problems caused by nutritional deficiency and imbalance have been increasing gradually" (p. 973). The ability to pinpoint practices of college students is displayed in the research to enhance our understanding of the issue.

The more students continue to struggle with what they are ingesting, the higher they are prone to be victims to health issues as well. The author goes on to state according to ÖZenoĞLu (2013), that "individuals who frequented pro-eating disorder sites had showed higher levels of body dissatisfaction and eating disturbance than a control group" (p. 973). Not only do these students have access to sites that support the disapproval of their body, they are also being told to deprive themselves of a nutritious meal. Proceeding towards further development the author concludes, "Inadequate; and unbalanced nutrition during adolescence not only affects physical performance, but also adversely affects mental health, cognitive functions and so the quality of life" (ÖZenoĞLu, 2013, p. 973).

Finally, ÖZenoĞLu (2013) found that "Dieting, body dissatisfaction, disordered eating and exercise behaviors are well documented among male and female university students worldwide" (p. 976). The

obsession to attain the perfect body image is forced down the throats of students instead of the promotion of living a healthy lifestyle. It is needless to say that students find themselves struggling every day to make the right food choices that will complement their body in more ways than one. The struggle continues for college students to find a nutritional balance that gives them happiness and confidence in their body's image.

Our final point of discussion includes the physical effects that body image places on college students. In the article "Social Media Use, Body Image, and Body Weight Status Comparison Between University Students With and Without Disordered Eating in University Putra Malaysia" (Eow & Gan, 2018), a break down on the physical aspect of college students on the effect from social media in today's society is studied. According to Eow and Gan (2018), "disordered eating, body dissatisfaction, and social media use are increasingly common among university students" (p. 129). Disordered eating was defined as fasting, dieting, binge eating, and laxative use. The reasoning behind this common issue is the ideal image that social media portrays on society. This issue has occurred due to the standards and expectations of social culture. The pressure from this area has affected our male and female college students due their approach of the issue. Eow and Gan (2018) have stated, "The general, individuals who develop eating concerns may consequently use more social media compared with those who do not" (pp. 130-131). It is crucial to understand the roles of body image, disordered eating, and social media used among university students due to the increasing prevalence rate.

From the article "Bones, body parts, and sex appeal: An analysis of #thinspiration images on popular social media" by Ghaznavi, & Taylor (2015), the authors present research of "#thinspiration" pictures which are visual images of the inspiration of being thin while promoting weight loss. Although it promotes weight loss, it has negative aspects of glorifying the dangers of eating disorder behaviors. This theory alone causes college students to have a negative condensation about their personal being. Social media has a cause and effect on body perceptions due to the way a person views themselves by its standards.

To conclude, this literature review has brought forth depictions of mental development, realistic fashions, student athletes, nutrition, and also eating disorders. The articles provided not only displayed the perceptions of college students on the effects of body image in today's society, but also highlighted the negligence to solutions that college students in today's world need.

Definition of Terms

Cultivation- the process of trying to acquire or develop a quality or skill.
Social media- websites and applications that enable users to create and share content or to participate in social networking.
Photo shop- alter (a photographic image) digitally using Photoshop image-editing software
Disordered eating (DE) - includes behaviors that are common features of eating disorders
Cognitive- is the mental action or process of acquiring knowledge and understanding through thoughts and experience, and the senses.
Thinspiration- the inspiration on being thin.

Methodology

The methods used to enhance a research study are what give it the substance necessary to be effective. First, the researchers reviewed several different validated sources that provided the background information necessary to explore our topic. Second, a series of questions were gathered to express exactly what we would like to study. The questions detail the perceptions of body image amongst college students in today's society. Next, the group created a survey to administer to 100 different individuals who were currently enrolled at a college campus. Their surveys were collected, analyzed, and assessed to benefit the study. Finally, the results will be discussed that will lead to a conclusion and better understanding of this study. It is hoped that the student researchers' methods will be clear, concise, and effective.

Population and sampling

The population of a research study consists of the participants who willingly chose to be a part of our study. The population for this study is defined as college students whose body images are affected by social media. With today's ever-changing society moving as fast as it is, we must always take into mind what our next generation is experiencing in their day to day exchanges. In reference to sampling, the researchers took a quantitative approach in ensuring quality results. The study took place on the campus of The University of Arkansas at Pine Bluff, with a student population of at least 2300. Clearly, a purposive focus was on the upper-class student population who had at least experienced one year on the college campus. With the assistance of 100 students, they were able to collect data and results on this particular campus.

Instrumentation

The instrumentation of this research study was a fifteen answer questionnaire.* A 15-itemed survey was designed from an infrastructure of supporting the topics that the researchers believed to affect college students (e.g., mental development, fashion, athletics, nutrition, and physical effects). These five topics were all sufficient enough to support the mass impact of social media on students today. The survey answers obtained may reveal the knowledge available to identify just how students think on this research study topic.

*See Appendix A.

Procedure and time frame

The procedure of the research study played a role in the effectiveness of our study. The researchers have gained knowledge only dating five years back. Reviews were recent and up to date with today's society. The study had begun March 1, 2018 and ended April 1, 2018. They had ample enough time to gain knowledge, conduct research, and draw conclusions on the research study in the time allotted. Their procedures provided no harm to any of the participants, and was simply a matter of opinion. If ever the participants would feel uncomfortable or neglectful to answering the questions presented in the study, they

were given the option for their survey to be destroyed and considered void in this study. A consent letter stating all such facts was provided.*
*See Appendix B.

Analysis plan

The analysis plan is described as the plan associated with determining the accuracy of the results. We have chosen to take on a quantitative approach in determining and breaking down the answer choices given to us by our study participants. A scale of "strongly agree, agree, disagree, strongly disagree, and N/A" were used for selection. Fifteen questions have been put together to answer the direct topic questions of mental development, realistic inputs, nutrition, student athletes, and also physical health. Each question was made relevant to one of these five topics to ensure that we stayed on task with what is most important throughout our research study. The effectiveness of the study is depicted from the answers given to us. We've decided to use a bar graph to ensure that the most popular selected answers were displayed. Our bar graph will highlight the unanimous answer choice chosen from each question on the survey administered to the participants. From these conclusions, we can merge together prior results and similar results to come up with answers from the study we have chosen to seek furtherance in.

Validity and reliability

Since our survey was not taken from another study we were tasked with creating a survey of our own. Having chosen the topic of "Perceptions of college students on the effects of body image in today's society" we have decided to use a fifteen lined questionnaire to assist in gaining the necessary for results needed for evaluation. To test the validity and reliability of the questionnaire, we have all completed one ourselves to see just how similar our results are to the ones given to us by our participants. Graciously, the researchers can say with much confidence that their results concurred with that of the ones tested. Similar standpoints of body image, self-worth, and physical desires have made the survey more than reliable in conducting this research study. No questions were misinterpreted, nor were they misconstrued to change the outcome of the study. Our results were consistent with one another, as well as with the study that has been exemplified.

Assumptions

From the background information developed from this study we can assume that most college students endure similar problems in relation to our topic. The assumptions are as follows: college students will always struggle with the media's perception of their image because of the constant images that are placed in front of them. The battle that college students experience with social media, their bodies, and health is an ongoing battle that needs a system to assist in getting their minds to more positively influential things.

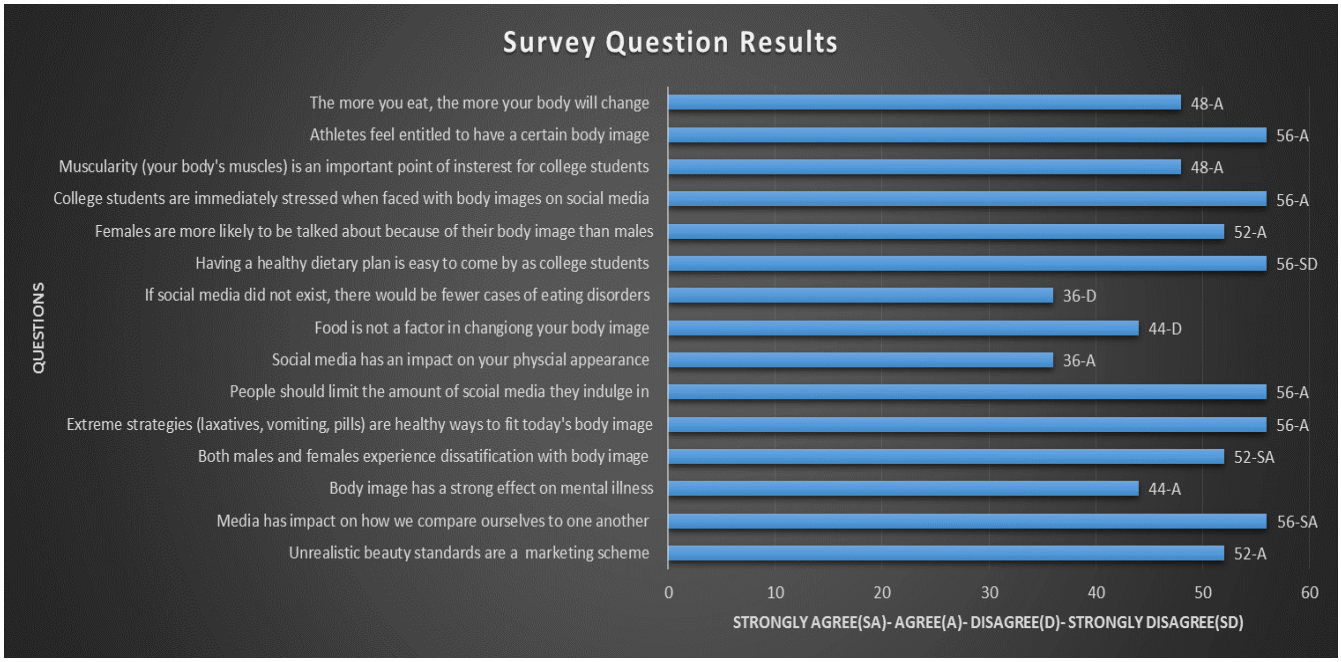
Scope and Limitations

The limitations of our study were as follows: the time frame in which our participants were studied, the amount of students surveyed as well as the campus population, the extent of research students could

perform on the individuals, the understanding of material presented to our participants, as well as the perception of these individuals on the topic presented. It is believed that the common factor in the limitations was the viewpoints of body image. No body's image is perfect, and not one body is the same. Although the researchers had ideal aspirations of what they would like to appear as, neglecting one's actual state of health is unnecessary in the perspective of physicality.

Results

Description of the sample



Analysis

The analysis of this study refers to five simple topics that were chosen to display the researchers' interest in this study. Questions one, six, and seven all proved that social media has an effect on a person's body image, while also highlighting that unrealistic body standards were goals for most college students. Questions two, three, four, and eleven proved that college students strongly agreed with the notion of social media impacting the comparison between student's bodies which change the positive mental development of students. Although those survey questions indicated both dissatisfaction between males and females, it proved the female college students' negative viewpoints of body image were far more developed than males. Questions five, nine, and twelve also believed that the disappearance of social media will not affect eating disorders and early sicknesses amongst college students. But, these questions also agree that stress of body image contributes to the development of extreme strategies to lose weight. Questions eight, ten, and fifteen all highlighted the importance of a healthy diet despite what social media believes, but also agrees on the statement of these meals being hard to attain. Finally, questions thirteen and fourteen proved that having a strong physique was important to college athletes on campus today.

Conclusions and Recommendations

The theory of college students and their perceptions of body image in today's society was a topic of great interest. The researchers spent much time and deliberation on the subject and believed that its significance was important. College students are consistently faced with new task daily that prove to be productive in the development of their minds. This study not only highlighted a growing issue amongst most students, but a necessity in self-development and esteem.

The study took place on the campus of The University of Arkansas at Pine Bluff. The researchers sampled 100 students on campus who have been on a college campus for at least one year. A consent letter and 15-question survey were administered to our willing participants to ensure accurate results. The time frame was one month, with special emphasis on reviews of the topic dating only four to five years back.

Results from our survey have concluded that college students, although picky in most subject matters, could all agree on the impact of social media in reference to body image. It was unanimous that unrealistic body standards were goals for most college students. Participants also indicated both dissatisfaction between males and females, but proved the female college students' negative viewpoints of body image to be far more developed than males. While the researchers thought that ridding the world of social media would be beneficial to physical health, the results revealed that the disappearance of social media will not affect eating disorders and early sicknesses amongst college students. The importance of a healthy diet is very important to college students but still remains hard to attain. Lastly, it was concluded that college athletes are at a constant battle with themselves and today's society continues to emphasize how their bodies should look.

In conclusion of this study, it was well indicated that body image is a well-known problem amongst college students and social media. Body shaming is real, disapproval is rapid, and unhealthy habits were results. Based on the results, this exploratory investigation of perceptions of college students on the effects of body image in today's society was successful and beneficial to the Senior Seminar students' knowledge.

Discussion

The findings of this study indicate the presence of social media on the impact of body image in today's society. The findings support existing theories in today's world of research. A connection was found between this study and studies presented earlier in the review. The reasoning of the student researchers' findings was due to the similarity between college students all around the world today. Although college students live in different locations and often times do not share similar views, majority still are of the same generation. The questions asked were relatable to the students and easily answerable as well. The reasoning of the results ending as such was a matter of opinion with our participants. The findings presented were structurally sound and key to the study.

Recommendations

The recommendations from this study are supported by the data and results. Actions should be taken in order to ensure proper development of college students today. More companies should aim to present a

more realistic body image that is relatable to everyone's body. Companies might even find themselves more successful if they relate to college students today. The researchers further also recommend that social media use should be turned down a few notches to ensure self-authenticity amongst the younger generation. In reference to our study, more campuses around the world should be surveyed to ensure relativity. The more students' opinions that are gathered, the more solutions are believed can be drawn from this research study. Future research is suggested.

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Appendix A

Dear Student,

Our names are Bridgette Jones, Kelsie Kelsey, Jatoya Thompson, Demetrius Thompson, and Miles Hawley. We are currently UAPB students from the department of Human Sciences enrolled in a Senior Seminar Course. We are writing a letter in request of your participation in our research. Our research topic: "Perceptions of college students on the effects of body image in today's society" is the focus of our study. This survey will include 15 questions that are based on your personal experience and opinions. We have chosen you because we feel that you live the everyday life of a college student. Your involvement in class, social settings, and much more account for the testimonies of situations that relate to body image. With your approval, we are asking you to sign and date this letter, as well as include your major. It is with great importance that we stress your confidentiality in this survey. If ever you feel uncomfortable with the questions asked you have the option to discontinue the survey, and your answers will be discarded. The survey will immediately follow after your approval. Thank you for your time, consideration, and thoughts on a topic that we believe is important in today's society.

Respectfully,
Human Sciences Senior Seminar Research Students

Signature _____

Date _____

Major _____

Appendix B

Survey Questions:

Perceptions of college students on the effects of body image in today's society.

Please circle the choice that your opinion best correlates with using the following scale:

- Strongly Agree (SA) Agree (A) Disagree (D) Strongly Disagree (SD) -

1. Unrealistic beauty standards are a marketing scheme.

SA A D SD N/A

2. Media has impact on how we compare ourselves to one another.

SA A D SD N/A

3. Body image has a strong effect on mental illness.

SA A D SD N/A

4. Both males and females experience dissatisfaction with body image.

SA A D SD N/A

5. Extreme strategies (laxatives, not eating, vomiting diet pills) are healthy ways to fit today's body image.

SA A D SD N/A

6. People should limit the amount of social media they indulge in.

SA A D SD N/A

7. Social media has an impact on your physical appearance.

SA A D SD N/A

8. Food is not a factor in changing your body image.

SA A D SD N/A

9. If social media did not exist, there would be fewer cases of eating disorders.

SA A D SD N/A

10. Having a healthy dietary plan is easy to come by as college students.

SA A D SD N/A

11. Females are more likely to be talked about because of their body image than males.

SA A D SD N/A

12. College students are immediately stressed when faced with body images on social media.

SA A D SD N/A

13. Muscularity (your body's muscles) is an important point of interest for college athletes.

SA A D SD N/A

14. Athletes feel entitled to have a certain body image.

SA A D SD N/A

15. The more you eat, the more your body will change.

SA A D SD N/A

An Analysis of College Students' Perceptions on Domestic Minor Sex Trafficking in Pine Bluff, Arkansas

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Abstract

Domestic minor sex trafficking (DMST) is modern-day slavery of children and the commercial sexual abuse of children through buying, selling, or trading their sexual services. DMST is a form of child abuse. The victim can be any person of nationality, age, socioeconomic status, or gender. In America, throughout college campuses, a lot of students are not informed of domestic minor sex trafficking. When thinking about domestic minor sex trafficking, most people do not think that this crime happens in our country, better yet our state of Arkansas.

The purpose of this study was to investigate the perceptions of college students attending the University of Arkansas at Pine Bluff on domestic minor sex trafficking in our country and in our state of Arkansas (a crime that is growing aggressively in the United States).

Fifty participants who were students attending the University of Arkansas at Pine Bluff participated in the study. Participants consisted of male and female students between the ages of 18 to 25 (N = 30 Females; N = 20 Males). Survey data were analyzed using Microsoft Excel software. Participants responded to ten yes or no descriptive questions about domestic minor sex trafficking (e.g., Questions like: have you heard about domestic minor sex trafficking; and do you think child sex trafficking is an organized crime).

The data yielded both quantitative and qualitative results. Results showed that female students were more knowledgeable and were more aware of DMST than males. Implications for interventions will be discussed. Further research also is suggested.

Introduction

This research was to explore the perceptions of college students on domestic minor sex trafficking (DMST) and to join in evidence on risk factors for DMST. Many people are familiar with the concern of

human trafficking, but many are not aware of the arising issues and concerns of young children that are becoming victims of sex trafficking.

The purpose of this study was to investigate the perceptions college students attending the University of Arkansas on domestic minor sex trafficking in our country and in our state of Arkansas (a crime that is growing aggressively in the United States). The study will also inform what type of minors are at risk of DMST and why minors are more vulnerable.

Domestic minor sex trafficking is the illegal movement of people, within national or across international borders, for the purposes of exploitation in the form of commercial sex, domestic service, or manual labor.

Statement of the Problem

Approximately 800,000 to 900,000 victims annually are trafficked across international borders. Between 18,000 and 20,000 victims are trafficked into United States annually. More than half of victims trafficked into United States are thought to be children; victims are probably about equally women and men. Victims can be trafficked into the U.S. from anywhere.

Domestic Minor Sex Trafficking (DMST) consists of prostituting or pimping of a minor, a victim that is under the age of 18, who is used in a commercial sex act as a trafficking victim. This crime also includes pornography, stripping, escort services, and other sexual services.

Potential Minors with greater risks of DMST are: Runaways, Homeless, Foster care youths, Drug addicted, Poverty stricken, and Mental health issues.

This investigation aimed to shed light about the perceptions of college students on domestic minor sex trafficking and to educate others on risk factors for DMST. Many people are familiar with the concern of human trafficking, but many are not aware of the arising issues and concerns of young children that are becoming victims of sex trafficking. Domestic minor sex trafficking is the illegal movement of people, within national or across international borders, for the purposes of exploitation in the form of commercial sex, domestic service or manual labor.

In America, throughout college campuses, a lot of students are not informed of domestic minor sex trafficking. When thinking about domestic minor sex trafficking, most people don't actually think that this crime happens in our country, better yet our state of Arkansas. They often think that this crime is committed in foreign countries. Domestic Minor Sex Trafficking (DMST) consist of prostituting or pimping of a minor, a victim that is under the age of eighteen, who is used in a commercial sex act is a trafficking victim. This crime also includes pornography, stripping, escort services, and other sexual services.

Potential Minors with greater risks of DMST are:

- Runaways
- Homeless
- Foster care youths
- Drug addicted
- Poverty

- Mental health

A trafficker may recruit these minors online, at public events, in malls, schools, on the streets, and in shelters. Traffickers also utilize technology to reach potential minor on social medial sites or pose as talent or modeling scouts online and intimidate minors into sending personal information and pictures online. Social media, smart phones, and webcams offer traffickers access to minors in developing ways to share pictures, market their victims, and maintain further control over their victims. Traffickers may be adults or other youth that gain trust of their victims through a process commonly referred to as grooming. Research has shown traffickers may also exploit other vulnerabilities or factors in a child's life such as existing trauma, low self-esteem, isolation from family or friends, lack of basic resources, sexual orientation, homelessness, or criminal behavior. For example, it has been reported by Timeline that the famous alleged R &B legend R. Kelly recruited women as young as 18, banned them from communicating with their family and friends, controlled what they wore and ate, and recorded sexual encounters with them. The parents of the two women believed their daughters were being held against their will, and have attempted unsuccessfully to have law enforcement intervene. R. Kelly had never been convicted of sexual misconduct during the time of this study.

The objective of this study was to obtain the perceptions of college students on domestic minor sex trafficking and to bring awareness to college students about this crime. This is crime that is unseen. The crime has limited awareness in that it was not shared with the public. The students here at our university need to understand that this crime is alive and present here in our state of Arkansas. This study is important to all students and minors, so that they will not become a victim to DMST. The benefit of this study is to bring awareness to college student about this hidden crime. A list of potential indicators of DMST is listed below.

Some Potential Indicators of Domestic Minor Sex Trafficking include the following:

- Extreme changes in behavior, such as loss of appetite
- Fear of the dark or sleep disturbances—nightmares, bed-wetting, fear of sleeping alone, or loss of sleep
- Regression to more youthful behavior such as thumb-sucking or excessive crying
- Expressing affection in ways inappropriate for a child of their age
- Unusual interest in or knowledge of sexual matters, or excessive masturbation
- Vaginal or rectal bleeding, pain, itching, swollen genitals, vaginal discharge, or sexually transmitted diseases
- Fear or intense dislike of a particular person or being left in a particular place
- Suicide attempts
- Getting excessive phone messages or calls
- Sexualized activity or conversations not developmentally appropriate for the child's age
- Having a significantly older boyfriend or girlfriend
- Entering or leaving cars or taxis with unknown persons
- Alcohol and drug use
- Having unaffordable new things such as clothes, money, or technological devices

Children who have been trafficked find it hard to tell anyone what happened to them. They change their stories, discrepancies in their story and many don't speak English. They are also afraid to speak out to authorities, afraid of what might happen to their family, friends, or themselves if they tell.

Now that we have identified potential victims and potential indicators of DMST about whom the victim might be, some characteristics of the traffickers/pimps/perpetrators will be described.

Characteristics of traffickers/pimps/perpetrators:

- Jealous, controlling and violent behavior
- Significantly older than female companions
- Pushy or demanding about sex
- Vague about his/her profession
- Promise things that seem too good to be true
- Encourage victims to engage in illegal activities to achieve their goals and dreams
- Buy expensive gifts or owns expensive items
- Encourage inappropriate sexual behavior
- Makes the victim feel responsible for his/her financial stability.
- Very open about financial matters.

Based on the research from the National Center on Safe Supportive Learning Environments (2013), the researchers found that social workers who provide services to these victims indicate that feelings of isolation and abandonment are often reported. However, the lack of a support network increases the vulnerability to trafficking. It is important to note that many teenage girls may be at risk of being recruited into the commercial sex industry simply by virtue of their normal maturation process. Wanting to take risks, feeling misunderstood by parents, and seeking romantic relationships can increase girls' susceptibility to the recruitment tactics of sex traffickers or pimps. Findings also suggest that low self-esteem accompanies school failure for girls, and the resulting sense of a lack of self-worth may make them more vulnerable to recruitment.

There are many signs that indicate an adult is involved in child trafficking according to National Society for the Prevention of Cruelty to Children (2017), such as:

- Making multiple visa applications for different children
- Acting as a guarantor for multiple visa application for children
- Travelling with different children who they are not related to or responsible for
- Insisting on remaining with and speaking for the child
- Living with unrelated or newly arrived children
- Abandoning a child or claiming not to know a child they were previously with

Definitions of the Study:

Child (minor, juvenile, youth) Persons under the age of 18 unless, under the law applicable to the child, majority is attained earlier.

Exploitation - Unfair, if not illegal, treatment or use of somebody or something, usually for personal gain.

Labor trafficking -The recruitment, harboring, transportation, provision, or obtaining of a person for labor or services, through the use of force, fraud, or coercion, for the purpose of subjection to involuntary servitude, peonage, debt bondage, or slavery.

Pimp- Any person who participates in the transporting, harboring, or selling of a person for a commercial sex act. This term can be interchangeable with sex trafficker.

Sex trafficking- The recruitment, harboring, transportation, provision, or obtaining of a person for a commercial sex act in which that act is induced by force, fraud, or coercion or in which the person induced to perform such act has not attained 18 years of age.

Literature Review

The best data estimates suggest that at least 100,000 American kids a year are victimized through the practice of child prostitution; that number ranges as high as 300,000 (National Center for Missing and Exploited Children, 2016). The National Human Trafficking Resource Center Hotline (NHTRC) reported a total of 36 human trafficking cases in Arkansas in 2015, including 29 cases of sex trafficking and 6 cases of labor trafficking. In 2014, 21 human trafficking cases were reported. Since 2007, the NHTRC has received reports of 112 cases of human trafficking in Arkansas.

Seventy-five percent of the child victims engaged in prostitution are under the control of a pimp (National Human Trafficking Resource Center). Estimates of 1.7 million runaway/ throwaway episodes happen every year and 1 out of 3 teens on the street will be lured into prostitution within 48 hours of leaving home (National Incidence Studies of Missing, Abducted, Runaway, and Throwaway Children, 2012).

In 2016, an estimated 1 out of 6 endangered runaways reported to the National Center for Missing and Exploited Children were likely child sex trafficking victims. Eighty- six percent of these likely sex trafficking victims were in the care of social services or foster care when they went missing (National Center for Missing and Exploited Children, 2016).

Effects of Domestic Sex Trafficking:

Psychological Trauma
Post-Traumatic Stress Disorder
Major Depressive Disorder
Substance Abuse among Survivors
Sexual Transmitted Diseases
Suicide and Depression
Increased Risk of Injuries (rape, sexual assault)
Phobias and Panic Attacks
Feelings of Helplessness, Shame, Humiliation
Cultural Shock from Finding Themselves in Strange Country

Regardless of the significance of the problem, the incidence of DMST is difficult to measure. Experimental research has not conclusively defined the scope of the problem as of today. Meanwhile, there are some significant findings from past studies like these statistics for example:

- Pimps prey on victims as young as 12 to 14 years of age.
- One study estimates as many as 325,000 children in the U.S., Canada, and Mexico are at risk each year for becoming victims of sexual exploitation
- One study estimates 30% of shelter youth and 70% of street youth are victim of commercial sexual exploitation. They may engaged or be pressed into prostitution for "survival sex" to meet daily needs for food, shelter, or drugs.
- Pimps may earn hundreds of thousands of dollars every year from selling minors.
- 75% of child victims engaged in prostitution are under the control of a pimp.

Historically, law enforcement and probation departments across the nation have been the primary systems addressing the complex needs of survivors of child sex trafficking. Through sting operations, crackdowns on gangs, and curfew sweeps, a law enforcement agency may be the first agency to interact with a sex trafficking victim. Today, child welfare systems and runaway and homeless youth programs are increasingly elevating their responses to child trafficking. It is strongly recommended that each community develop cross-system mechanisms and organization for collaboration among public agencies and other participants, while building upon the processes and relationships already in place.

Methodology

Researcher's Role: The researcher was an undergraduate student at the University of Arkansas at Pine Bluff. The student was senior-level and enrolled in a Senior Seminar capstone course during Fall 2017. The Senior Seminar student developed a consent form, a survey, and other research-related work assigned.

Instrumentation: The questionnaire which contained 10 descriptive questions was given to each participant that measured the perceptions of college students on domestic minor sex trafficking who were attending the University of Arkansas at Pine Bluff in Jefferson County, Arkansas.

Data Collection: Data collection was begun in mid-October 2017 and ended in November 2017. Consent forms were completed before the surveys were administered. Anonymity and confidentiality were assured and maintained.

Data Analysis: The Statistical Package for Social Sciences (SPSS) and Excel constructed the analysis of the results for this research. Data yielded mixed results.

Limitation: The study was conducted during a 10 week-period within the Fall Semester of 2017. The duration time frame of the investigation was limited and may affect the results of the study.

Results

For this research study, 50 participants that was selected from on campus were administered surveys in Senior Seminar on research topic, "Perceptions of College Students on Domestic Minor Sex Trafficking." The various experimental methodologies employed reflect studies documenting the effect and knowledge of domestic minor sex trafficking. Participants consisted of male and female students

between the ages 18 to 25. This research study investigated college students' awareness of domestic minor sex trafficking. The questions are displayed in table chart examples 1 and 2. The following research questions were asked:

1) Have you heard about domestic minor sex trafficking?
2) Did you know that domestic sex trafficking exist in Pine Bluff, AR?
3) Are children being trafficking in Pine Bluff?
4) Do you think domestic minor sex trafficking a major crime?
5) Do you think domestic minor sex trafficking an organized crime?
6) Would you contact someone if you suspected domestic minor sex trafficking?
7) Do you know of any victim or survivor of domestic minor sex trafficking?
8) Have you ever received any formal education (ex: training classes or seminars) on domestic minor sex trafficking?
9) Are you interested in learning about domestic minor sex trafficking?
10) Are all victims of domestic minor sex trafficking females?

The survey questions were distributed by the student researcher to students in her class and random students across campus. A total of 50 surveys were distributed and collected. The survey data were analyzed using Microsoft Excel software. The participants responded to ten yes or no questions about Domestic Minor Sex Trafficking. For instance, questions like: have you heard about Domestic Minor Sex Trafficking and do you think child sex trafficking is an organized crime? The data that were analyzed yielded both quantitative and qualitative results.

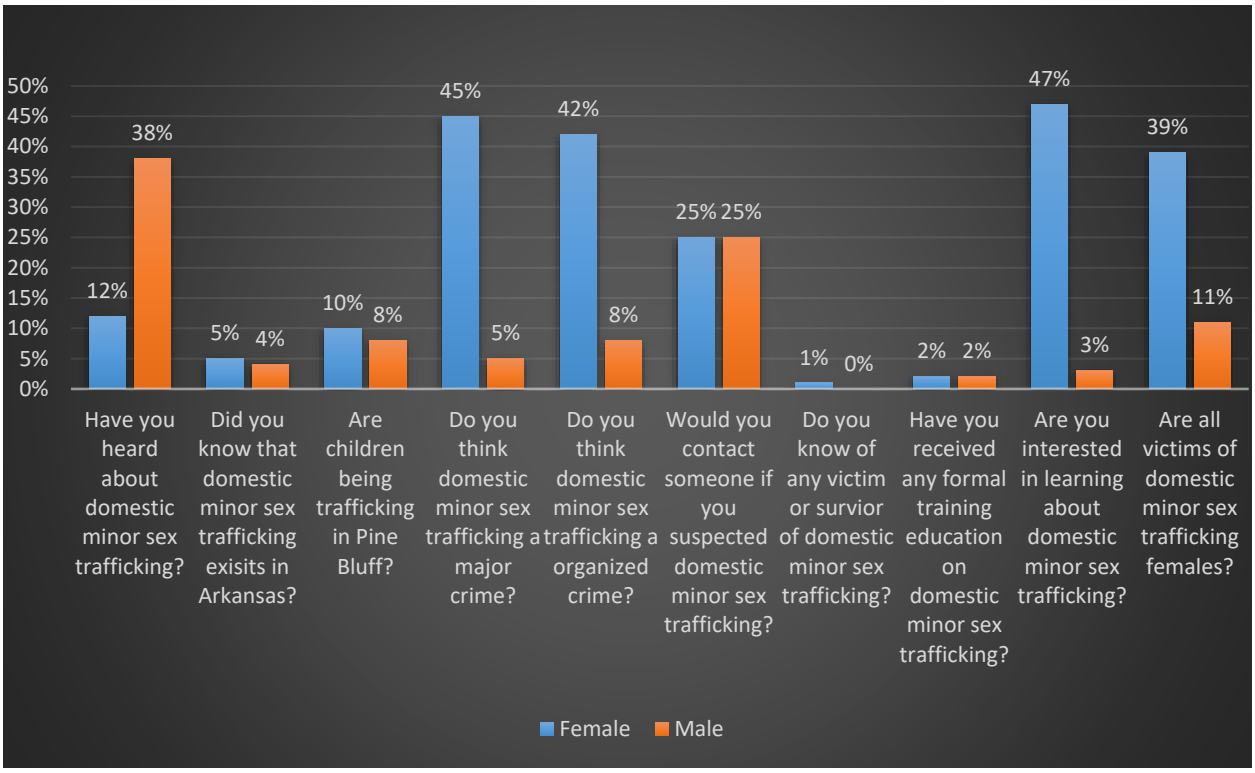
The graphs below depict the results reported by the participants. The targeted audience consisted of 50 students on campus (N=30 females; and N=20 males). Of the participants, 12 people had not heard about domestic minor sex trafficking, while the other 38 participants had heard about domestic minor sex trafficking. The interviews and results were based on factoring the gender of our participants, and the percentage of knowledge per questions. Race and age information were not a factor while conducting this interview. The basic demographic results of the interviews based on the ten questions asked are shown below.

Table 1 show a series of ten questions reflecting the percentage of who was knowledgeable about Domestic Minor Sex Trafficking.

According to the graph's designated color code below, the blue color represented the female responses while the orange color represented male responses.

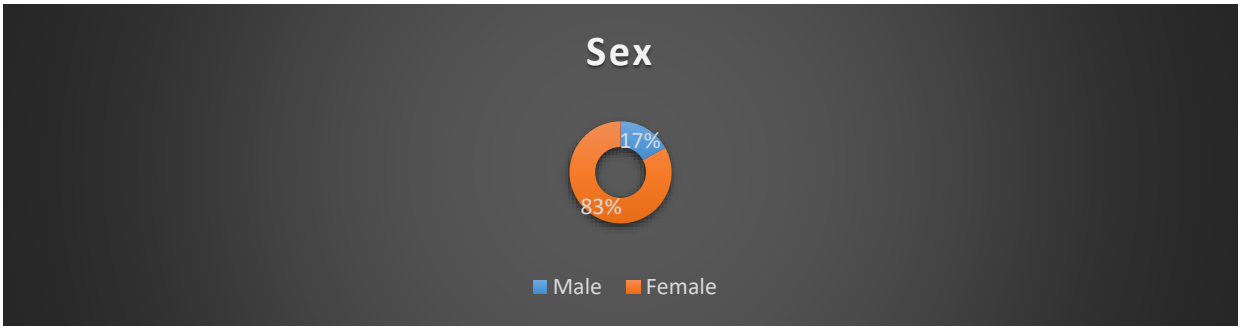
The three graphs below depict the results reported by the participants.

Example Table 1: Percentages of How Male and Female College Students Perceived Domestic Minor Sex Trafficking



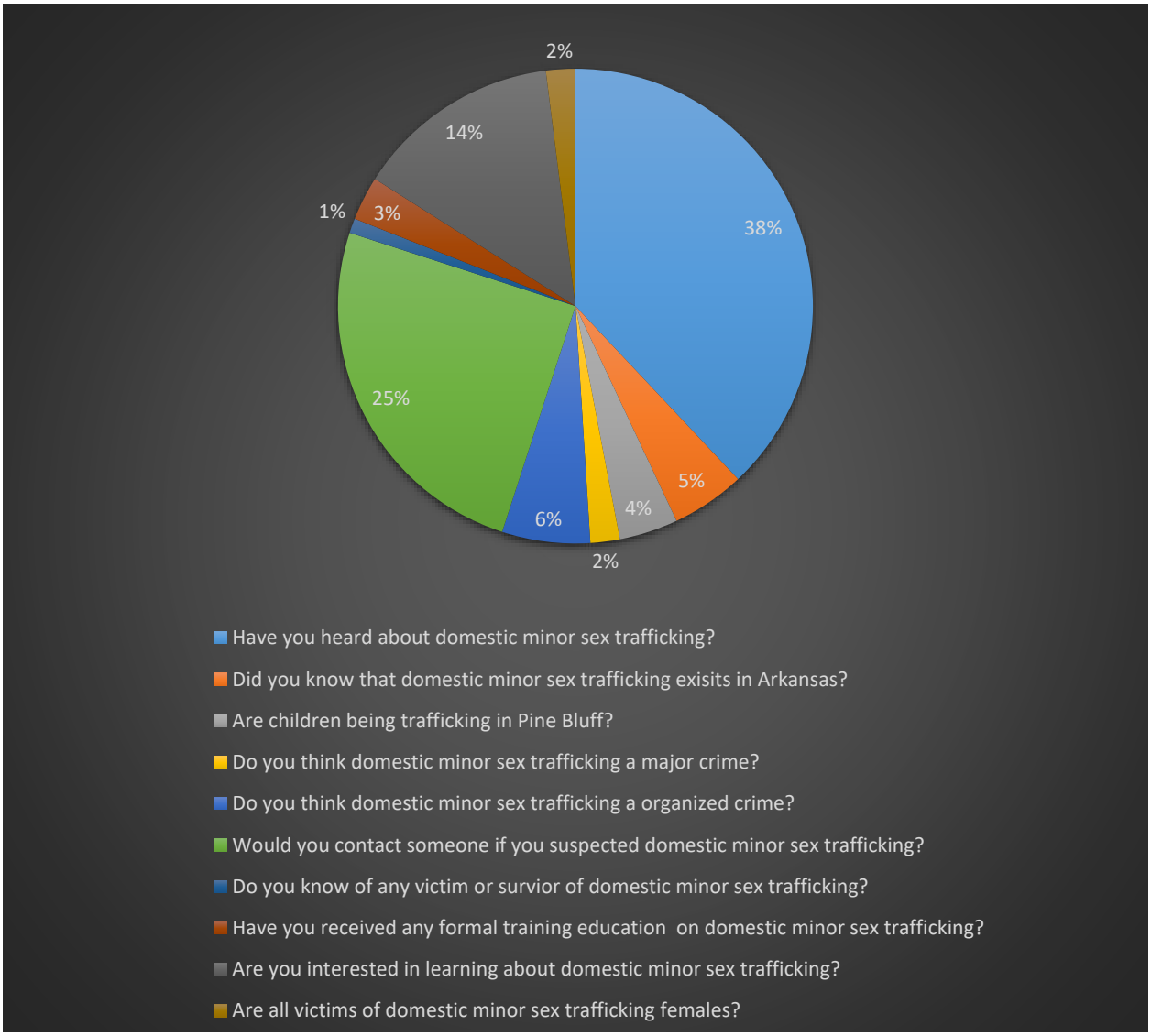
In Example Table One, only 38% of males reported that they had heard about domestic minor sex trafficking, while 12% of females reported that they had heard about domestic minor sex trafficking. Five percent of females reported that they knew that domestic minor sex trafficking existed in Arkansas, while 4% of males reported that they knew of this crime existence in Arkansas. Ten percent of females reported that they were aware of children being trafficking in Pine Bluff, while 8% of males reported about this awareness in Pine Bluff. Forty-five percent of females reported that they think domestic minor sex trafficking was a major crime, while 5% of males reported that DMST was thought of as a major crime. Forty-two percent of females reported that they think domestic minor sex trafficking was an organized crime, while 8% males thought domestic minor sex trafficking was an organized crime. Twenty–five percent of both females and males stated that they would contact someone if they knew of someone that was a victim of DMST, while 0% males didn't know of anyone being a victim of DMST. Two percent of both females and males had received some type of training on DMST. Forty-eight percent of females were interested in learning about DMST, while 3% of males were interested in learning about DMST. Thirty-nine females believed that all victims of DMST are females, while 12% believed that all victims of DMST are females.

Example Table 2: Series of ten questions reflecting the Percentage by Gender that participated in the Study.



The chart above reflected that 17% of male students and 83% of female students had participated in the survey.

Example Table 3: Series of ten questions reflecting the percentage of who was knowledgeable about Domestic Minor Sex Trafficking.



Thirty-eight percent of the participants reported that they had heard about domestic minor sex trafficking, while 62% reported they had not heard. Five percent of participants reported that they knew that domestic minor sex trafficking existed in Arkansas, while 4% participants having reported that they were aware of children being trafficking in Pine Bluff. Two percent participants reported that they did think DMST was a major crime, while 6% participants reported they thought DMST was an organized crime.

Twenty-five percent participants reported they would contact someone if they suspected DMST, while 1% participants reported that they knew of a victim or survivor of domestic minor sex trafficking. Three percent participants reported that they had received some formal training education on domestic minor sex trafficking, while 14% participants reported that they were interested in learning more about domestic minor sex trafficking. Finally, two percent participants had perceived that all victims of DMST were females.

In the three graphs that were used in the study, they showed that the female students were more knowledgable and were aware about DMST. It was interesting that both genders agreed that they would report or contact someone if they suspected DMST.

Participants also provided comments in regard to their perceptions on domestic minor sex trafficking. The qualitative results were as follows:

When asked whether children are being trafficking in Pine Bluff, one respondent replied, “I only know what I heard and seen, so # 3, I don’t know how to answer that.” One participant stated, " Sex trafficking is a heinous crime that needs to be stop." Another comment made by a participant was that, " I think it is important that everybody know the number so they can call if they think someone is sex trafficking, the number is 1-888-373-7888. I'm not sure if it is going on in Pine Bluff." Another comment from a participant was, " I am unaware if children are being trafficking in Pine Bluff, so I just stated no. I have heard about child sex trafficking but don't know much about child trafficking.” Also, another participant stated," I would like to learn more about this issue and how it may affect our local community and also I would like to know how often this crime occurs.” A participant also stated, " Child sex trafficking or sex trafficking is a serious crime that gets swept under the rug or not public enough to cause the government to actually look into the crime. Some people say that the government is a part of sex trafficking." A participant also stated," Not from Pine Bluff." Finally, the last comment from a participant stated," I feel that no child should be treated as a sex object to please no man’s or woman’s own desire and this crime should be stopped and dealt with quickly; and this crime against our babies is sicking."

Conclusion

In conclusion, perceptions of Domestic Minor Sex trafficking have evolved over time. Many years ago, Domestic Minor Sex Trafficking was nothing more than unrecognized crime. Generally, Domestic Minor Sex Trafficking was lumped in with prostitution and slavery. Today it is a growing recognized crime, a major public problem, and a topic of much research. Researchers have struggled to find why this crime is unreported and unseen. Despite this difficulty, research continues in more sophisticated directions and many community agencies are bringing this crime awareness to the public.

Domestic minor sex trafficking is a very serious crime as it affects our youth in many ways and persists into adulthood. There are many misconceptions about DMST and when this happens, this crime goes unreported or unseen. Therefore, there's a need for some clear understanding about trafficking. It is important to learn how to identify this horrible crime and start reporting signs or indications of DMST to law enforcers.

It is depressing to say that this crime is a terrible act for our minors to endure, but it is even sadder to know that it is not been reported. The sex trade of our children in the United States and our city of Pine Bluff, Arkansas is alive and well. Based upon a small convenience sample and the limitations of this exploratory study, it is suggested that further research needs to be done to shed more awareness on domestic minor sex trafficking in Pine Bluff, Arkansas as well as in our country. More education is needed to address this crime openly through seminars, research, partnerships with agencies such as the Department of Health and Human Services and the National Center for Missing and Exploited Children, and advocacy for students.

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The growth of ICT in this era persuade involvement of youth in e-commerce.

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Abstract

Daily routine of people today is related in Information Communication and Technology (ICT) either activities and socioeconomic. The ICT through digital economy had opened new way business activity called electric commerce known as e-commerce (Berisha Shaqiri,2015). This research study about involvement youth generations doing e-commerce activities, which is to investigate the factors that persuade their involvement, to identify the medium and type of product sold in e-commerce, also to analyze the problems that facing by them in doing e-commerce selling. The research conduct by online survey questionnaire as the method to find research data and the respondents target is youth in age 18-21. This study identifies that medium effectively used in doing e-commerce is Instagram, followed by WhatsApp and then Facebook. While the most factor youth doing e-commerce determined that it able to help increase stipend and then, next factor is the power of internet to help youth selling their product. As a conclusion we can say, the involvement of youth generation as a seller in e-commerce still growth since this is the easy way to increase their monthly income.

Keywords: youth; e-commerce; risks in e-commerce; ICT; seller; medium used in e-commerce; most product sold in e-commerce;

1. Introduction

We are now living in the digital era. This era is supported by the growth of Information Communication and Technology (ICT) that without realizing affected our daily routine activity and social. The evolvement and spread of ICT like cloud computing, mobile computing, big data, artificial intelligence (AI) and Internet of things (IoT) are rapidly penetrating society and also transfiguring the business operation and processes (Kuruwitaarachchi, et. al (2018). The digital technology introduced also had opened a new way of business activity called electronic commerce or known as e-commerce (Berisha Shaqiri,2015). The e-commerce process began since 1965, by the usage of Automatic Teller Machine (ATMs) to withdraw money and do purchases through point of sale terminal and credit cards (Senn, 2000). Rosmiati (2018), Kalakota and Whinston (1997) defined e-commerce as an activity of buying/selling goods and services electronically through the Internet network. E-commerce involves commercial transactions between buyers and sellers over the internet for the exchange of products, services and information (Turban et al., 2008).

According to Dykema (2000), from year 2000 to 2005, the online retail sales are projected to increase from $45 billion to $269 billion. Khatibi (2003) mentioned that the total revenue from e-commerce activities in Malaysia was estimated at RM187.3 million in 1999 and the figure will roughly double every year and is expected to reach RM5.98 billion by the year 2003. IDC (2007) showed that the overall e-commerce spending increased to US$22.3 billion in 2007 and the online buyers in Malaysia had reached to 7.1 million in 2008. Malaysian who involved in e-commerce is in the range 15 to 24 years old (Jehangir et al, 2011).

1.1 E-commerce and contribution

Several studies had proven that e-commerce system has been making significant contributions toward those who involved. We attach finding by several studies as stated in Table 1.

Table 1. The benefits of e-commerce

Research	Finding
Rosmiati et al.(2018)	Online business can save time and cost, no need to queue to get the item/service, easy to get latest price (sometimes the price is cheaper that price from physical store).
Kamaruzaman et al.(2010)	The e-commerce business reduces goods and service costs, increased availability (24x7), lowering transaction cost for buyer and seller eliminating intermediaries, decreasing administrative, marketing and logistics costs, providing a competitive environment to improve the quality of goods and services, increase the convenience of obtaining goods and services, and allowing for a provision of more customized offering as well as a new way of managing relationships.
Niranjanamurthy et al (2013)	The seller also able to scale up rapidly with e-commerce, as they are not bound with physical limitations. They also able to list many different items and the buyer have lots of product choices because there is no limited shelf size in e-commerce. This allows e-commerce businesses to "stock" a wide range of products

1.2 Research Objective

With the support of technologies and proven it has lots of benefits, we believe that many youths involve in e-commerce. The objectives of the study are:

1. To investigate what are the factors that persuade youth to get involve in e-commerce (as seller).
2. To identify the medium, choose by youth while doing the e-commerce.
3. To analyze the problem face by youth in using e-commerce.

2. LITERITURE REVIEW

There are many factors that make a person involve as e-commerce consumer or seller. Zaremohzzabieh, Z. et al. (2016) find that entrepreneurial knowledge that can lead a person to establish their own e-business and the person attitude to be self-employed have significant influence on the entrepreneur's intention to use ICT in e-commerce. Other factors to influence youth to embark into e-commerce are ease of use with highly significant effect, time saving and convenience as studied by Yamunah Vaicondam, Muthaloo Subramaniam and Mustapha Aliyu (2020).

Nowadays, it is relatively cost low for starting any business through Internet. With all the advantages of e-commerce and if Malaysia as the developing country able to overcame the barriers identified by Abdalslam.S.Imhmed.Mohmed, Nurdiana Binti Azizan, Mohd Zalisham Jali (2013) that are the consumer knowledge and awareness of evolving e-commerce ecosystem, consumer low level of trust on the system, the most needed government involvement in managing the different aspect of e-commerce activities or regulation and finally the telecommunication facilities that need to be improved.

ICT plays an important role in developing a country through sustainable economic growth and competitiveness. The ICT development in the trade area has been the focus of the leaders, industrialists, entrepreneurs, traders, etc. (Musa, 2008). Musa (2008) also said that communication media and advertising are interrelated since what can be gain from advertising to let their product and services known worldwide will become the profit to the advertiser.

"Technology related developments such as the rise of powerful search engines, advanced mobile devices and interfaces, peer-to-peer communication vehicles, and online social networks have extended marketers' ability to reach shoppers through new touch points" (Shankar et al. 2011, 30). According to Darke et al. (2016) social media help business owner to engage their prospect consumers. Safia, A. Chai, et al. (2019) also has listed seven factors that potentially affect e-commerce adaptation behavior. The factors are "e-word of mouth on social media, higher visibility of products on social media, recommendations of products by YouTube and social media sites, direct communication/ live chat with customer care representatives, rating and reviews by customers on social media, and trust and willingness to buy online". The popularity of digital platforms has disrupted traditional distribution channels, increased reach of social networks, and changed the way people interact (O. C. Ferrell et al., 2017).

Savita Mehta , Sanjeev Bansal and Teena Bagga (2017) said that the presence of youth on various social network sites is in conformity with the worldwide trend of popularity of this new media of social interaction. The influence factors for purchase and expenditure through social media are from opinions and recommendation from friends alongside with product review. Furthermore, youth take lead in adopting newer means of social interaction and they adapt equally fast to the demands and technicalities of these means and study done by Tanushree Sanwal, Sandhya Avasthi, Shikha Saxena, Krishna (2016) said that e-commerce has spurred employment in industries producing software, and systems used by E-commerce and other occupations associated with websites and networks. The youth especially in the area of engineering and technology are benefiting from this. More and more software specialists are required in the market.

However, in the process of buying and selling through e-commerce study of trust in e-commerce (Rachel & Caterina, 2012) shown that, consumers worry if losing money while not getting products in online shopping. In another word, they get defrauded by Internet frauds. Based on most the shared information about those frauds (Web Of Trust), two most common Internet frauds is: Phishing and malware. Additionally, according to Rachel & Caterina (2012) and Chaffey & Smith (2013), there also exist some other issues that might cause bad experiences for customers. Such as: poor web design, inconvenience of online communication, long waiting time of shipping, product doesn't match description and etc.

Motivation to involve in e-commerce as seller are relatively low but still attracting youth with higher finance resources due to their knowledge to the benefits that can be gain from e-commerce, stated by Aidahani, A. et al. (2019). Youth acknowledge the growth of technologies have shape the future of e-commerce. The e-commerce enabling technology that been used by top e-commerce websites such as fifth generation (5G) wireless systems, blockchain technology, the internet of things, machine learning and artificial intelligence allowing a seller to more easily post products. Advanced technologies shaping the e-commerce landscape in the region. Kim, M., & Choi, D. (2018).

3. METHOD

The growth of development of technology in the world of internet becomes an important part of the selling and buying among peoples especially youth generations. Rosmiati et al. (2018) found that, using e-commerce can save time and cost for consumers. No need to linger queue to get a good or service desired. According to JF Ebert (2018), results show that web-based questionnaire more less cost and fewer mistake so this method used to gather information from youth generation.

3.1 Framework

Refer the figure 1 as framework for this research.

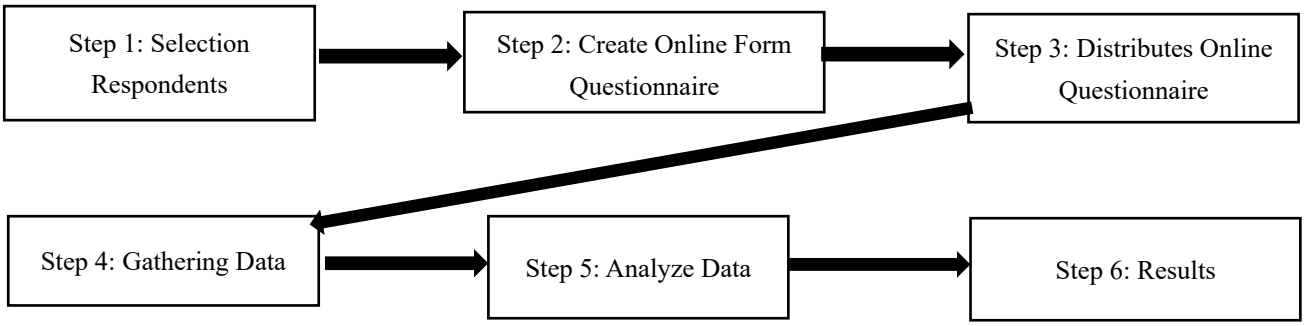

Figure 1. Step by step methodology

3.1.1 Step 1: Selection Respondents.

This step is determining youth generation as the target respondents, based on Kim (2018) establishment of identity in the internet space that meets the development stage of the youth should be treated as an important aspect. Total sampling from online survey is about 40 youths.

3.1.2 Step 2: Create Online Form Questionnaire.

The questionnaires are develop based on Kothari (2019) ideology where descriptive method is applied in order to study the view of current phenomenon in e-commerce. The categories of questionnaire divided into the following:

1. Real factor of involvement youth in e-commerce as a seller.

2. Problem faced by youth in doing e-commerce.

3. Medium that youth generation used for online business.

4. Type of product chosen by youth generation in their online business.

Therefore, a set of questionnaires provided for the purpose set up based on literature research to achieve the objective of the research.

3.1.3 Step 3 and 4: Distributes Online Questionnaire and Gathering Data.

The questionnaires were distributed by using online. The respondents involve are about 40 youths among age 18-21. Survey had done by using online survey as effective method and able to gather data with faster as mentioned by Coomber (1997) which internet can be a valuable source of indicative as opposed to easily generalizable data.

3.1.4 Step 5 and 6: Analyze Data and Results.

The analysis and results are about to identify the factor youth generation doing e-commerce, the medium used and type of goods sells in the e-commerce. It also analyzes the kind of problem faced while doing e-commerce business. These results related with objectives in this study.

4. RESULTS

In the research, we discussed several matters between factor youth generation doing in e-commerce as seller, the medium used and type of goods sells in the e-commerce. This research also determines the

problem that face by youth in doing e-commerce business.

4.1 Real factor of involvement youth generation in e-commerce as a seller

The result in Figure 2 show over 32 respondents of youth involve in e-commerce as a seller since they want to increase their stipend. This is the main factor that youth intense to gain extra in their monthly expenses. The second factor is the power of internet to sell the product. This shown 30 youths generation said because of the power of internet, they involve in e-commerce since they can make an income at home using computer or smartphone and internet (Tsetsi & Rains, 2017). The third factor shown 22 respondents said they can easy to get the prospect. The second and third factors are completely related. If more user of internet, so more customers can be attracted (Nabot *et. al*, 2018). Others factor shown 19 respondents are less cost to do the business and the youths generation are interested in e-commerce. The factors because of profit and viral product just shown 9 and 11 respondents. While the youth generation choose to involve in e-commerce as a seller because of interested with the product only shown 6 respondents. This shown youth generation tends to gain more money in order to accommodate their expenses (Chavali, 2020).

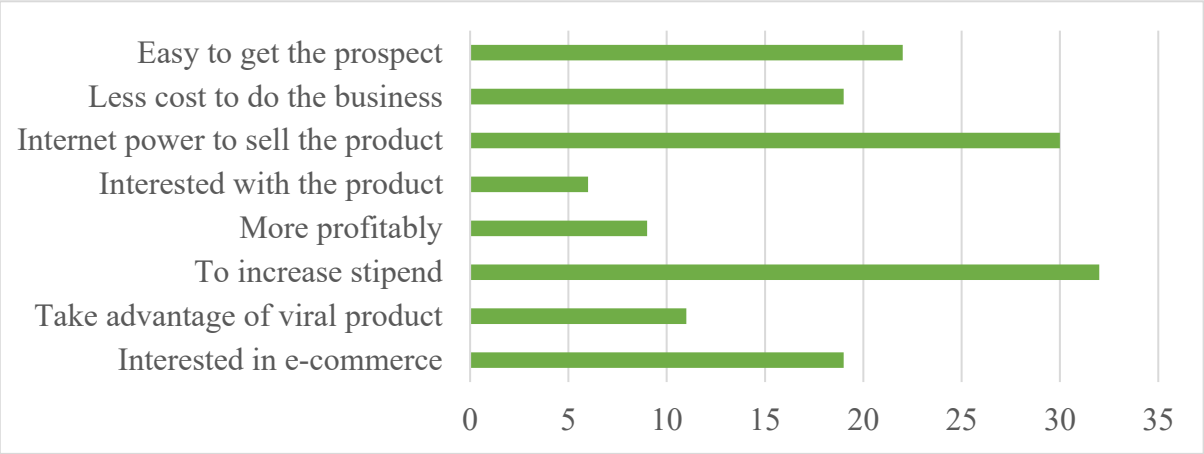

Figure 2. Real factor of involvement youth generation in e-commers as a seller.

4.2 Problem faced by youth generation in doing e-commerce

The Figure 3 shown, most problem face by youth in e-commerce as a seller is security systems. About 42 respondents said they have a problem with security system of e-commerce. Sometime e-commerce has weak security systems which may lead to cybercrimes (Khan, 2019). This is related to scammers issue since 37 respondents said scammer is also main problem in doing online business. This also type of cybercrime. This result shown 28 of youth generation have a problem with financial source. This issue is more to finance issue like not enough fund to proceed their business. The limitation of knowledge in IT also contribute to the problem in e-commerce. The result shown 18 of youth generation lake in IT knowledge. Only 5 respondents face the problem with hackers.

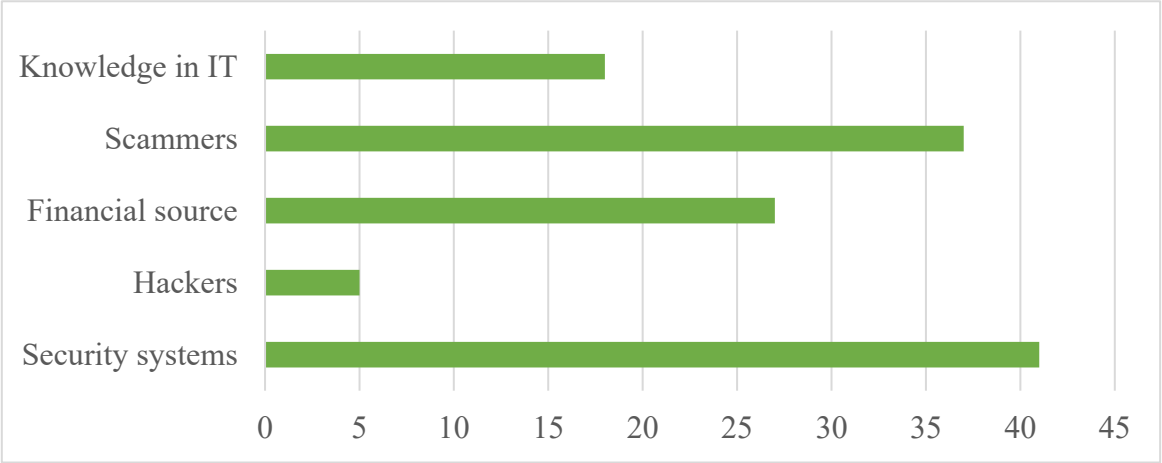

Figure 3. The most problem face by youth generation in doing business online.

4.3 Medium that youth generation used for online business

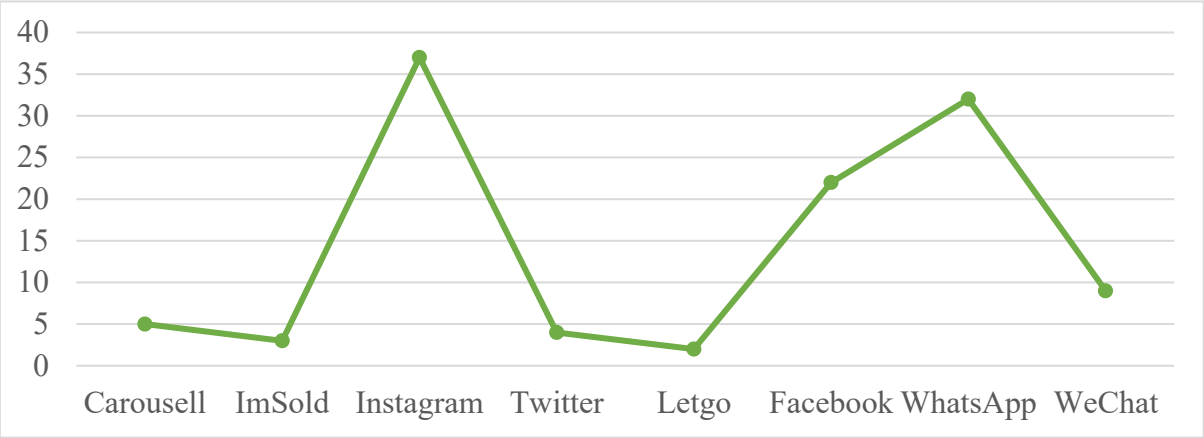

Figure 4. Popular medium used by youth generation to do their business.

As we can see in Figure 4, Instagram is the famous medium used by respondents for online business. About 37 respondents use Instagram as the medium since Instagram is famous among youth generation (Jiang & Ngien, 2020). The second famous medium is WhatsApp. The usage of WhatsApp application is growing now a days (Kumar & Sharma, 2017). About 32 respondents use WhatsApp in their business. Followed by Facebook. 22 respondents used Facebook as their medium to do an e-commerce activity since Facebook have a billion daily active users (Appel, 2019). Only 9 respondents used WeChat to do their business. While about 2 respondents used Letgo, 3 respondents used ImSold, 4 respondents used Twitter and 5 respondents used Carousell. Since applications Instagram, WhatsApp and Facebook are used by many users, so that youth generation used this medium in online business in order to gain many prospects.

4.4 Type of product chosen by youth generation

Figure 5 shown, about 30 youth generation choose cloth as their product while doing online business since clothes are more marketable and basic need for buyer (Lee & Hwang, 2019). Besides clothes, shoes are also the famous product sold by respondents. About 13 respondents sell shoes through e-commerce. This is because shoes are the most trending and stylish products nowadays. Other than that, 12 youth generation sell beauty product since the product interact woman buyer (Okeke *et. al*, 2020). Only 9 respondents choose sport equipment in their business since the sport equipment need bigger capital. Only 7 respondents choose food and drink as their product since buyer nowadays like to taste foreign food and drink. The nature of youth generation was to update their social life in social media, this make a cloth as a best product in online market.

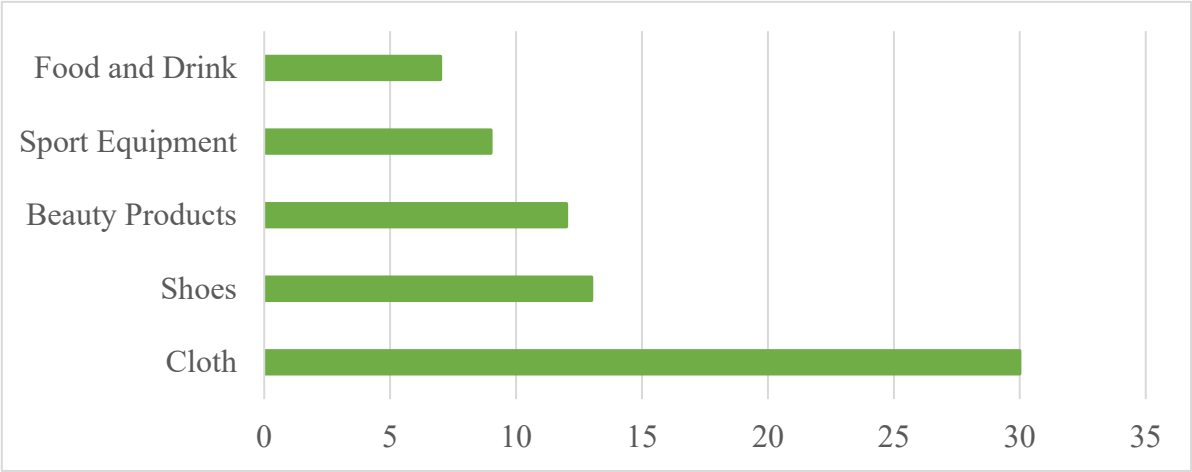

Figure 5. The type of product chosen by youth generation in their online business.

5. Conclusion

Malaysia has double the growth in e-commerce according to the statistics department of Malaysia; the e-commerce growth rate in Malaysia is expected to grow from the 10.6% in 2016 to 20.8% by 2020. This situation makes a youth generation takes an advantage in involving as the seller in e-commerce.

However, this research conducted in order to determine what the real factor of youth generation involved as seller in e-commerce. Besides that, we discover about the activities in online business. This research shows the truth factor about youth generation involve as a seller in e-commerce is to expend their monthly income in order to fulfill their expenses. The youth generation more interested to sell a cloth or involve in fashion since that is their nature. Moreover, the youth generation used Instagram and WhatsApp as their medium in doing online business. Unfortunately, lake of IT knowledge make youth generation face the problem about security systems.

As a conclusion we can say, the involvement of youth generation as a seller in e-commerce still growth since this is the easy way to increase their monthly income. Involvement in e-commerce also less cost and risk to start their business.

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Socio-cultural practicality of Oromo People as Represented in Novel

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Abstract

The main objective of this study is to demonstrate how Gadisa Biru the author of the novel `Kuusaa Gadoo` symbolize Oromo`s socio-cultural issues in a representative way in the life of characters and the major themes of the novel. The study is qualitative research, it involves textual analysis method together with relevant conceptual tools and frameworks and therefore it is analytical. Furthermore, the data used for the research is taken from primary source which is a novel entitled `Kuusaa Gadoo`. From the novel different extracts are taken based on the research questions. Extracts used as a data were classified under each topic and analyzed using textual analysis methods and realism theory. Then, the analysis and discussion were undertaken by using the concept of scholars to make the research more visible and logical. As a philosophy of realism theory, realism portrays the world as it really appears. Therefore, to evaluate the realistic representations of different agenda of the research, it is crucial to bring the idea in the text to the actual world. From the analysis and discussion made it is found that, in `Kuusaa Gadoo`, all events and episodes were realized in the novel without any fantasy and extraordinary overstatement. The socio-cultural situations realized in a novel `Kuusaa Gadoo`, is pictured in a similar way of Oromo people`s life style of the Derg regime. Even though the dictatorial government appreciated assimilation, the Oromos reserved their socio-cultural activities and practiced as much as possible. Among the socio-cultural elements reflected in the novel we can list friendship, confer, wedding and arbitration as major ones. In general, the novel `Kuusaa Gadoo` reflects the real socio-cultural situation of Oromo peoples during the Derg regime and the author critically perceived the actual picture of the society`s life and represented reasonably.

Key words: novel, practicality, represented, socio-cultural

1. Introduction

Literature is linguistically documented facts and ideas through which people used to preserve their deeds and worldviews from one generation to the other (Owamoyala, 1993). This shows the close relationship existing between literature and the society; hence literature is a product of the society. They also show literature's sensitivity to the society, not only in recording events and situations through language, but as an agent of promoting development in all its implication by propagating the social values. The thematic preoccupation of literary artists generally over the years varied from one duration to another, depending on the prevailing socio-economic, political and cultural circumstances of the time. "Literature is a social institution, using as its medium language, a social creation…Literature represents life and life is in large measure, a social reality, even though the natural world and the inner or subjective world of the individual have also been objects of literary imitation" (Wellek and Warren, 1968, p. 228).

Novel as a genre of literature is an extended work of fiction written in prose. It is a narrative characterized by "a greater variety of characters, greater complication of plot (or plots), ampler development of milieu, and more sustained exploration of character and motives (Abrams, 1999). Novels are an important and valuable means of alerting mankind to the different problems that present in our society today. Indeed, they help us realize what is unjust and condemnable, and incite us to take action to eradicate such behavior and ideals. The novel is an imitation of human life "follows the procedures adopted by philosophical realism in its attempt to ascertain and report the truth" (Ian, 1957, p. 31).

Realism in general and the novel in particular is based on the following premise, or primary convention: "that the novel is a full and authentic report of human experience, and is therefore under an obligation to satisfy its reader with such details of the story as the individuality of the actors concerned, the particulars of the time and places of their actions, details which are presented through a more referential use of language than is common in other literary forms (Ian, 1957, p. 32). From this point of view, the novel verbally represents 'life' as apprehended through the physical senses of its novelist.

However, Oromo literature is very young in serving the society in this regard and it is difficult to say Oromo literature is well developed. Also, there were no comprehensive studies that dealt with the socio-cultural realties represented in the novel. Even though novel emerges as a powerful medium to present the age in a descriptive and analytical manner and represents the social, cultural and historical growth of society at great length, Oromo novels were not analyzed in a wide range to realize these facts. This indicates the knowledge gap in the areas of socio-cultural realities portrayed in Oromo novel. This study, therefore, attempted to fill the gap in this respect.

2. Review of Related Literature

2.1 Literature and Culture

When dealing with issues of the relationship between culture and literature, it is useful to have a definition of culture in mind. Culture can be defined as "the actual grounded terrain of practices, representations, languages and customs of any specific society" (Barker, 2003, p. 7). What culture is concerned with is how we make sense of the world, and meanings are generated through different signs, of which language is the most important signifying system. Studies of language and stories are therefore of great importance in culture studies. Barker (2003) writes that: "Narratives offer us frameworks of understanding and rules of reference about the way the social order is constructed" (p. 28).

If we want to learn something about the norms, values and customs of a society, stories can help us understand how that particular society makes sense of the world and create meaning through language and narratives. When analyzing the novel, we shall be looking at what the stories reveal about the practices, representations and customs of the societies the stories emerged from. Narrative theory provides tools that enable us to look at how culture is represented in a text. Choices made in relation to for example narration and time and space are often reflections of the explicit and implicit cultural issues the text deals with, and can reveal something about values and ways of seeing the world of both the world of the text itself, and the cultural formation from which the narrative emerged.

Although different societies have their own characteristic but in many issues they are in common. Their Loyalty to cultural issue made people to select suitable solution, in order to this successfully they shout transmits these legacy, one of the most useful ways is literature, which is a very important way for culture components. Teaching is a process in which opens its doors for flourishing life to everybody. As a matter of fact the society tries to transmit its culture to people, it has been attempt to convey it to the mind of young people, on the other hand when it's that culture is in the process of development, the unnourished minds growth in a way in which not only to accept the culture but also to learn it (Mohamed, 2014).

The interaction between culture and literature is due to involvement of culture in different area like tradition thoughts, and human perspectives and in this process the literature acts as a powerful instrument. In fact this interaction both improves the culture and literature sublimity, human being need to both literature and cultural values which are the outcomes of their views. In fact, the literature not only is affected by society, but also its effect on society because the art not only reconstructs the life, but also forms it. People do it by following their champion's way of life, and therefore become in love like them, and suicide themselves like them. There is no doubt that young people are influenced much than old persons, when they read materials. So it cane supposed simply as a redundancy from life rather as a paraphrasing of life (Mohamed, 2014).

In short, the relationship between literature and culture is a bilateral relationship, because on the one hand, authors which consider the elements of culture composed of some traditions, beliefs, values, create valuable literature materials and therefore, help to flourish a culture, and on the other hand, culture considers these materials as its achievements and enrich materials as a general rule, we should believe that literature is independent of the culture of society. Because, any time that culture was dynamic and in

harmony with literature, the culture was also enriched and full of achievements and focusing on nation's history, it becomes clear that the glory of different cultures and great civilizations of the world depends on different factors. One of the most important factors is literature which has important impact on elegance of people. In fact, there are a direct relationship between literature and culture and both of them are in harmony with each other. The culture includes the beliefs, values, of a society and the literature, on the other hand, expresses them in different literature shapes. Therefore it finally leads to glory and outcome of a culture.

2.2 Literature and Social Issues

There are different norms of behavior in different societies and they are reflected in their respective literature. This reflection shows the reciprocal relationship between literature and society. Literature, in fact, is a social phenomenon and it differs from one social system to another because social institutions and forces directly influence literary works. Every society has its own characteristic structure having norms of behavior, values, ideas, and problems. These norms provide different ideas, themes, symbols, images and other aspects of literature. Therefore, a literary work of one country differs from that of other countries. The root cause of this difference is the impact of the particular social structure.

In the words of Hudson (2006), "literature is a vital record of what men have seen in life, what they have experienced of it, what they have thought and felt about those aspects of it which have the most immediate and enduring interest for all of us. It is thus fundamentally, an expression of life through the medium of language" (p. 10). In short, literature grows out of life, reacts upon life, and is fed by life.

The great literary works contain social, political, environmental, religious, economic and domestic values of the day. The form and style of literature change with the changes in the temper of the age and society. So literature is regarded as the expression of society. The relationship between literature and society is a two way. It influences society and gets influenced by the society. For instance, the society provides the raw material to the writers, but the same type of raw material does not produce the same type of literary works. In fact, the nature of literary form and style depends upon the worldview and creativity of the writer.

2.3 Social Realism

Literature has thousands of threads which can weave the beautiful piece of art. Each thread has its own importance in the creative work. In the same way, there are different narrative techniques for the narration of literature. Among the narrative techniques, Realism, in literature, is an approach that attempts to describe life without idealization or romantic subjectivity. Although realism is not limited to any one century or group of writers, it is most often associated with the literary movement in 19th century France, especially with the French novelists Flaubert and Balzac. George Eliot introduced realism into England, and William Dean Howells introduced it into the United States. Realism has been chiefly concerned with the commonplaces of everyday life among the middle and lower classes, where character is a product of social factors and environment is the integral element in the dramatic complications in literature, an

approach that proceeds from an analysis of reality in terms of natural forces. Realism, a style of writing gives the impression of recording or 'reflecting' faithfully an actual way of life (Trivedi, 1991).

Social Realism is a keen depiction of social condition. It implies a moral awareness also. Social insight is a heightened consciousness or comprehensive understanding of the social and cultural milieu - a sense of social fact. Socially conscious refers to an awareness inspired by a social ideology. It implies extreme social involvement and commitment to the socialist programme. Social Realism includes social consciousness, social sense and experience and social insight. It is an all-embracing term, indicating sound and systematic grasp of the socio-political web, all rolled into one. Social Realism unravels the layer within layers of the social fabric through fictional medium. By choosing an appropriate story, characters, language and fictional technique, the novelist aims to present the multifarious aspects of society and its complex functioning. Social Realism is not just realism represented in novels. It is, on the other hand, the novelist's way of dealing with realism or sometimes dealing with social facts and events of society for his novel's sake. In the novelists' hands it remains a technique by which truth is represented in an artistic way (Taghizadeh, 2014).

Social Realism developed as a reaction against idealism and the exaggerated ego encouraged by Romanticism. The consequences of the industrial revolution became an apparatus; urban centers grew, slums proliferated on a new scale contrasting with the display of wealth of the upper classes with a new sense of social consciousness and the social realists promised to fight the beautiful art, any style which appeared to the eye or emotions. They focused on the ugly realities of contemporary life and sympathized with working-class people, particularly the poor. They recorded what they saw, as it is existed, in a dispassionate manner.

'Social' is an omnibus word covering all aspects of human activity that display an awareness of others. Simply speaking "Social Realism" is an extraordinary reach of understanding of social life. Still better, it is an intellectual power of probing into the nature and function of society, its various institutions and traditions, and their functioning. It is an intellectual penetration of social process.

Social Realism involves individual, social and cultural changes in all the spheres of life with their intricacies, and nuances: facts relating to family, the class, the marriage, the school, the politics, the inter-relation, economy, morality, religion, and educational standards. It relates more to social readjustments and social maladjustments such as unemployment, youth unrest, industrial indiscipline, crime, war and their causes and consequences.

3. Method of the Study

The study is qualitative research, it involves textual analysis method together with relevant conceptual tools and frameworks and therefore it is analytical. The novel will be read and examined critically. According to Abiy (2009), qualitative research involves and seeks to describe various aspects of behavior

and other factors studied in the social sciences and humanities. In qualitative research data are often in the form of descriptions, rather than numbers. Document analysis, the process of using any kinds of documents, can be used as a methodology in qualitative research as a singular method of research or as a supplementary form of inquiry. Hence textual analysis method is best feet with the objective of the research since the main focus of the research is examining realistic representations of socio-cultural issues in `Kusaa Gadoo` .

Purposive sampling technique is used to select the novel that represented the social realities of Oromo society. Accordingly, the following criteria are set to select the novel. Firstly, based on readings of different research works and theories social realities that are considered to be very significant in a given society are identified. Then, novels in which the identified social realties represent are distinguished from different time and writers. Based on this, one novel is selected i.e. 'Kuusaa Gadoo, which is written by Gaaddisaa Birruu in 1991. It also attracted the interest of the researchers since it is a novel published for the first time officially in a history of Oromo society immediately when Derg left the power.

The study employs primary data. The primary data and the main focus of the research is on the novel Kuusaa Gadoo. The research is relied on primary source material for developing an accurate results and discovering information related to the context within which the research questions are developed. Data is collected thorough reading of the novel selected for the research purpose. The novel and theories on the respective social realities were read closely and investigated in-depth. Through intensive reading extracts taken based on the social realities identified in research questions. The extracts are used as a representative data of the novel used for the study.

In the analysis part, the study involves the various tools which allow the understanding of reality in the 'Kuusaa Gadoo`. The first of these processes is the analysis of the themes of socio-cultural reality of the Oromo society in the novel. Moreover, the researchers interpret how the writer reflects the social issues of Oromo society realistically.

Therefore, analysis and interpretation have been used as analytical procedures in this research. As it is indicated before, the themes are identified based on the theoretical framework –social realism used in this study. Consequently, the selected novel has been intensively read by the researchers and extracts cited from it**.** Extracts taken from the novel for illustration purposes has been translated into English using communicative translation method. This translation method attempts to produce the exact message of the source text with emphasis on acceptability to the target text readership (Newmark, 1991). The data obtained from the novel analyzed and interpreted in accordance to the concepts and frameworks discussed against scholars view. Finally, conclusion has been given for each interpretation.

4. Analysis and Discussion

4.1 Socio-cultural Realities

In novel `Kuusaa Gadoo` the author elucidated different socio-culture issues in fact, literary texts cannot be out of the life experience of the society that includes social activities and cultural values. Therefore, this section briefly discusses these socio-cultural issues as represented in novel.

4.1.1 Mistress

Love is natural and it is one among the social life of human being. It is the natural phenomenon that can takes place between families or two opposite sex male and female. This can be seen in the `Kuusaa Gadoo` between different characters: Dechasa and Yadeshi, Dechasa and Genet, Asfawu and Aberash, Asfawu and Yadeshi. This can be realized from extracts next to this.

> Jaallalli Dachaasaafi Yaadashii yeroo xiqqoo keechatti o`e. Dhugaa dubbachuuf jaalalli akkanatti bitaa mirgaa wal qixxaatee walitti dhufu yeroo bay`ee hinargamu. Waan kana ta`eef yeroo xiqqootti jaalalli isaanii gurra nama bay`ee ga`e (f. 39).

> The love of Dechasa and Yadeshi became very warm in a short period of time. To speak the truth most of the time there is no such love that is equal in both sides. Because of this their love reaches the ear of peoples` in a short time (P.39).

In the novel Dechasa the husband of Yadesh is a hero. He started love with Yadeshi when he was workinging at health station of Bokoji. They see each other for the first time when Yadeshi went to the health clinic the work place of Dechasa for medical examination. Dechasa has been attracted when he was giving treatment for her. He started his communication with fun, when she came again for checkup they know each other more and exchange their address. Garadually, he invited Yadeshi to his home and she started visiting him. Previously Yadeshi was suggested by her family to be given for another boy as a wife, but it was out of her interest. Since, they loved each other very much in a short time, the love of Dechasa and Yadeshi becomes miraculous to all the society of their village. As their relation becomes intensive their love increase from time to time and they meet each other daily and enjoy together.

> Namoota yaadashiin akka Dachaasaa irraanfattu godhan keechaa tokkoffaan Asfaaw Hayleeti. Mana niitii dhirsa qabduutiif karaa cufame akkuma arganitti itti hinseenaniif malee Yaadashiin qalbii Asfaaw kan fudhatte har`a odoo hinta`iin Dachaasaan Odoo jiruuy.Amma garuu bay`uma itti tole.Tokkoffaa mana abbaan warraa hinjirre, lammaffaa sababaaf kan ta`u Yaadashiin dhugaatii gurgurti (f.34).

> Among the persons who deed Yadesh to forget Dechasa was Asfaw Haile. The time for the attraction of Asfawu by Yadeshi was not now; it was when Dechasa was at his home. But, he was not convenient to get her because of it is not easy to enter to the home of the married woman and fenced road. Nonetheless, it was convenient very much now. First, there is no husband at home, second, Yadeshi is selling beverage (P.34).

As it is narrated in the novel, Yadeshi was Dechasa`s wife and their love also very interesting and have one son from each other. Since, Dechasa was not graduated from University they discussed as a family with Yadeshi and Dechasa`s relatives decid to join university leaving his family at their village Bokoji town. Based on this Dechasa has been join Addis Ababa University and started his education. To support her life Yadesi started selling chaticala (local drink) and Asfaw got the way to enter to her home and satisfy his love interest that was developed in to his heart during the presence of Dechasa.

Previously Asfaw had wife her name was Abersh. He overlooked his family and started to interrupt others life too. He started visiting Yadeshis` home day to day with his friends to drink chaticala after work time using as an opportunity the absence of Dechasa and beverage. Gradually, he separated from his friends and started staying with her for a long period of time especially during night time and discussing about love. Then Yadeshi started forgetting Dechasas` true love in a short period of time which is amazing and difficult to define what human beings really are? This reality is what our societies were living yesterday, what we are living to day and what we will live in the future.

This is the time at which Asfawu and Yadeshi enjoy their love being together. As it is understandable he stayed at Yadeshis` home, their deed looks like the one who is living a single life; but both have family. Such measure is very difficult and dangerous for both families. It distracts and took to bad life. In addition to this such experience is not acceptable culturally so the society isolate them. In Ethiopian culture, the lady with husband and a male with wife not expected to be with other male and female. The one who did this can be considered as a rubbish person; nobody gives him/her value.

4.1.2 Confer

Literary texts convey universal themes and concerns. Human beings are social animals and they discuss on their personal and common agendas being together in pair or in group. This experience is not exceptional for Ethiopians or somewhere else it is universal. This reality is portrayed in `Kusaa Gadoo` and realized from the extracts as follows:

> ... "maal? Maal siin jedhe?" jetteen Asteer.
> Gannatis,"Mee na dhiisi giiftii too, ol jedheetuu ana hin ilaalle" jetteenii..(f. 9).

> … "What? What he said?" said Aster
> Genet also said, "Please leave me my boss, even he didn't see me" …(p.9)

This discussion was took place between Genet and Aster who was a friend of Genet. They were discussing about the boyfriend of Genet that is Dechasa. According to the culture of Ethiopian`s discussion about boyfriend and girlfriend is common. This dialogue is secrete and not shared for all. Ladies discuss about their boyfriends' with lady, boys discus about their girlfriends` with boy. This is a reason why these to ladies talking together. Since Aster knows about the concerns she was asked her the discussion she was made with Dechasa. Genet also told her as she was not successful to discuss with him. When such condition is happened between two lovers the friends help each other by giving advice, seeking solutions

for problems, being with each other to make not to feel sad. Or the friend may advise her friend to stop the relationship from her boyfriend by gossiping his bad side to her. Supporting not to be hopeless or giving advices not to be demoralized, indicating there will be an opportunity some other days to discuss and reach agreement or as there is no always positive responses for everything and to prepare her for good or bad answer. This social duty is not an easy task because the one who fail in love and didn`t satisfy his or her need may psychologically harmed. In this case friend can protect each other from such and other related moral issues.

> "Moo guddo! ' Na jaalladhuun jaalala hinuumtu' jechaa hindhageenyee?"
> "Dhuguma kun jechi durumaa jira. Haata`u malee anaafi Dachaasaadhaa kan jedhamu miti. Kun kan jedhamu namni jibba nama irraa qabu na jaalladhu jedhaniif nama hinjaallatu jedhuufi."
> "Ati akka Dachaasaan si hinjibbine hinbeekta jechaa dhaa?"(f. 9).
>
> "Oh my dear! Don`t you hear? The saying 'love me cannot create love'"
> "It is true this saying already exists. But, this saying is not for me and Dechasa. It is for someone who hates same body. Such person may not love someone because of somebody says love me."
> "That means you know that as Dechasa don`t hate you?" (p.9).

This dialogue also took place between the two girlfriends Genet and Aster. From the preceding extract Genet don`t get the chance to discuss with Dechasa about her love. Here Aster advices her that as one side loves is not fruitful. According to Aster`s saying thinking only in one direction is bad, because Dechasa may not have love from Genet. But, since Genet loves him very much she was resisting not to accept Aster`s advices. As to Genet, in case Dechasa may not love her she believes as she can make him to love her.

In this discussion one can observe that the care of Aster for Genet. She was advices her to be careful and think in bidirectional. This is preparing her friend for the next response from Dechasa, if he replies in a direction Genet don`t expected she may badly harmed mentally or psychologically. But, if her expectation be in either side positive or negative she will be protected from harm. This sounds the deed of good friend.

4.1.3 Wedding

Weeding is among different cultural value of Oromo society. This cultural experience can be takes place based on the interest of both male and female or based on the interest of the males` and females` family without the knowledge of the boy and female, may be some times at the knowledge of family and the boy. Those realities were reflected in `Kuusaa Gadoo` and revealed with the next different extracts:

> Tufaan Yaadashii ilaallatee, dubara keechaa filatee odoo hinta`iin, abbaan isaatiifi abbaan Yaadashii waan wajjin guddataniif, waan xuwwaa tokko dhuganiifi dimshaashumatti

> bay`ee tokko waan wal jaallataniif, jaala isaaanii jabeechuuf har`a odoo hinta`iin oggaa ijoolleen lachuu daa`ima xixiqqoo turan, intala tee ilma kiyyaaf adaraa waan waliin jedhaniifi (f. 60).
>
> Tufa had not select Yadeshi for fiancée among many ladies, but the reason for his acceptance was the friendship of their fathers`, they growth up together, they have a common social practices monstrance and in general the main reason was their fathers` limitless love they have for each other, to strengthen their love more both fathers said each other your lady for my boy when their children's were broods (p.60).

This cultural weeding is based on the interest of both youngsters` family. In Oromo culture social bond intimacy can be more constructed through marriage. For this reason the families who has respects for each other, who has interest to continue together for a long time, who has concern to have more and meaning full relationship proposes their children for each other early at their childhood. This indicated that the maximum level of family's love and respect in Oromo`s culture.

In this citation the story revealed this situation. The agreement to give their children for each other was made between Tufa`s and Yadeshi`s father when they were kids without the knowledge of both. This idea bases only the families and both the concerned bodies I mean the teenagers` interest was not considered. In such cases families sometimes challenged when the teenagers resist not accepting their proposal and forced them to do so. The one who do not accept his or her family`s choices considered as disrespecting the family and overlooked by the family. Finally, the one who goes out of the interest of his/her family los every support and family attention to the end. Most of the time, the teenagers fear such complications and go with the interest of their family admitting every short coming. In such cases life will be in a lottery system; they sometimes successful and sometimes not. This shows how culture affect once life, as there is beautiful and helpful cultures there in society there is also bad traditions that needs modification or adaptation.

> Gara Yaadashiitii garuu akka waan isaan heerumaniifi, jiruu ishii isaan ishiidhaa jiraatanii, yaada ishii gaafachuun hinyaadamu ture. Odoo gaafataniillee Tufaa namicha qubaan farramu Yaadashii intalli kifilii ja`aa naa ta`a jettee hinfilatti jechuun dhugaa hinfakkaatu…. Kanaafuu fakkaata kan ishiin Dachaasaa hojjetaa mootummss argannaan odoo oolchitee hinbulchiin daftee jala lixxe (f. 60).
>
> However, in Yadeshi`s side as they will married instead of her and live her life it was not expected to ask her interest. Even if she was asked it is unbelievable that Yadeshi who was six grade students prefer Tufa who signed in finger i.e. uneducated person …it seems for this reason that she immediately attached to Dechasa who was government worker (p.60).

From the text in the cultural marriage, even though there is a minor opportunity for males to have information about the whom he is going to get married, the ladies are not lucky for such information except

they may got an information informally from neighbors or relatives. As one can realized from the citation Yadeshi and Tufa were forced to marry each other based on family`s proposal without their interest and knowledge. However, Tufa was pre informed and agreed with his family`s suggestion even though she was not his preference previously. For Yadeshi there is no body who considers her as a human being that has interest and right to decide about herself. Without the information she informally got from others, her family didn`t asked her interest to marry Tufa. Even they were not academically matching each other, she was learning six grades but he was illiterate. So, she was interested and loves the one who is educated i.e. Dechasa.

From the discussion, we can deduced that the severity of culture and the value of females. Families didn`t care for the interest of their ladies and the educational back ground of the boy who is going to married her even though she is educated. Every decision was made on her life by her families without her involvement. Such decisions revolved from the societies` belief which is one giving less value for females' education saying that "educating female has no value" that is why they forced Yadeshi to stop her education from six grade and married Tufa an illiterate person. Two, the societies experienced that male over domination. Females were considered as passive, order taker, decision taker and but not as decision makers. The societies appreciate when everything comes from the males' side including the decision of female`s fiancé. Such traditions affect the life of females in Ethiopia in general particularly the Oromo`s females increasing their reliant on males.

Since Yadeshi`s family were not happy for her wedding with Dechasa, they ignored her and have been curse. Their saying shows that their disconnection in their lifelong. This is a very serious decision that indicates how much families interrupt females' life and decided on her such harsh measures. Such culture comes from generation to generation through practices and deep-rooted in the society. Now days, such conditions showed modification to some extent especially for those an educated one. But, the practices are there for those uneducated teenagers since they were guided by their families.

4.1.4 Arbitration

Negotiation is among the cultural conflict resolution mechanisms in Oromo culture. Disagreement can be occurring between different bodies because of several reasons. Wedding without the permission of teenagers` family results in disagreement family and teenagers. According to Oromo`s culture such disagreement should be negotiated by elders and gate solution. This practice observed in the `Kusaa Gadoo` through the subsequent citations:

> "Odoo warra ishii wajjin walitti araaramnee Gazzuu isaanitti kenninee Yaadashiin adabattee barachuu hindandeech. Gazzuu akka nurraa fuudhan duwwaaf odoo hinta`iin amma yoomiitiitti warra ishiitiin addaan cittee hafti? Abbaa, haadhaafi obboleewwan ofiitiin addaan citanii jiraachuun jiruu hinguutu. Akkuma taane taanee warra ishii araarfachuu nuu wayya"Jedhee Dachaasaan yaadeeti galgala Yaadashiif yaada kana dhiyeeche .

> Ishiinsis "Ani duraanuu kanan isaanitti mufadheef waan siin addaan na baasuuf xaaraniif malee jibba biraa qabaadheeti miti. Ammas nuu araaramnaan anaaf gammachuun kana caalu hinargamu" jetteen. … Mammire Laxxiyibeluun waan nabsi abbaatii isaanii ta`eef ulfina guddaa walirraa qabu isaaniin itti ergina yaada jedhrratti waliigalan (f.73).
>
> "If we make reconciliation with Yadesh`s family we can give Gezu to them and Yadesh can continue her education. Not only for giving theme Gezu, but also for how long she disconnected from her family? Life is not meaningful without father, mother, sisters and brothers relationship. In any circumstance it is better to reconcile with her family`s" Dechasa think this idea and discuss with Yadeshi during night time.
> She also said "Even before, I felt discomfort because of they were trying to separate me from you, now if they reconcile with us there is no thing gives me happy more than this one"… They decided to send Mamire Letiyibelu thinking that since he was their religious father they give value for each other (p.73).

In Oromo culture there is a procedure to come with the female's family after marriage especially for those undertake their marriage without the permission and interests of their families. They can go to the lady`s family after elders negotiation and her family`s agreement. Since Dechasa`s and Yadeshi`s marriage was based on their own interest, negotiating her family for reconciliation was mandatory. So, Dechasa thought the importance of negotiation with her family`s and discussed with Yadeshi, she also agreed on the idea. However, the negotiation must be took place by elders or religious fathers or very intimate friends. As a result they agreed to send Mamire Letyibelu thinking that they may not resist him since he was their religious father.

The negotiation was very critical to make smooth the relationship of both families. Unless and otherwise the question of negotiation not comes from Dechasa`s side they pass their lifetime without any relationship. According to the society's culture the question of reconciliation never raised from the family of Yadeshi`s side, it is considered as abasement. Enquiring for reconciliation from the boy side had different interpretations; in one side it gives a meaning of respecting the lady`s family. In other way it is considered as valuing the culture of the society. If this missed her family feels as their respect and the societies' cultural value was corrupted, so they never apologies them.

From the description made one can simply observe how much arbitration challenging the elders or religious fathers especially when it is teenager's interested based marriage. When they are not successful they lost two things. One, the value they developed through their life which is gained from the society. Second, they detached from the family those they couldn't negotiate them and comes to an agreement. This is seen when Memiru leaves Yadeshi`s family home without saying goodbye. It indicates stopping communication with that family, this may continue for a lifelong or they negotiate by other elders and come to agreement through the time. But, even though they come to agreement their relationship will be not continue as the previous one; it will be limited.

5. Conclusion

From the discussion and analysis made it is found that Gadisa Biru in his novel `Kuusaa Gadoo` portray the real events of Oromos` socio-cultural practices and customs in advance as it was been in Derg regime. Different Oromos` socio-cultural issues such as friendship, confer, wedding and arbitration are characterized in novel that are actually familiar in societies practices. Therefore, we can say the socio-cultural situations in `Kuusaa Gadoo`, pictured in a similar way of Oromo people life style during the Derg regime.

In general, Oromos` socio-culture were undermined during the Derg regime by the dictatorial government that appreciates assimilation however, the Oromos were struggled and reserved their socio-cultural activities and practiced as much as possible even though there is no official right to exercise. This is clearly shown through the life experience of the characters in novel.

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Prevalence and Current Practices of Self-Medication among Students of the Biomedicine Degree at the Health Sciences School

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Abstract

Self-medication is often seen as a solution for the immediate relief of symptoms, however, bringing serious consequences to consumer's health and serious public health problems in Brazil and the world. Still, regarding self-medication, the conduct of University students in the health area is observed, since the habit in this group is high. Given these facts and the need for epidemiological and toxicological evidence on self-medication of this school group, this study aims to verify the prevalence of self-medication in Biomedicine Degree students of the Universidade Brasil. It is a cross-sectional study conducted with 63 scholars from the first three graduation years of the Biomedicine degree at the Universidade Brasil, in Fernandópolis, São Paulo. A validated questionnaire with social and medication consumption variables was applied, followed by statistical analysis by the Mann-Whitney test. As a result, self-medication was considered an option for 59 of the participants, most of them juniors, female, aged between 18 and 20, with no previous college degree, with medical insurance and aware of possible health risks, even after access to classes or online surveys. The clinical condition preceding self-medication included mainly headache, myalgia, fever, and allergies. There was a preference for anthelmintic, anti-inflammatory, analgesic, antipyretic medication, mainly antibiotics, and central nervous system stimulants. The habit of self-medication increases, gradually, during the graduation period, therefore is suggested the implementation of an educational campaign in the Biomedicine course curriculum to undo this cycle of chemical substance consumption.

Keywords: Cross-sectional Study, Self-medication, Adverse Reaction, Private College Students, Corticosteroids, Central Nervous System Stimulants.

1. Introduction

It's defined as self-medication the practice of consuming medication without prior consultation with a health professional. Self-medication is practiced by people who deal with their health problems and

disorders through medication obtained without a doctor's prescription, thinking it is effective when consumed[1].

This habit has been impressive for its easy accessibility to medications without medical orientation by the general population. It is noteworthy that this habit can promote adverse medication reactions to consumer health[2]. Also, with the advertising of several medications in digital media, it has become easier to acquire them in drugstores, resulting in a misinterpretation of the risks that this practice can cause, boosting uncontrolled use, causing damage to the body due to therapeutic effects[3]. It is important to point out that the high consumption of medicines is more and more frequent, causing constant damage to health.

The factors that most interfere in the self-medication occurrence are the lower social classes due to the difficulty of obtaining a medical appointment, often looking for pharmacists, friends or relatives, to acquire medicine to treat their health problem[2]. It should be noted that self-medication does not occur only in poor social classes; it is evident in people with high acquisitive power. Thus, the upper social class, even having greater knowledge and education, makes use of medications on its own, ignoring the risks they may bring[4].

Another detail that deserves to be highlighted is the conduct of college students in the health area since self-medication in this group is high, especially students who have medical insurance[5]. Because they are biomedicine students, it is expected a higher consciousness and lower consumption of medications, however, the more knowledge, the higher is the inappropriate medicine consumption by students[6]. It is important to emphasize that self-medication has as the main problem to hide or hinder the correct diagnosis of existing diseases, causing dependence, hypersensitivity and leading to risks of large proportion and difficult clinical reversion[7].

Still, regarding self-medication among college students, it is interesting to point out that a few studies have been found on scientific databases, mainly students of the Biomedicine Degree, which makes it necessary to carry out more research in this area. Given these facts and the need for epidemiological evidence and toxicology on self-medication of this school group, this study aims to verify the prevalence of self-medication in Biomedicine Degree students of the Universidade Brasil, Campus Fernandópolis, São Paulo.

2. Materials and Methods

The study was approved by the Research Ethics Committee of the Universidade Brasil under the advisory opinion 3.261.199 and CAAE number: 10891419.1.0000.5494.

This research was a cross-sectional epidemiological study conducted from August 2019 to December 2020. The inclusion criteria considered included students enrolled from the first to the third year of graduation in the Biomedicine Degree at Universidade Brasil, Campus Fernandópolis, São Paulo with the respective signature of the Free and Informed Consent Term. It excluded those who refused to participate or presented themselves in prescription medication therapy.

A 12-question questionnaire adapted from Servidoni[8] was used for the study. The following were considered in the multiple-choice questionnaire: 1) Degree Level, 2) Gender, 3) Age, 4) Undergraduation, 5) Marital Status, 6) Health Insurance Payment, besides the use of self-medication and associated details

are in the questionnaires: 7) Self-medication without medical prescription, 8) Before self-medicating, have you looked for information, orientation or additional clarifications of the medication?, 9) Are you used to read the medicine package leaflet before self-medicating, 10) Awareness of health risks, 11) Medication Types, and 12) Previous clinical conditions. The application of the questionnaire was done individually in class to verify the prevalence of self-medication in students. The study also discussed adverse medication reactions related to the use of self-medication.

The data analysis was carried out by descriptive and inferential statistics, with values of $p<0.05$ and application of the Mann-Whitney test by the SPSS Statistics Software (Version 23) linked to the functionalities of the Excel program (version 2.016).

3. Results

The sample studied involved 63 students from the first to the third year of graduation from the Biomedicine Degree at the Universidade Brasil, being 15 (23,81%) freshman students, 19 (30,16%) sophomore students, and 29 (46,03%) junior students. Of these students, 45 (71,43%) were female and 18 (28,57%) were male (Table 1). The predominance of the age bracket was between 18 and 20 years old, with 34 (53,97%) students. 25 (39,68%) students between 21 and 30, and 4 (6,35%) students over 30 years old. Regarding the educational level, only 10 (15,87%) students had previous undergraduation and 53 (84,13%) had no previous education. Still in Table 1, 55 (87,30%) were single and 8 (12,70%) students were married. 40 (63,49%) students had no health insurance, and 23 (36,51%) of the participants reported having health insurance.

Table 1: Epidemiological characteristics of Biomedicine Degree students (absolute and relative values).

CHARACTERISTICS	INFORMATION	N	%
Gender	Female	45	71,43
	Male	18	28,57
Age	18 to 20 years	34	53,97
	21 to 23 years	15	23,81
	24 to 26 years	7	11,11
	27 to 30 years	3	4,76
	Over 30 years	4	6,35
Undergraduation	No	53	84,13
	Yes	10	15,87
Marital Status	Single	55	87,30
	Married	8	12,70
Health Insurance Payment	Yes	40	63,49
	No	23	36,51

Concerning the behavior of the participants about the use of non-prescription medications (Table 2),

it was verified that 59 students have already taken self-medication, 39 (61.90%) students have the habit of self-consumption of non-prescription medication (drugs that are not obligatory to present a prescription) and 20 (31.75%) students with the same habit, however, it is obligatory to present a prescription for medicine consumption. On the other hand, 4 (6.35%) students do not show the vicious cycle of self-medication. Before starting self-medication, 47 (74.60%) students looked up for information about the medicine that would be used, 16 students (25.40%) did not look up for information. As for the reading of the package leaflet, 16 (25.40%) students sought additional information, 22 students (34.92%) sometimes sought information, 20 students (31.75%) rarely sought details of the medication, and 5 (7.94%) students never sought additional information on the medicine. Of the 63 participants, 62 students (98.41%) did not believe that self-medication can bring health risks and 1 (1.59%) student believed that self-medication can cause serious risks to the body (Table 2).

Table 2: Variables describing the prevalence of self-medication among students.

VARIABLES	INFORMATION	Prevalence of self-medication	
		N	%
Have you ever self-medicated without a doctor's prescription?	No.	4	6,35
	Yes, but there was no need for a medical prescription.	39	61,90
	Yes, even though it is mandatory to present a medical prescription for consumption.	20	31,75
Before self-medicating, did you seek additional information, guidance, or clarification on the medication?	No.	47	74,60
	Yes.	16	25,40
Do you usually read the medicine leaflet before self-medicating?	Always.	16	25,40
	Sometimes.	22	34,92
	Rarely.	20	31,75
	Never.	5	7,94
Do you believe that self-medication can bring health risks?	No.	62	98,41
	Yes.	1	1,59

As for the most commonly used medications, Table 3 shows that anthelmintics (10.04%), anti-inflammatory medications (8.55%), analgesics (7.99%), antipyretics (7.43%), antibiotics (7.62%), and central nervous system (CNS) stimulants prevailed (example): Ritalin, Vyvanse) (7.25%), cough syrups (8.45%), cold/flu medications (10.63%), antiallergic/antihistamine (6.13%), and muscle relaxants (5.58%), and others with low consumption.

Table 3: Self-consumed medications by students.

MEDICATIONS	N	%
Anthelmintics	54	10,04
anti-inflammatory	46	8,55
Analgesics	43	7,99
Antipyretics	40	7,43
Antibiotics	41	7,62
stimulants (CNS)	39	7,25
cough syrups	39	7,25
cold medications	37	6,88
antiallergic/antihistamine	33	6,13
muscle relaxants	30	5,58
anti-flu	23	4,28
oral contraceptives	21	3,90
nasal decongestants/vasoconstrictors	16	2,97
Antiasthmatics	15	2,79
Antacid	12	2,23
systemic corticosteroids (oral)	10	1,86
vitamins and supplements	9	1,67
Laxatives	8	1,49
anxiolytics, antidepressants, hypnotics (treats insomnia)	8	1,49
nasal corticosteroids	4	0,74
drops otological (for ear)	3	0,56
Antidiarrheal	3	0,56
Antispasmodics	2	0,37
against flatulence	1	0,19
Others	1	0,19
Anabolics	0	0,00

Table 4 demonstrates the clinical condition before self-medication, which included cephalea in 57 students (10.86%), myalgia in 56 students (10.67%), and cold symptoms in 47 students (8.95%), allergies in 46 students (8.76%), fever in 44 students (8.38%), sinusitis in 37 students (7.05%), pharyngitis, tonsillitis, and laryngitis in 36 students (6.86%) and epigastralgia in 35 students (6.67%) and other clinical conditions with lower rates.

Table 4: Clinical condition that led students to self-consumption of medications.

CLINICAL CONDITION PRECEDING	N	%
Cephalea	57	10,86
Myalgia	56	10,67
cold symptoms	47	8,95
Allergies	46	8,76
Fever	44	8,38
Sinusitis	37	7,05
pharyngitis/tonsillitis/laryngitis	36	6,86

Epigastralgia	35	6,67
Toothache	28	5,33
Nausea	27	5,14
skin lesions	19	3,62
intestinal pain	17	3,24
Rhinitis	15	2,86
anxiety, depression and insomnia	13	2,48
Reflux	12	2,29
difficulty focusing on studies	11	2,10
ear infections or inflammations (otitis)	10	1,90
lung diseases	6	1,14
other clinical conditions	6	1,14
orofacial lesions	3	0,57

In Tables 5, 6, and 7, the inferential part of the statistical crossings was analyzed. The results of these Tables did not present significant statistical tests. However, the descriptive crossing of the junior students in Table 5 was more significant, due to the higher consumption of over-the-counter medications, knowing that it is mandatory to use a prescription to consume the medicine. Table 6 shows that the age group between 18 and 20 years old was the most significant to the use of over-the-counter medication with mandatory prescription use. Table 7, on the other hand, shows that the gender who consumes the most over-the-counter medications is women, which shows that they are the largest medications consumers.

Table 5: Cross-referencing data between Degree Level X With the information: Have you already self-medicated without prescription.

VARIABLES	1º year		2º year		3º year		TOTAL		Value p[1]
	N	%	N	%	N	%	N	%	
No.	2	13,33	0	0,00	2	6,90	4	6,35	**P = 0,540**
Yes, but there was no need for a medical prescription.	6	40,00	15	78,95	18	62,07	39	61,90	
Yes, even though it is mandatory to present a medical prescription for consumption.	7	46,67	4	21,05	9	31,03	20	31,75	
TOTAL	**15**	**100,00**	**19**	**100,00**	**29**	**100,00**	**63**	**100,00**	

[1]Value p regarding the Mann-Whitney test p>0.05.

Table 6: Cross-referencing data between Age group X With the information: Have you already self-

medicated without prescription.

VARIABLES	18 to 20 years		21 to 23 years		24 to 26 years		27 to 30 years		Over 30 years		TOTAL		Value p[1]
	N	%	N	%	N	%	N	%	N	%	N	%	
No.	3	8,82	1	6,67	0	0,00	0	0,00	0	0,00	4	6,35	**P = 0,425**
Yes, but there was no need for a medical prescription.	21	61,76	7	46,67	4	57,14	3	100,00	4	100,00	39	61,90	
Yes, even though it is mandatory to present a medical prescription for consumption.	10	29,41	7	46,67	3	42,86	0	0,00	0	0,00	20	31,75	
TOTAL	**34**	**100,00**	**15**	**100,00**	**7**	**100,00**	**3**	**100,00**	**4**	**100,00**	**63**	**100,00**	

[1]Value p regarding the Mann-Whitney test P>0.05.

Table 7: Cross-referencing data between Gender X With the information: Have you already self-medicated without prescription.

VARIABLES	Female		Male		TOTAL		Value p[1]
	N	%	N	%	N	%	
No.	3	6,67	1	5,56	4	6,35	**P = 0,210**
Yes, but there was no need for a medical prescription.	30	66,67	9	50,00	39	61,90	
Yes, even though it is mandatory to present a medical prescription for consumption.	12	26,67	8	44,44	20	31,75	
TOTAL	**45**	**100,00**	**18**	**100,00**	**63**	**100,00**	

[1]Value p regarding the Mann-Whitney test P>0.05.

4. Discussion

It is important to emphasize that the practice of self-medication is mostly performed by women between 18 and 20 years old during the 3rd year of graduation from the Biomedicine Degree at Universidade Brasil, Campus Fernandópolis, São Paulo. For Fernandes et al.[9], the high rate of self-medication among biomedicine degree students is due to the information acquired during graduation. Rossi and collaborators[10] explain that microbiology and pharmacology disciplines can bring problems if not correctly addressed in the course curriculum. The same authors report that students who have already studied the disciplines considered themselves able to self-medicate and indicate medicines to other people.

For the adepts of this practice, self-medication is considered a way out for an instantaneous relief of the symptoms, however, it can cause serious damages to health[9] and even death-risk, in case of not known

for what the medicine is indicated and the type of medication effect in the organism is.

It is also important to point the adverse events to medications, which are causing a major problem in worldwide public health, generating a high cost and resulting in high mortality rates[11]. In this context, it is important to highlight the consumption of central nervous system stimulants (CNS) by University students, such as Ritalin and Vyvanse (Table 3). Students reported that they could easily obtain these medications without a medical prescription, using them to increase concentration capacity and mental performance during classes, as well as sleep deprivation, consuming twice as much during exams to keep them active during bimonthly evaluations.

To Chatterjee[12], brain stimulants are psychostimulants with the ability to increase mental functions such as memory, attention, concentration, wakefulness, and intelligence, in addition to antidepressant properties, improving mood and cognitive development, for this reason, many students in college education consume these substances indiscriminately. Morgan et al.[13] make it clear that the use of CNS stimulants increases stress levels, which can reduce the students' life quality, making them susceptible to diseases and have repercussions on clinical practice and patient care.

Another very important aspect is the anti-inflammatories consumed by students (Table 3). It is good to remember that diclofenac and nimesulide cause liver toxicity reactions. The toxicity of diclofenac is associated with glucuronic acid, its main reactive metabolite, which makes the covalent binding of cells[14, 15]. According to Pedroso and Batista[16], the chronic use of this medication has been related to drug-induced hepatitis, which happens asymptomatically. The authors suggest that diclofenac may have been potentialized when associated with vitamins B1, B6, and B12. The nimesulide toxicity is due to mitochondrial dysfunction, with depletion of the enzyme's nicotinamide adenine dinucleotide phosphate and glutathione, occurring the increase of reactive oxygen species, calcium, and hepatic cell necrosis[17]. According to Bernardes et al.[18], nimesulide is frequently associated with hepatic lesions such as acute drug-induced hepatitis, which in the majority of cases occurs within therapeutic doses, thus, hepatotoxicity is associated with the formation of reactive metabolites that encode proteins, induce oxidative stress and mitochondrial injury.

This fact highlights that drugstores sell medicines without prescription, stimulating self-medication, even if the medicine requested does not require a medical prescription and the symptoms manifested are not of great relevance. Another inference of such manifestation is the sale and delivery of the medication to the customer. It is important that the pharmacist has specific knowledge about the medication, the symptoms, and guides how the medication's effect can affect the body, as well as its chemical composition and adverse reactions. Thus, the pharmacist should guide the consumer in the search for the medication only when necessary and prescribed by the doctor[19].

The inappropriate ingestion of medications is often described as insignificant by most people, but it should be noted that the practice of self-medication can cause risks and complications to the body, evolving with digestive hemorrhages, bacterial resistance, and allergic reactions to the medication, making the individual addicted to the medicine. At the beginning of the medication's effect, self-medication offers well-being and relief at the moment, prolonging and covering up an undiscovered disease, causing the person to develop serious complications[20].

Still, regarding self-medication criticism, the consumption of various types of medications is

observed (Table 3) by students and some of these medications should be pointed out to prolonged use. Thus, it is important to evidence that with the concomitant use of corticosteroids, various organ systems can suffer serious functional damage, occurring serious adverse events in the organism[21]. The excessive use of this medicine causes unbalanced "sodium-potassium" ions equilibrium, increasing the excretion of water and mineral salts, dehydrating the cells[22]. Another effect is the inhibition of fibroblasts, causing purpurities and ecchymosis, besides the loss of collagen and the conjunctive tissue[23]. The most worrying is the chronic use of this medication that induces apoptosis of osteoblasts, contributing to avascular necrosis[24,25]. It is verified that prolonged treatments with high doses of corticosteroids have side effects that make the treatment a dangerous alternative for the user[26]. Due to these diversities, the wrong use of this medicine becomes dangerous to the health and even to the consumer's life, and may contract another type of disease, worsening the clinical condition, or even leading to the patient's death[27].

What draws attention is the self-medication used by health professionals themselves, even with all the levels of information and experiences they deem fit for this practice, although they know of all the risks and harm that can occur during the process[28].

5. Conclusion

Students know the risks and side effects that medications can cause to health, yet self-medication is frequent among undergraduate students of the Biomedicine Degree at the University of Brazil. It is suggested educative action to undo this cycle, starting with the pharmacies, prohibiting the sale of medications without presenting a prescription, as well as the implementation of pedagogical methods in the course of biomedicine can influence the actions of substance consumption, reducing the practice of self-medication and improving the students' quality life.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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Design and development of an unmanned aerial vehicle for agricultural spraying in Brazil

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Abstract

This paper presents the development of the unmanned aerial vehicle (UAV) and its configurations as a platform for agricultural sprayers, with a hopper with a capacity of 100 kg, which can perform better maneuvers than conventional agricultural aviation, for precision spraying on small and medium Brazilian properties agricultural. The development and construction focused on precision spray agriculture, taking into account the reduction of costs and accident risks, modernizing, and complementing the activity. Prince Air Models Ltd. made the prototype with resources from FAPESP under Brazilian patent number PI 0404045-7 B1. It presented acceptable results for all flight situations requested with 100 kg of payload and flying in typical maneuvers and agricultural patterns.

Keywords: Unmanned Aerial Vehicle; Precision agriculture; Sprayer;

1. Introduction and Objectives

Brazil is one of the world's largest exporters of grains, particularly for crops such as soybean and corn. Although allowing cultivation during all seasons, the climate also favors developing pests, diseases, and weeds without having their cycles interrupted in the winter. Crop protection is essential to maintain high

productivity levels, so sprays are applied when necessary during the growing season [1]. Nowadays, there are currently two spraying techniques in Brazil, one aerial and the other terrestrial.

According to [2], aerial application is a technology that is more economical and advantageous, as it reduces the application time; apply the product in adverse conditions of irrigated or waterlogged soils; it allows for higher quality and uniformity of application and does not cause damage to the crop's kneading and soil compaction. However, despite the advantages, there are some disadvantages, such as more excellent environmental conditions. Therefore it is necessary to fly at very low altitudes, in operational terms, to avoid dispersion of pesticide in the application; the planes even fly just three or four meters from the ground, which makes the operation even riskier. Another disadvantage is the high cost of aircraft investment and the lack of pilots specialized in agricultural flights.

Therefore, to meet these circumstances, agricultural UAV is developed quickly, providing robust support for promoting agricultural production security, quality and safety of agricultural products, agricultural ecological security, and agricultural trade security [3].

UAV is the acronym of Unmanned Aerial Vehicle and refers to a class of aircraft that can fly without a pilot's onboard presence. They can be flown by electronic equipment present on the vehicle and a GCS (Ground Control Station) or directly from the ground. In this last case, it is common to associate the system with RPV expression (Remotely Piloted Vehicle) since it is remotely piloted and operated by radio-controlled devices [4].

According to [5], "A small Unmanned Aerial Vehicle (SUAV) is well suited for missions that are dangerous to perform with human pilots or inconvenient to carry out with larger UAVs. It has a limited range and payload capacity, but it is a low-cost system and does not require a specially trained air force pilot and extensive logistics. The SUAV is designed to perform high-risk missions like monitoring radioactive fallout due to nuclear accidents, searching for people lost in hostile environments (fires, mountains, ocean, etc.), and surveillance of borders, pipelines, and power lines. Such types of tasks require a reliable aircraft with a high-performance flight computer and advanced payloads/sensors. A normal mission layout is to take off, climb to mission altitude, navigate to the target area, perform the assigned task, return home, and land."

This paper aims to develop a UAV for agricultural spraying to eliminate risks and reduce operating and investment costs. They are mainly idealizing to ensure low weight via compact solution, small size, and simplicity, restricting the equipment to its operational need. Although there is a wide variety of unmanned aircraft in operation today, there is still a significant lack of approach to their agricultural use, making a comprehensive and detailed study in this field essential.

2. Literature Review

The history of unmanned aerial vehicles began in 1883, when Douglas Archbald installed a wired anemometer on a kite to measure wind speed at different altitudes, reaching a height of 1200 feet. On June 20, 1888, in France, Arthur Batat attached a photographic camera to a pipe, therefore being the first recorded photographic by aircraft [5].

In 1935, Reginald Denny designed and tested the RP-1 or RPV (Remote Piloted Vehicle), the first

radio-controlled unmanned aerial vehicle. From that moment, the search for improvement began, so that, in the following years, the RP-2 and RP-3 prototypes appeared, with several flight tests. In November 1939, the RP-4 prototype was completed, so that, at that time, it was the most complete of the RPVs. The US Army has ordered 53 units, giving them the designation OQ-1.

In the meantime, in 1938, the German company Ruhrstahl AG started developing "Fritz X" guided glider bombs, adopted from a rocket engine and 300 kg of an explosive charge, for the attack against battleships. It was used in combat for the first time on September 9, 1943, sinking the Italian battleship Roma.

Another historic milestone in UAVs' use was during the Lebanon war, in 1982, in the Bekaa Valley, when Israel Air Force destroyed 17 of the 16 Syrian anti-aircraft batteries after reconnecting with an unmanned aerial vehicle, model IAI Scout [6].

In 2002, an American unmanned aerial vehicle, Predator RQ1, was used during the Afghanistan war. This was considered the first real use of an unmanned vehicle with a missile launch.

In Brazil, the first reports of UAVs occurred in the 1980s, when the Aerospace Technological Center (CTA) developed the Acauã project (Figure 1), whose main objective was the development of a testbed platform to increase the level of knowledge in the area of electronics (control, remote control and telemetry). As a secondary objective, it aimed to develop a UAV prototype with the potential for several other militaries or civilian applications, such as tactical reconnaissance at low altitude, identifying radar operation frequencies, and sensing natural resources. In total, five cells (four metallic and one made of composite material) were built for use in ground and flight tests [7].

Figure 1. Brazilian UAV Acuã

The University of São Paulo (USP), on the campus of São Carlos, develops the ARARA project with support from Embrapa - a Brazilian agricultural research company. The objective is the development of model airplanes for obtaining aerial images for environmental and agricultural monitoring. The ARARA (Radio-Assisted and Autonomous Recognition Aircraft) project focuses on developing and using SUAVs for aerial monitoring. Its main objective is to replace conventional aircraft used to obtain aerial photographs,

for monitoring agricultural areas and areas subject to environmental problems, with small UAVs that carry out pre-established missions by users [8]. The ARARA SUAV (Figure 2) was built entirely of fiberglass cloth and resin. It has the following characteristics: 2.3 m long and 3.2 m wide and is equipped with a 40 cm³ gasoline engine with 4.8 hp power [9].

Figure 2. Brazilian SUAV ARARA

Research in this area in Brazil is still very recent and the main work with UAVs is aimed at civilian applications, such as police surveillance of urban and border areas, inspections of power transmission lines, road monitoring, activities in agricultural areas like crop monitoring, pest control and forest fire [10].

3. Material and Methods

3.1 Development of prototype

The AgroRobot aerial platform project was developed by Prince Air model Ltd. in Tupã, São Paulo, with resources from the PIPE program - FAPESP - São Paulo State Research Support Fund, process no. 02 / 07889-9 under Brazilian invention patent no. PI 0404045-7 B1. The aircraft was developed from the technical data of an ultralight KR2 aircraft. The aircraft design methodology is described by [11], whose steps can see in figure 3.

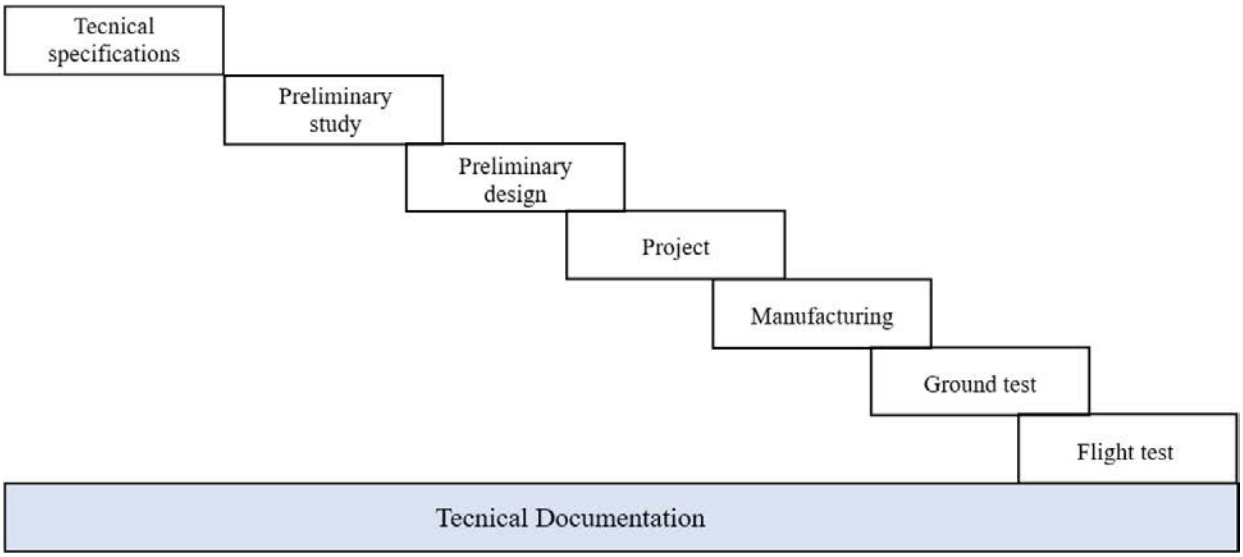

Figure 3. Aircraft development steps arrangements

As for aircraft design philosophies, two essential concepts stand out, called Minimum Solution and Free Solution. The concept of Minimum Solution, defended by many designers (especially from the European current), is based on the assumption that the aircraft must be the smallest and lightest possible capable of fulfilling the mission for which it is destined [11].

Kovacs, in his work Philosophy of Design, explains this concept stating that the aircraft must be the leanest, the most spartan as possible. Still in the minimum solution contest, highlights the famous expression of Bill Stout, "simplify and add Lightness," which remains an essential warning to this day. Such principles could be applied to airplanes of any size [12]. This design philosophy, adapted for this paper, can be summarized in four topics:

i) Ensure low weight via compact solution, small size, and simplicity;

ii) Restrict equipment to the level of operational need;

iii) Combining more than one function (whenever possible) for the largest possible number of airplane components;

iv) Adopt a powerplant with reduced dimensions and low specific weight and specific consumption.

The concept of Free Solution can be defined as the one in which the aircraft is designed without meeting any of the four topics listed above. The philosophy of the project used in the development of AgroRobot was that of the minimum solution, ensuring low weight and low cost with performance within the projected for agricultural spraying missions.

3.2 Materials

The parts that integrated the AgroRobot prototype were professionally manufactured at the Prince Air Model Ltd. factory. Various materials were used, and for that, the AgroRobot was divided into four main components (wing, fuselage, landing gear, and empennage), with their respective materials. Figure 4 shows the materials used in each manufactured component.

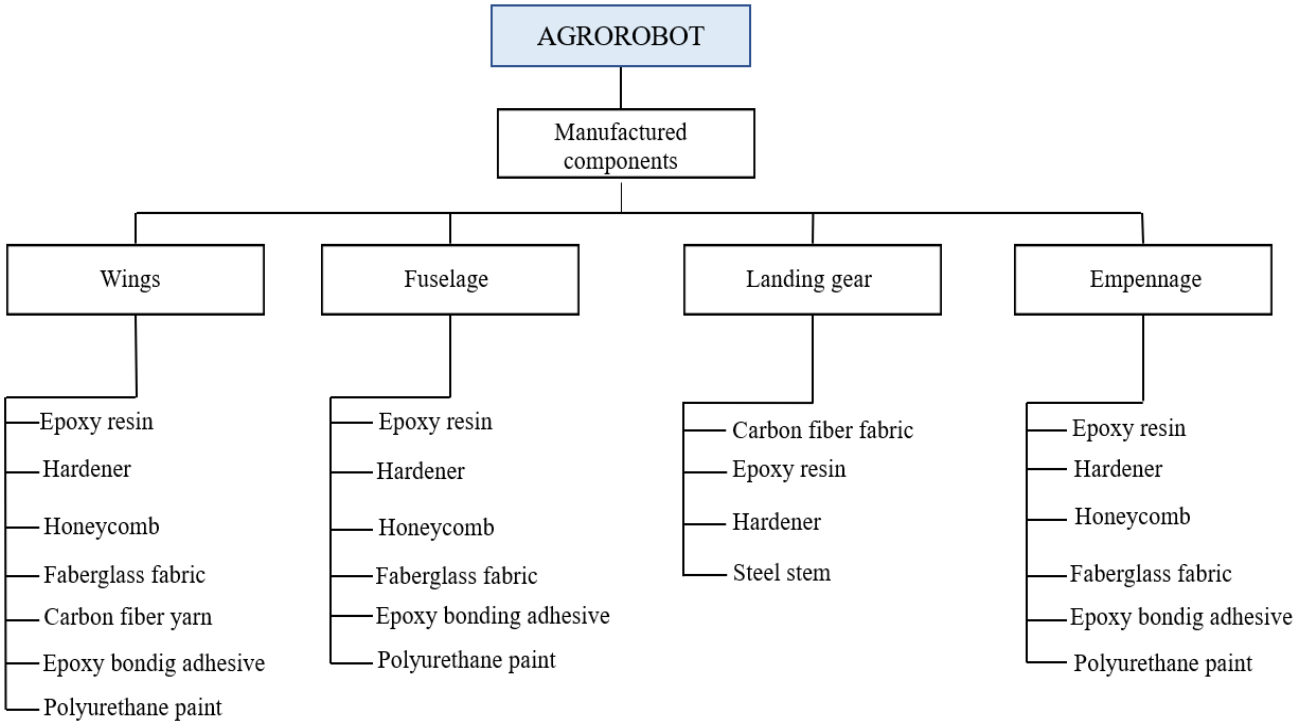

Figure 4. Materials used in the AgroRobot.

3.3 Flight Control Systems

UAVs have as their main component a control system capable of keeping the aircraft stabilized and executing maneuvers that lead it through a selected route and mission [13]. Presently, the development of flight control systems for this type of aircraft is being favored and facilitated by the tremendous technological development verified in recent years and mainly by reducing the costs of electronic components allowing a large number of companies to build UAVs with flight control systems for commercialization. The following describes the flight control system used in AgroRobot.

The AgroRobot aerial platform was adopted within several flight control systems, the MP2128g UAV autopilots manufactured by MicroPilot Co.

The MP2128g series of controllers developed by MicroPilot Co. of Manitoba / Canada is designed to stabilize and guide a wide variety of fixed-wing UAVs. This autopilot consists of altitude maintenance and speed maintenance system, a turn coordination system, a GPS navigation system, an automatic takeoff and landing system, and all the sensors necessary for complete control of the aircraft.

The control board (Figure 5) has thirty-two PID controllers Proportional-Integral-Derivative configurable by the user, which can be adjusted independently. The MicroPilot systems also have telemetry capabilities, with data transmission at a rate of 100 definable fields per second. The controllers are capable of driving up to twenty-four servos. It also allows the installation of an ultrasound wave altimeter, which is very important for low-altitude flights, in the case of the AgroRobot.

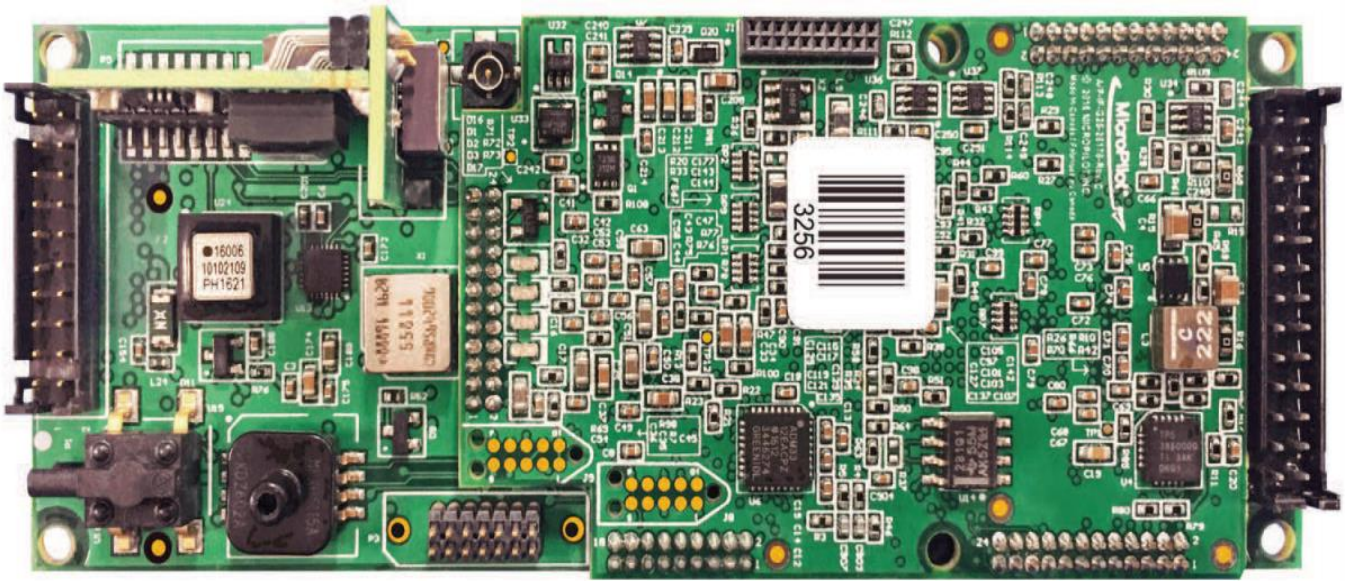

Figure 5. MP 2128g MicroPilot flight control board

The illustrated flowchart showing all the connection possibilities between radio control, ground station, and control of flight surfaces by radios modem is shown in Figure 6.

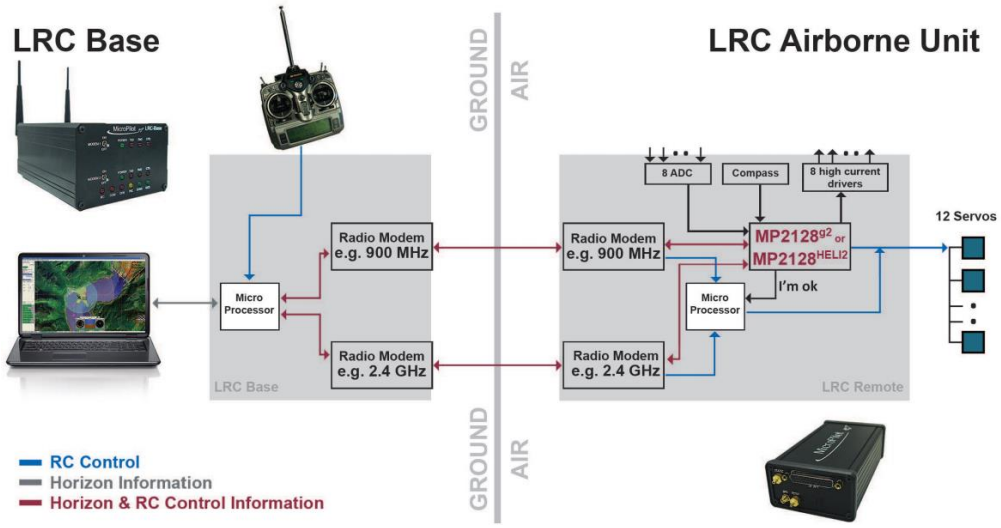

Figure 6. Flowchart showing all the connection between LCR base and LCR airborne

The system with active autopilot enables autonomous object control with the possibility of the current PID controller settings' current correction. However, it is still possible to take manual control over the mini-plane by switching into radio receivers, ensuring the RC signal transmission [14]. The system items were attached inside the AeroRobot in the way shown in Figure 7, where S1, S2, S3, S4, S5, S6, servomechanism, B1, B2, B3 Power sources, BEC, Battery eliminator circuit, AO, autopilot MP2128g, and RC, the receiver of the remote radio control signal, BW water bomb with a brushed engine.

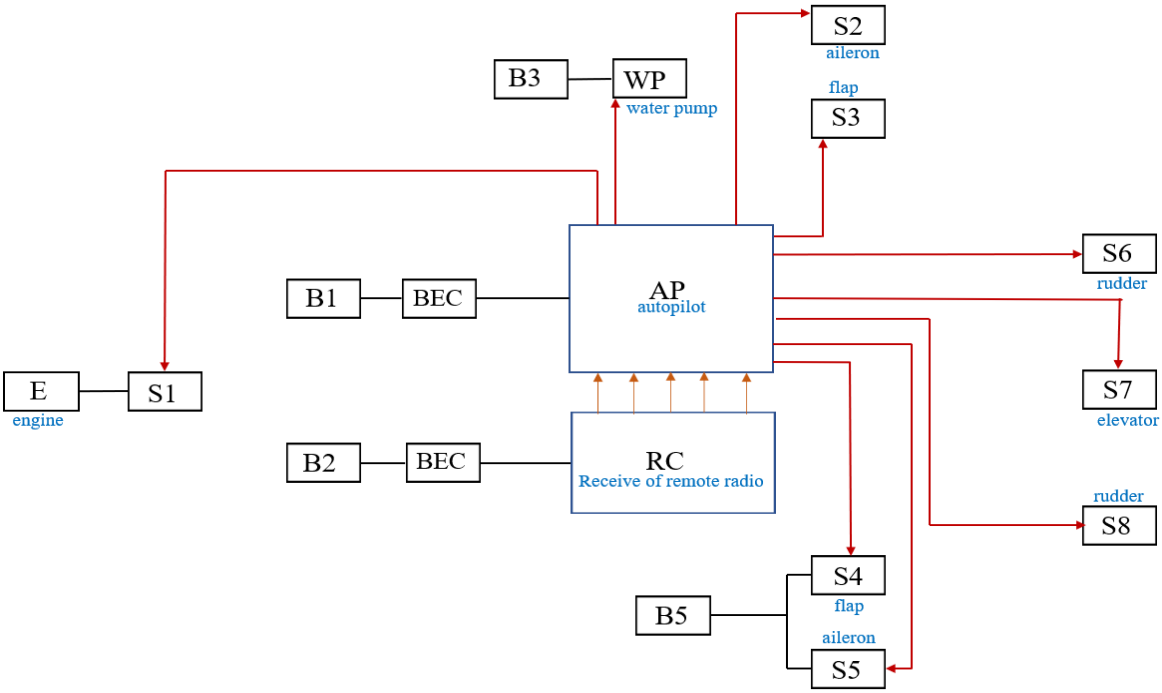

Figure 7. Block diagram of the avionics arrangements on AeroRobot

MicroPilots systems provide a ground station (Ground control), as shown in Figure 8, which allows you to receive telemetry data, images in real-time, flight in R / C radio control mode, control embedded equipment, and edit flight routes and missions.

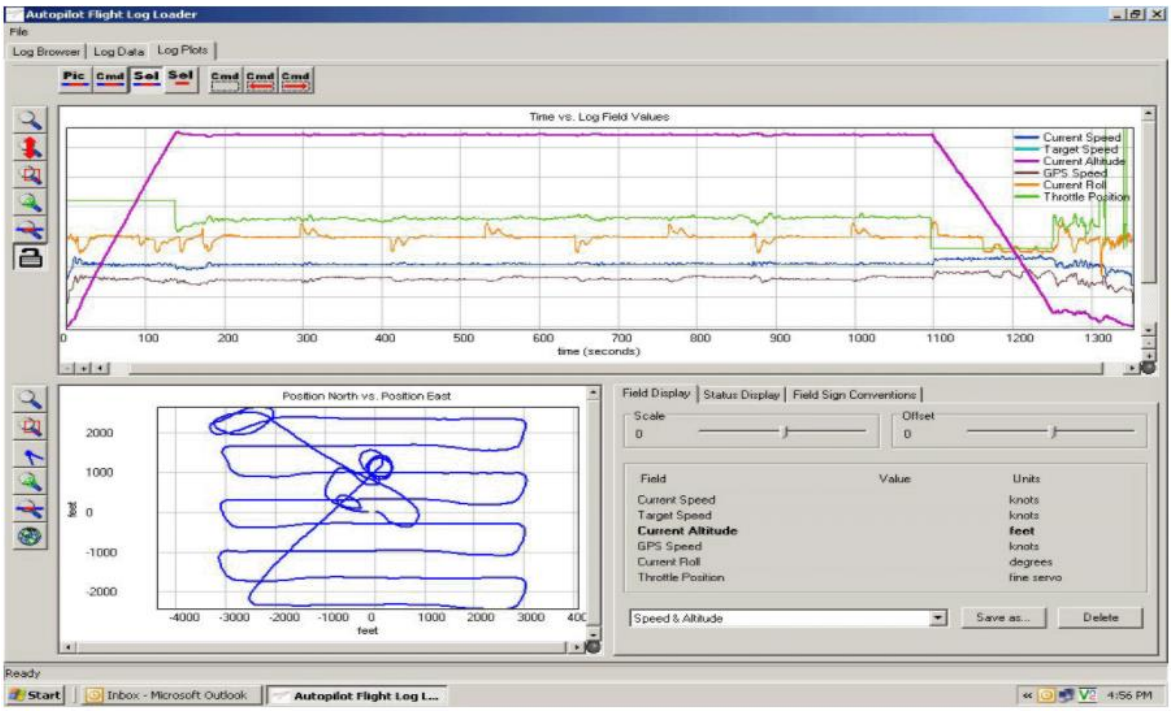

Figure 8. MP 2128g MicroPilot ground station screen

3.4 Spraying system

The spraying system is activated by the autopilot and consists of a 100-liter tank connected to a centrifugal pump driven by a Brushed motor. This pump feeds the two sprayers AU 5000 LD. The flowchart in Figure 9 shows the spray system.

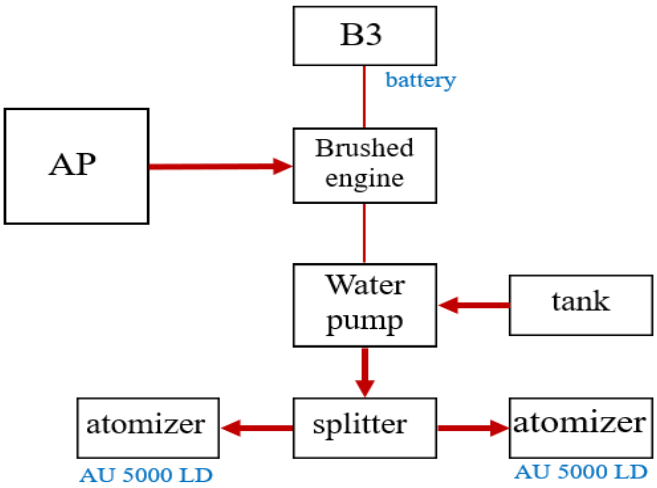

Figure 9. Flowchart of the spraying system

The Micronair AU5000 LD atomizer, produced by Bromyard Industrial Estate - England, is the latest development in rotary atomizer technology, designed to minimize drift in spraying. The flow to each atomizer is controlled by a variable restrictor unit (VRU). It provides finger-tip control of the flow by the adjustment of a 7-position control knob.

The lightweight and low drag of AU5000 atomizers enable them to be fitted directly onto the standard spray booms of most agricultural aircraft without any structural modification (Figure 10).

Figure 10. AU5000 LD atomizer

The airflow drives the atomizer past the aircraft through three highly efficient fan blades. These are adjustable in pitch, enabling the rotational speed to be varied to produce the required droplet size. Each atomizer can handle a flow of 0 – 23 liters/minute (0 – 6 USG/min). It enables the same installation to be used for a wide range of output rates from ultra-low volume (ULV) to the conventional application at 20 – 50 liters/ha (2 – 5 USG/acre).

3.5 Design of wings

The mission to be performed by the AgroRobot, which is to transport a large payload and having to perform maneuvers typical of conventional agricultural aviation, the design of the AgroRobot wing was optimized with the choice of the RAF 48 airfoil, shown in Figure 11, which has a high lift coefficient and a low drag coefficient for the predicted attack angles.

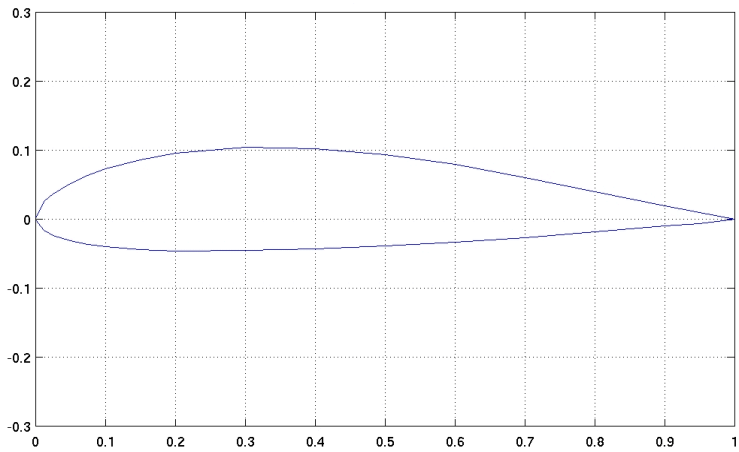

Figure 11. RAF 48 airfoil

Flaps have been designed to increase lift at low speed, thus reconciling a high CLmax for landing and takeoff and low drag for cruising and spraying speed. In addition to evaluating the CLmax of the profile used, we also verified the behavior of the CLxα curve to analyze the flight behavior close to stall speed. Figure 12 shows a graph with the characteristics of the RAF 48 airfoil.

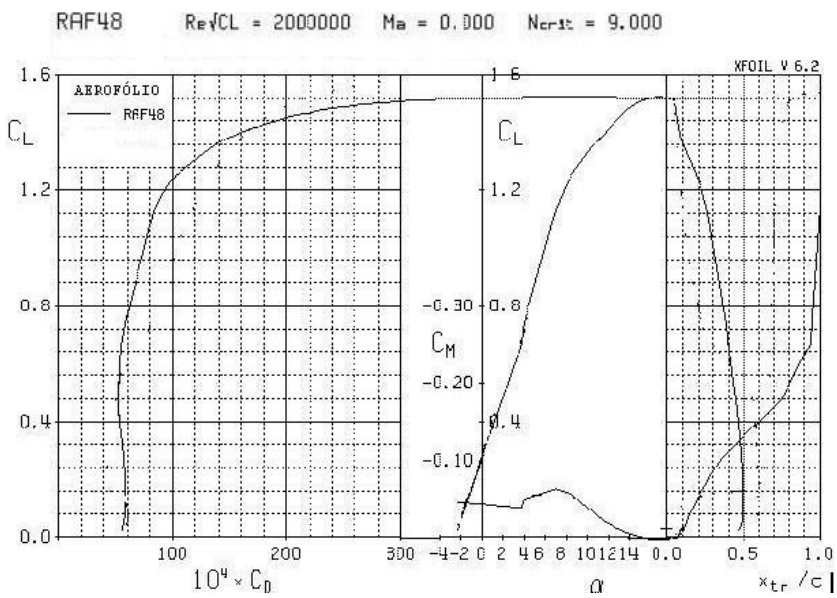

Figure 12. RAF 48 airfoil characteristic curves

3.6 Engine

The AgroRobot propulsion system consists of a Simonini Mini 3 engine (Figure 13), two-stroke, single-cylinder, air-cooled Otto cycle, and a speed reduction system pulleys and V-belts, 24Vdc electricity generator, built-in starter, and rated power of 33 Hp. The graph (Figure 14) shows the power and torque curves provided by the Mini 3 engine.

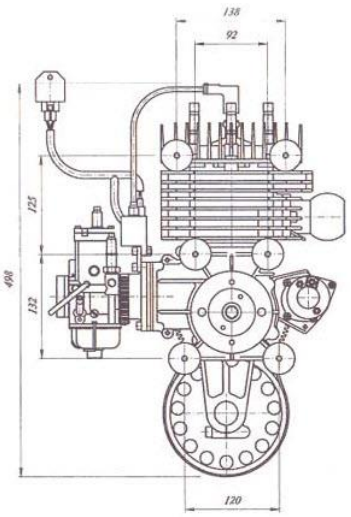

Figure 13. Mini 3 engine by Simonini

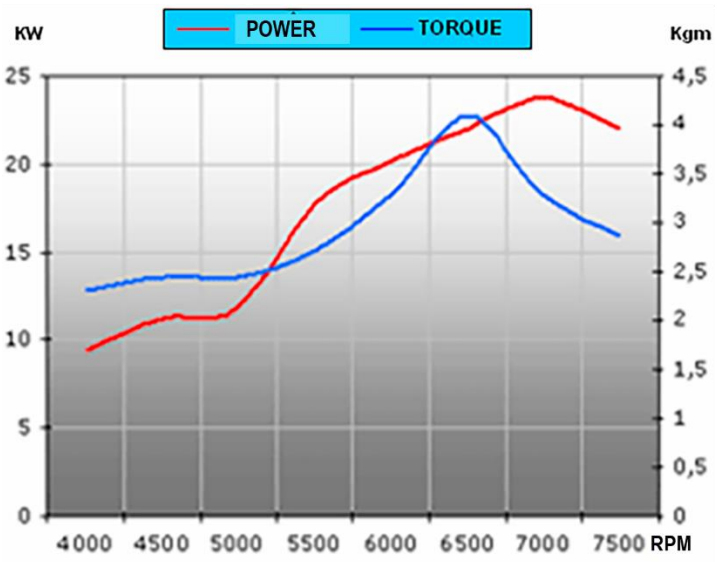

Figure 14. Graphs of power and torque of Mini 3 engines

The airflow drives the atomizer past the aircraft through three highly efficient fan blades. These are adjustable in pitch, enabling the rotational speed to be varied to produce the required droplet size. Each atomizer can handle a flow of 0 – 23 liters/minute (0 – 6 USG/min). It enables the same installation to be used for a wide range of output rates from ultra-low volume (ULV) to the conventional application at 20 – 50 liters/ha (2 – 5 USG/acre).

4. Results and Discussion

4.1 General data

The AgroRobot has an empennage with a double-tailed tail (H-Tail). The powertrain assembly is installed on the front of the fuselage. The shape and size of the fuselage have space to carry a 100 kg hopper tank. The upper part of the fuselage is removable, allowing easy access inside of the aircraft.

The fuel is conditioned on the wings' inside through two tanks' built-in material composed of fiberglass and epoxy resin. The wings are fixed to the fuselage through the central stringer and screws.

The front landing gear is attached directly to the fuselage, in front of the wing stringers junction. The rear landing gear is attached to the fuselage and controlled by a servo motor independent of the servo motors that act on the rudders. The AgroRobot has eight flight control surfaces (two flaps, two ailerons, two elevators, and two rudders).

The propulsion system consists of an air-cooled Simonini Mini 3 two-stroke Otto cycle engine, with a pulley and V-belt speed reduction system, a 24Vdc electricity generator, built-in starter, and rated power of 33 Hp. The propeller is manufactured by the engine manufacturer, Simonini Flying S.R.L, with two blades, wood, and a radius of 65 cm.

The wing was designed using the RAF 48 airfoil, which has a good lift coefficient and a low drag coefficient for the predicted attack angles.

The spraying system consists of a spray tank, a pressurization pump, a turbine (flow meter), an electric

valve, and a control box, which is connected to the DGPS of the Autopilot. The atomizers planned to be installed are AU5000 LD. The technical characteristics and dimensions of the AgroRobot are shown in Table 1.

Table 1. AgroRobot UAV technical features

Description	Extent
Wing span (m)	6.00
Wing surface (m²)	4.20
Length (fuselage, m)	4.05
Height (fuselage. m)	0.94
Weight (body, g)	37,000.00
Payload capacity (g)	100,000.00
Fuel weight (g)	3,600.00
Flight envelope sea level (m/s)	10.00 - 20.00
Cruise altitude (m)	150.00
Cruis speed (m/s)	25.00
Range limits (km)	15.00
Endurance limites (h)	1.00

4.2 AgroRobot UAV platform design

The final design resulting from the development of the AgroRobot is shown in figures 15, 16, and 17 [9].

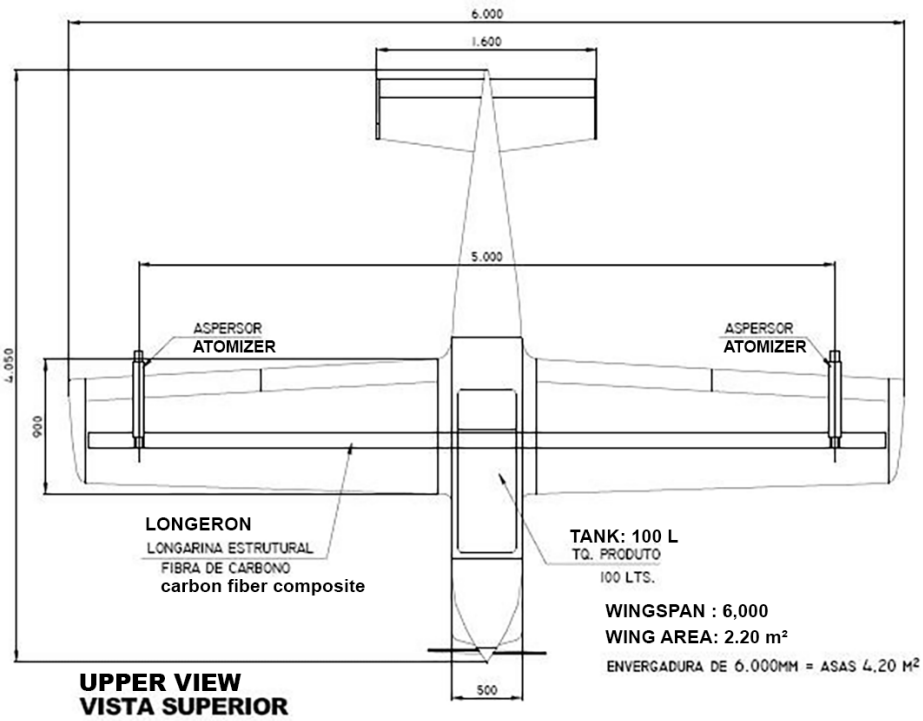

Figure 15. The AgroRobot plan view

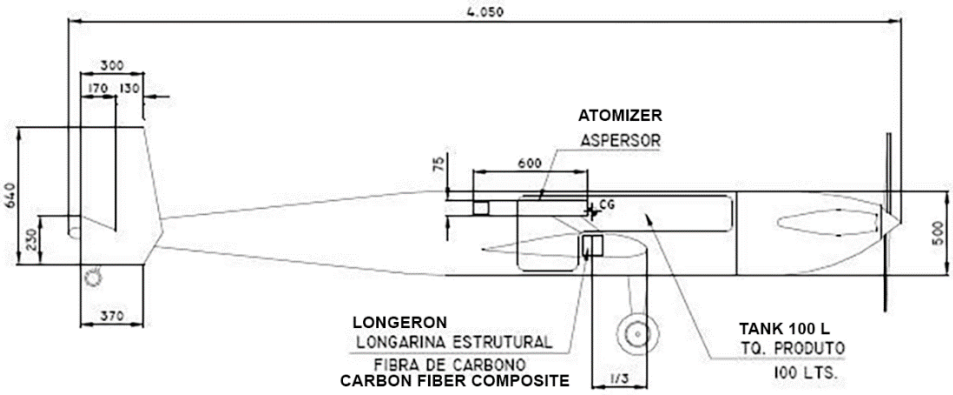

Figure 16. The AgroRobot side view

Figure 17. The AgroRobot 3D view

5. Conclusion

The prototype showed satisfactory results for the situations required in the project, for takeoff and landing. In-flight, the prototype demonstrated excellent performance, doing return curves (180º), with excellent wing inclination, fully coordinated, with directional stability at low-altitude flight, and presented excellent empennage efficiency. The fuselage demonstrates excellent structural rigidity, and the wings resisted the loads due to maneuvers typical of agricultural flight, carrying 100 kg of payload.

It was concluded that the AgroRobot is an autonomous flying platform with a large payload capacity and sufficient maneuverability to carry out agricultural spraying flights.

The wing longeron's structural rigidity made of a composite of carbon fiber and epoxy resin is sufficiently strong and rigid enough to install the rotary atomizers' support without causing rotational and dimensional deformation of the wing.

6. Acknowledgements

The authors would like to thanks FAPESP (Proc. Nº 02/07889-9) for financial support.

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Appendix

Appendix 1.

Brazilian Patent number PI 0404045-7 B1

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Ministério do Desenvolvimento, Indústria e do Comércio Exterior
Instituto Nacional da Propriedade Industrial

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(73) Titular(es): José Roberto Rasi

(72) Inventor(es): Jose Roberto Rasi

Economic-Financial Indicators Applied to the B3 Industrial Machinery and Equipment Sector

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Abstract

In the business context, the Analysis of Financial Statements is an important tool to understand the economic and financial situation of companies, in addition to assessing the results obtained by corporations. This study analyzes the financial statements of companies that manufacture industrial machinery and equipment, using economic and financial indicators to understand the variations that occurred in the sector between the years 2013 to 2018. The segment was chosen because it is included in the Capital Goods, which has a significant influence on the world economy. The study was characterized as a quantitative documentary research using information published by organizations in B3. Among the results, it appears that the sector has high levels of indebtedness, expressing dependence on third party capital to operate. It is also noted that the return of companies fluctuates during the period, characterizing the time of economic instability in the country.

Key words: Analysis of Statements. Economic indicators. Management accounting. B3.

1. INTRODUCTION

In the current conjuncture of Brazil, the industry is responsible for a slice of 22% of the Brazilian GDP and for each R $ 1.00 produced in the secondary sector, R$ 2.40 is generated in the economy as a whole, while agriculture and trade and services generate R$ 1.66 and R$ 1.49 respectively (PORTAL DE INDUSTRIA, 2019).

According to the IBGE in 2018, Transformation Industries advanced 1.3% per year, influenced by the growth in volume of the Added Value of the manufacture of automotive vehicles, paper and cellulose, pharmaceuticals, metallurgy and machinery and equipment.

It is well known that industry plays an important role for the national economy, which is why it is important to monitor and understand the changes undergone by the sector over time.

The analysis of the financial statements is of paramount importance for providing indices and indicators that are extremely important for companies, and for bringing internal and external users to the company's situation, as well as for recognizing the positive and negative points.

To understand the results presented by the industry, the analysis of the balance sheets and income statements of the main companies in the country is one of the tools available to users, since the investigation can clarify the variations incurred in the sector of industrial machines and equipment.
This work will analyze the industrial sector directed to the manufacture of machines and equipment using the companies of the segment which are registered in Brazil Bolsa Balcão[1], namely: Bardella SA Industrias Mecânica, Electro Aço Altona SA, Industrias Romi SA, Inepar SA Industria e Construções, Kepler Weber SA, Metalfrio Solutions S.A.

In order to study the equity situation of the companies, the general, current, dry and immediate liquidity indexes will be compared. General indebtedness indices, level of indebtedness, indebtedness composition index and fixed assets will also be opposed.

To analyze the profit and return of the companies, the economic indicators of return on equity, return on INVESTMENT, operating and net margin will be analyzed.
EBITDA indicators (Earning Before Interests, Taxes, Depreciation and Amortization) will also be compared as a way to assess the valuation of companies.

The definition of the research question took into consideration the identification of the changes undergone by the companies in the sector and will assess quantitatively whether these changes were positive or

negative during the analyzed period. Based on the delimitation of the proposed research theme, the research question for the study is: What changes occurred in the economic and financial indicators in the Industrial Machinery and Equipment sector classified in B3 in the period from 2013 to 2018?

2 THEORETICAL FRAMEWORK

2.1 ACCOUNTING

According to the researched literature, it is reported that only in the 15th century, with the institution of the double-entry method, does accounting start to take shape to become what it is today, say Lacombe and Ribeiro (2013). About Luca Pacioli, responsible for exposing and explaining the double-entry method, Iudícibus (2015) calls him “the father of accounting authors”.

2.2 MANAGEMENT ACCOUNTING

Accounting is divided into two aspects, Financial and Managerial Accounting. Coutinho et al. (2015) conceptualizes Financial Accounting as general accounting, used by all companies and mandatory for tax purposes.

According to Alves (2013, p.3) "Managerial Accounting will be responsible for generating the data for a reading and consequent production of information essential to the management of any company". And its purpose is “To coordinate the optimization of economic performance aiming at the growth of the company's wealth. (CORONADO, 2017, p.25)

In summary, Coronado (2017) presents the list of the main functions attributed to managerial accounting, namely: Managing the management process; Support performance and result evaluation; Manage the economic and financial information systems; Meet market agents (shareholders, government, banks)

2.3 ANALYSIS OF FINANCIAL STATEMENTS

The correct information in the financial statements is essential. For this, it is necessary to carry out a detailed analysis of the main reports structured by accounting.

According to Lins and Filho (2012, p.129) the analysis of the statements is divided into two distinct natures: retrospective and projective. The retrospective provides fundamental feedback on the analysis of the effectiveness of decisions made previously and the efficiency with which they were made. On the other hand, the projective allows to imagine scenarios and expectations related to the future economic and financial performance, indicating probable risks and difficulties to which the company may be subject.

2.3.1 Economic-financial indicators

For Júnior and Begalli (2015, p.313), the use of indicators represents one of the main methods for assessing the economic and financial performance of institutions.

The indicators consist of numbers and percentages extracted from various associations made between the elements distributed in the balance sheet and income statement. (BENEDICTO; PADOVEZE, 2011, p.147)

2.3.1.1 Liquidity Indicators

According to Assaf Neto (2015, p.187), liquidity indicators are used to demonstrate the financial situation of an institution in view of its financial obligations. However Benedicto and Padoveze (2011) explain that liquidity ratios measure the ability of assets and rights to settle liabilities. This study will have the application of four liquidity indices: the General Liquidity Indicator, which makes the direct relationship between current assets and realizable in the long term with the total obligations of the company due in the short and long term (MARION; RIBEIRO, 2017).

The purpose of this indicator is to understand the company's long-term financial health and was chosen because it will be used in order to understand, in general, the net situation of the companies analyzed; Current Liquidity Ratio, which indicates how much the company has current assets for short-term liabilities, that is, current liabilities (NETO, 2015). Express how much of current assets there is for each $ 1.00 of current liabilities. It serves to analyze the short-term liquidity capacity of companies; Dry Liquidity Index, which Ribeiro (2015) defines as the quotient that expresses the company's net capacity to meet its short-term obligations, that is, how much resource the company has in the short term, disregarding inventories in order to settle its Liabilities Current. It serves to analyze the solvency of companies in the short term if they cannot count on the stock to perform the settlement of their obligations; Immediate Liquidity Index, which for Assaf Neto (2015).

2.3.1.2 Indebtedness Indicators

The main objective of these indicators is to identify the participation of important groups in the balance sheet as a percentage and to measure their presence in relation to shareholders' equity. They also show what participation of assets has been financed with equity and third party capital and whether it is dependent on their resources. (BENEDICTO; PADOVEZE, 2011).

For Junior and Begalli (205), the General Indebtedness Indicator, evidences the participation of the capital of third parties present in the Total Assets of the company. The closer to 1, the higher is the percentage of the Capital of Third Parties applied in the Assets.

According to Marion and Ribeiro (2017) the Indebtedness Composition Indicator reveals how much of the organization's short-term liabilities represent of its total liabilities, that is, for each $1.00 of the total liabilities, how much the company owes in the short term. The ratio is inversely proportional, the lower the index, the longer will be the time for the company to obtain resources in order to pay off the obligations in their entirety.

When the Indebtedness Level Indicator is used, the objective is to verify the existing proportion between the Capital of Third Parties and the Equity. (RIBEIRO, 2015).

The Fixed Assets Indicator has the objective of exposing the slice of Equity applied in Fixed Assets, both in its acquisition and in the maintenance of the assets. (LINS; FRANCISCO FILHO, 2012, p.161).
By analyzing this indicator it is possible to verify if the company can maintain its Fixed Assets with its own capital, or if there is a need for external capital to do so. (RIBEIRO, 2015).

The Equity Fixed Asset Indicator, aims to expose the share of Equity invested in Fixed Assets, both in their acquisition and in the maintenance of the assets. (LINS; FRANCISCO FILHO, 2012, p.161).
Analyzing this indicator, it is possible to verify if the company is able to maintain its Fixed Assets with its own capital, or if there is a need for external capital for this.

- Profitability and Profitability Indicators

Profitability Indicators help to measure the economic capacity of the organization, showing the final result obtained by the capital invested in the company. (RIBEIRO, 2015, p.171)
According to Iudícibus (2017) the use of the Profitability Indexes is justified because it could not express the Return in absolute values since they present a limited informative utility, since comparing values of companies of different sizes will not show which one was more efficient in the search for results .

Return on Equity: Martins, Diniz and Miranda (2017, p.206) consider the most important profitability indicator precisely because it demonstrates the company's ability to remunerate the capital invested by the partners, since the company that manages to remunerate its associates according to their expectations, fulfilled its obligation with investors who believed in the potential

Rate of Return on Investment: Francisco Filho and Lins (2012) attribute to this indicator the function of demonstrating the ability to generate profits for each $ 1 invested, that is, relating the Result to the Total Assets and the greater the result, the greater the return obtained by the investment of the company.

Operating margin: it is a profitability indicator used to indicate the share of Operating Profit in Net Revenue. In other words, it demonstrates, after the appropriation of operating expenses, how much Operating Income represents from net sales. (PEREZ JÚNIOR; BEGALLI, 2015, p.327)

Net Margin:quotient similar to the Operating Margin, however the relationship analyzed is the share of Net Profit in Net Sales. Indicates the percentage of net income obtained in the year. (RIBEIRO, 2015, p.172)

EBITDA: (Earnings Before Interest, Taxes, Depreciation and Amortization), which means Earnings Before Interest, Rates, Depreciation and Amortization, has achieved a lot of prominence in recent years, so much so that Martins, Diniz and Miranda (2017) define it as " a God in the world of evaluations ". Benedicto and Padoveze (2011, p.246) define the concept of capacity to generate Gross Operating Profit by adding to operating profit expenses with Depreciation Amortization.

3. METHODOLOGY

With regard to technical procedures, the study will use bibliographic and documentary research seeking to expand knowledge about the topic, clarify concepts in relation to the research problem and obtain a database for the preparation of the study. Documentary research based on Brasil Bolsa Balcão will be used in order to obtain the data to be analyzed.

The data collection procedure will take place through documents published on the website of Bolsa Brasil Balcão, where are the companies that trade their shares on the Brazilian stock market. Specifically, these are the Balance Sheets and the Statements of Income for the Year, which constitute the consolidated financial statements of the companies object of the study during the periods from 2013 to 2018.
The companies chosen for the study are listed in the Industrial Goods sector, Machinery and Equipment sub-sector and Industrial Machinery and Equipment segment, which represent 75% of the total population.

4.1 CONTEXTUALIZATION OF COMPANIES

It is important to note that all the information in this topic was extracted from the email address of each of the organizations, that is, the entire text was written by the companies themselves.

Bardella Mechanical Industries SA: The company established and consolidated its position as a leader in the supply of equipment to the Metallurgy, Energy, Oil, Gas, Material Handling, Service, Drawn Steel and Rolled Steel sectors, with its own technology or supported by technology agreements with foreign companies world-renowned.

Electro Aco Altona SA: Paul Werner was a German engineer full of ideas who did not hesitate at the invitation to install the first telephone exchange in Blumenau. Thus, in 1923 he left Germany for the then small city in southern Brazil. In Blumenau, he met Ersnt Auerbach, a blacksmith located in Bairro Altona (now Itoupava Seca). From entrepreneurship and the desire to develop solutions, Auerbach & Werner emerged on March 8, 1924.

Starting from household and agricultural utensils, the company grew, incorporating steel in 1933 under the name Electro Aço Altona SA, becoming the symbol of pioneering spirit and the courage to innovate.

Indústries Romi SA: Institutional. It started its activities in 1930 with a car repair shop founded by Américo Emílio Romi, in Santa Bárbara d'Oeste - SP - Brazil. Today, it is an internationally renowned company, whose products and services are consumed in the national market and exported to all continents.

Inepar Industry and Construction SA: IESA / INEPAR has been operating for more than 60 years in the development of Brazil's industry and infrastructure, with emphasis on energy, oil and gas, process equipment, material handling, reactive compensation and mass transportation. In Brazil, IESA / INEPAR manufactured turbines and generators that account for more than ¼ of the energy generated daily; operated

in 100% of Petrobras' 15 refineries and participated in the construction of 7 oil exploration platforms; delivered approximately 3,000 overhead cranes to a variety of industries at home and abroad; produced the largest ore handling machines in operation; produced more than 30% of reactive compensation in large transfers of power generation to transmission lines; developed most of the high and extra high voltage transmission lines; performed repair, maintenance, supply and manufacture in more than 200 locomotives; is on telecommunications was a pioneer in cable television, CDMA cell phones and wireless.

Kepler Weber SA: With factories in Rio Grande do Sul and Mato Grosso do Sul, Kepler Weber operates in the agribusiness sector, in the post-harvest stage of the grain production chain. The Brazilian company manufactures equipment for the storage, processing and handling of bulk materials, specializing in the development of complete storage solutions for its customers. Our product portfolio consists of metal silos, horizontal and vertical conveyors, dryers and grain cleaning machines.

Metalfrio Solutions SA: The history of Metalfrio is intertwined with the very emergence and development of the commercial refrigeration industry in Brazil. The company was created in 1960 to produce refrigeration system components, but soon changed its focus to meet the specific demand of beverage and ice cream manufacturers, who until then had each manufactured their own equipment.

The company is a market leader in Latin America. Through direct selling or through its distributors and sales representatives, located in 74 countries on five continents, Metalfrio supplies its products to customers who are among the largest global manufacturers of beverages and foods.

To facilitate viewing and reading the results, organizations will be identified by the following legend:

Table 1 - Legend of Representation of Companies

COMPANY	SUBTITLE
Bardella Mechanical Industries SA	THE
Electro Aco Altona SA	B
Indústries Romi SA	Ç
Inepar Industry and Construction SA	D
Kepler Weber SA	AND
Metalfrio Solutions SA	F

3. ANALYSIS OF RESULTS

3.1 LIQUIDITY INDICATORS

Below, the results obtained by calculating the net worth of the companies studied will be presented in order to understand the ability to honor their debts, according to the concept presented.

Figure 1 - Results of Liquidity Indicators

BARDELLA SA (A)

	LG	LC	LS	LI
2013	0.91	1.01	0.68	0.05
2014	0.89	1.20	0.87	0.11
2015	0.85	1.02	0.73	0.01
2016	0.62	0.91	0.61	0.01
2017	0.49	0.95	0.54	0.02
2018	0.44	0.78	0.47	0.01

ELECTRO ACO ALTONA SA (B)

	LG	LC	LS	LI
2013	0.48	1.81	1.35	0.17
2014	0.48	1.74	1.14	0.30
2015	0.52	2.15	1.47	0.29
2016	0.47	1.70	1.02	0.12
2017	0.62	0.97	0.57	0.01
2018	0.66	0.97	0.60	0.29

INDUSTRIAS ROMI SA (C)

	LG	LC	LS	LI
2013	1.40	1.90	1.24	0.26
2014	1.46	2.06	1.31	0.41
2015	1.59	2.84	1.76	0.58
2016	1.60	2.14	1.23	0.42
2017	1.73	2.11	1.25	0.43
2018	1.67	1.92	1.09	0.28

INEPAR SA (D)

	LG	LC	LS	LI
2013	0.46	0.51	0.34	0.02
2014	0.28	0.22	0.09	0.00
2015	0.46	0.40	0.25	0.00
2016	0.31	0.29	0.17	0.00
2017	0.26	0.24	0.15	0.00
2018	0.17	0.13	0.12	0.00

KEPLER WEBER SA (E)

	LG	LC	LS	LI
2013	1.40	1.79	0.91	0.06
2014	1.66	1.72	1.06	0.05
2015	1.21	1.63	1.13	0.04
2016	1.60	1.52	1.20	0.10
2017	1.54	1.34	1.00	0.06
2018	1.66	1.55	1.01	0.03

METAL FRIO SOLUTIONS SA (F)

	LG	LC	LS	LI
2013	0.92	1.27	0.99	0.37
2014	0.84	1.16	0.88	0.38
2015	0.73	0.92	0.72	0.35
2016	0.79	1.36	1.10	0.34
2017	0.79	1.03	0.79	0.35
2018	0.80	1.09	0.85	0.20

3.1.1 General Liquidity (LG)

> "This indicator reveals liquidity, both in the short and long term. Of every $ 1 that the company holds in debt, how much rights and assets are in current assets and long-term assets ". (ASSAF NETO, 2015, p.188)

Analyzing the indicator throughout the period, it can be seen that companies A, B, D and F never obtained an index higher than 1, with company D having, in 2018, only 0.17 being the lowest overall liquidity index of the companies analyzed. On the other hand, companies C and E have always been above 1, where

company C reached the highest indicator among all companies, presenting 1.73 in 2017.

It can be noted how much companies C and E have higher indexes than the others in the analyzed period, with company C concluding the period with a positive variation of 19% and company E with a variation of 18.5%. Between 2013 and 2018 company A showed a relatively large drop of approximately 52%. In contrast, company B increased its General Liquidity by 38%. Company D presented the biggest negative variation, ending the period with an indicator 64% lower than that calculated in 2013. Finally, company F showed a 14% decrease in LG over the period.

Analyzing the data, it is also possible to state that 50% of the companies (B, C and E) ended the period studied, 2018, with greater general liquidity than when they started in 2013. With the other half (A, D and F) occurred the opposite situation, ended with a lower index than they started.

3.1.2 Current Liquidity (LC) and Dry Liquidity (LS)

Following the results obtained in the LG index, company C is the one with the best levels of LC and LS, keeping the LC greater than 2 in practically the entire period and the LS has remained above 1 in all years, highlighting that this fact was not repeated by any other company.

When it comes to LC, all companies at some point reach an index greater than 1 except company D, which does not exceed 0.51. By changing the focus to LS, company A, like D, is unable to reach an indicator greater than 1.

Company E maintained a positive prominence in the results achieved because, in addition to maintaining an LC index always greater than 1, only in 2013 did it record LS less than 1. Company B achieved similar results in relation to LS, where it maintained rates above 1 for much of the period, but scored 0.57 and 0.60 in 2017 and 2018.

After calculating the average LC and LS in the period, the following numbers were obtained:

Table 2 - LC and LS indicators

Companies	LC	LS
THE	0.98	0.65
B	1.56	1.02
Ç	2.16	1.31
D	0.30	0.19
AND	1.59	1.05
F	1.14	0.89

It is noticed that, again, the negative highlight was the responsibility of company D, which obtained results far below the others. In addition to companies C and E, which had already presented high numbers of LG, it is possible to highlight company B with high levels of LC and LS for the analyzed range in comparison to the others.

3.1.3 Immediate Liquidity (LI)

As Immediate Liquidity considers only cash and cash equivalents, usually cash, bank and short-term financial investments, this indicator reveals the percentage of short-term debt that can be settled immediately.

When analyzing the results, what draws attention is the fact that all companies present LI well below 1. This finding is explained by Assaf Neto (2015, p.187) when he comments on the companies' lack of interest in maintaining monetary resources excess cash, as this asset has low profitability.

Although all companies have a low LI index justified by Assaf Neto's argument, it is still possible to observe two extremes in the organizations studied. Company C continues to have the highest liquidity ratios while company D has extremely low values, where the highest value is only 0.02. The arithmetic mean was determined, which are as follows: A: 0.03 | B: 0.20 | C: 0.40 | D: 0.01 | E: 0.06 | F: 0.33[2],

Thus, it is possible to visualize the difference between companies, where C and F presented the best results while A and D the worst, it should be noted that organizations do not have the practice of using nominal values in cash.

3.2 CAPITAL STRUCTURE INDICATORS

Junior and Begalli (2015) mention that they are indicators that demonstrate the participation of the capital of third parties in the company, it allows to identify that the greater the participation of capital of third parties in the company, the greater the indebtedness.

3.2.1 Indebtedness Level (NE)

Assaf Neto (2015), recommends that this indicator demonstrates how much the company sought third-party resources compared to equity capital.

Regarding the interpretation of this indicator to state whether the level is good or bad, Junior and Begalli (2015) emphasize that this statement depends directly on the cost of obtaining the resources and also on the return achieved in their applications.

It should be noted that company D has an Overdraft Liability, that is, the total liabilities to third parties is greater than the total assets (negative equity), to obtain the real results the formula had to be adapted by adding once the value of the PL in the calculation. As the Third Party Capital is greater than the total assets, consequently the level of indebtedness is quite high, reaching numbers such as 10.93 in 2013 and 8.54 in 2015.

Another company that stands out when analyzing the results is company F, which starts the period with 3.51, reaches 31.22 in 2015 and ends 2018 with 14.88. As previously mentioned, the merit of this analysis

of the Level of Indebtedness is not qualitative, but it can be said that, compared to the other companies, company F presented a high index.

The other companies remained constant during the period without showing significant increases or decreases. Company E showed results less than 1 in all years, this is similar to company C, which only in 2013 and 2014 obtained results greater than 1. In 2018, the index of company A diverged in relation to the other years.

3.2.2 Debt Breakdown (CE)

> "This quotient reveals the ratio between short-term and total obligations, that is, how much the company will have to pay in the short term for each real of the total of existing obligations ". (MARION; RIBEIRO, 2017)

Thus, this indicator shows the share of short-term liabilities in the composition of total liabilities. Results will be between 0 and 1.

In this regard, most companies concentrate their fundraising in the short term. Contact is made more clearly when looking at the averages for this indicator, given that the index is greater than 0.50 for five of the six companies.

A: 0.63 | B: 0.37 | C: 0.58 | D: 0.66 | E: 0.72 | F: 0.67

In general, the only company that has short-term resources to a lesser extent than long-term resources is company B, achieving an interesting result if based on Marion's thinking, in such a way that, in case of financial difficulties, the company has more time to settle your commitments. All other companies experience a percentage of Short Term Liabilities greater than 50%.

3.2.3 *General Indebtedness (EG)*

This indicator makes it possible to observe the predominant source of funds invested, whether third party capital or own capital. The higher the value of this index, the greater the company's dependence on third party capital.

There are two distinct movements on the part of organizations: the group of companies formed by A, D and F increase their level of EG over the period, making the Third Party Capital have a large participation in Total Assets. On the other hand, companies B, C and E have a negative variation, that is, they decrease the index making the participation of Equity predominate in the composition of Total Assets.

3.2.4 Fixed assets (IPL)

> "This indicator shows how much the company invested in fixed assets in relation to shareholders' equity. In other words, how much of its own resources was allocated to maintaining and / or expanding the company's productive capacity ". (LINS; FILHO, 2012).

When comparing this concept with the results obtained, it is possible to state that companies A, C and E maintain their Fixed and Intangible assets with their own resources throughout the period. In turn, companies B, D and F have high levels of Third Party Capital in the composition of Fixed / Intangible. The highest index registered is under the responsibility of company F, where in 2015 it registered an IPL of 9.50. It means that the company used, in addition to all its own capital, an additional 8.50 times (9.50 - 1 = 8.50 x 100 = 850%) Third Party Capital to maintain and / or expand the company's productive capacity.
It appears that, of the six companies analyzed, four of them show a decrease in the level of fixed assets. Given this fact, it is possible to assume that there is an interest in reducing the index by companies.

3.2.5 Profitability and Profitability Indicators

For Lins and Filho (2012), "These indicators seek to demonstrate, in general, the return of the company in the period analyzed in order to enable the assessment of the efficiency of operational activities".

3.2.6 *Return on Equity (RPL)*

> "It indicates the return on the capital invested by the shareholders, shareholders and owners". (JÚNIOR; BEGALLI, 2015, p.325)

Regarding their interpretation, Júnior and Begalli (2015) also comment that this indicator represents the return on each $ 1.00 invested in equity and that measuring whether the result is good or bad depends on the investor's expectation and the general result of the sector.

When observing the results obtained by the companies, it appears that the companies present both positive and negative results with the exception of company D, which presents only negative RPL during the entire period. It is noteworthy that the negative results are repeated more than the positive ones.

The lower result of company F in 2015 is due to the loss earned in the period, which was very high when compared to the other years combined with the reduction of the PL in the same year.

3.2.7 *Rate of Return on Investment (TRI or ROI)*

For Marion, Ribeiro (2014), considers it the most relevant quotient for management, as it is an instrument used by organizations to identify their performance.
Ribeiro (2015) comments that this indicator shows the capacity to generate net profit for each $ 1.00 invested.

Company A, presented only a positive result in 2014, where it reached 1% profitability on assets. On the other hand, in companies B and C, positive results dominated over the years, with negative returns only in 2016, where they obtained -1% and -4%.

Company D, repeating the results of the RPL, presented only negative numbers, having 2016 as its worst year, failing to generate a return of 32% of its investment. The companies E and F showed different situations between themselves, where company E, in general, had a higher ROI with 2014 as its best year,

16%, and company F showed in its best year, 2016, a return of only 3% of your assets.

3.2.8 *Operating Margin (MO)*

According to Júnior and Begalli (2015), this index demonstrates the representativeness of Operational Profit in relation to the Net Revenue generated by the company.

Company A presented negative MO in all years except in 2014, where Operating Profit was 1% of Net Revenue. Company B obtained a positive result in 2017, reaching 25%. Company C had the best index in 2018, when it showed 11% OM.

Analyzing company D, it continues with negative results as in all years, being the worst result of Operating Margin 2016, where it obtains negative MO in 874%. An extremely bad result due to the drop in Net Revenue and a significant increase in Operating Loss.

Looking at the results of company E, it is noted that 2014 was the year in which there was the highest OM, reaching 15%. The lowest result occurred in 2016, with -8%. When analyzing the OM of company F, a fact diverges from what has already been observed: all companies have negative value in 2016, except company F, as it manages to reach its highest Operating Margin this year, obtaining 4%.

3.2.9 *Net Margin (ML)*

> "The quotient reveals the profitability margin obtained by the company due to its sales, that is, how much the company obtained from Net Profit for each $ 1 sold". (RIBEIRO, 2015, p. 172).

When analyzing the results of company A, it is noted that ML was low for the entire period, with a negative emphasis on the result of 2018 when it reaches a Net Loss of 102% of Net Revenue. Its best year was 2014 when Profit is 2% of Revenue.

Companies B and C get better results in percentage terms for ML, where B reaches 18% in 2017 and C at 11% in 2018, repeating the result of MO. The worst year for both companies was 2016, when they presented the only negative value for this indicator: -1% for B and -7% for C.

Company D, which has already shown negative results for all previous profitability indicators, again presented values below zero. The highest resulting number was -0.38 (loss of 38% of Net Revenue) in 2013 and the lowest was -9.05 in 2016.

When checking the results of company E, it is found that its best ML index was in 2014, when the organization demonstrates a 15% Profit on Revenue. The worst mark was in 2017 presenting -6%. When the focus is on the results of company F, the highest value was found in 2016 with 3% and the lowest was in 2015 with -10%.

3.2.10 *EBITDA - Profit before Interest, Taxes, Depreciation and Amortization*

It is observed in the results of company A that its performance was negative in four of the six years analyzed, which reached positive values only in 2014 with 0.07 and 2015 with 0.08. Company B, on the other hand, presented positive EBITDA in the entire period, obtaining its best result in 2017, reaching 0.34.
When portraying the results of company C, it is noted that the company generated positive results after five of the six years analyzed, excluding only the year 2016 when the company culminated in the result of -0.02. Exposing the results of company D, it is verified again only the presence of negative indicators, confirming the poor financial and economic health of the organization.

Finally, EF companies present results consistent with the other analyzed indicators. As for company E, positive results occur in most of the temporal sample, reaching two negative peaks followed in 2016 and 2017 when registering -0.05 and -0.02. The values presented by company F point to an increasing variation composed only of positive records, since it starts the study in 2013 with 0.03 and ends 2018 with 0.10.

4. FINAL CONSIDERATIONS

Economic-financial indicators are one of the main tools for assessing certain aspects of companies' performance (PEREZ JÚNIOR; BEGALLI, 2015). Through the use of indicators, the development of the study presented made it possible to verify the changes incurred in the economic and financial indicators in the sector of Industrial Machinery and Equipment classified in B3 in the period from 2013 to 2018.

With these numbers, it means that companies with the best results in the segment are able to commit a low percentage of their own capital to third party capital and raise little external capital to finance their operations. Another interesting point is to highlight that companies are able to keep their fixed assets with equity.

Regarding the return and profit performance, the sector - in general - does not present expressive results. The period starts with reasonable profitability, going through a decrease between 2015 and 2016. In 2013 no company achieved prominence in ROI, however 2014 was characterized as the best year for the companies Bardella SA (A) and Kepler Weber SA (E). Corporations reached 1% and 16% respectively for the indicator in the year.

Of the six companies studied, three had their worst numbers in 2016, being Electro Aço Altona SA (B) with -1%, Indústrias Romi SA (C) comprising -4% and Inepar SA (D) reaching -32% . Only Metal Frio Solutions SA (F) achieved its best result in 2016, showing 3%, thus establishing a recovery after going through its worst year.

At the end of the analysis, the year of 2018 promoted a positive highlight only for Indústrias Romi SA (C), which showed an index of 7%.

From the figures presented, it is noted that the sector's performance was not regular during the period and the companies achieved different results over the years. The return on capital invested in the sector took place in a distributed way, so it is not clear which was the best year for the segment.

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A Trajectory Simulation Approach for Autonomous Vehicles Path Planning using Deep Reinforcement Learning

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Abstract

Autonomous vehicle path planning aims to allow safe and rapid movement in an environment without human interference. Recently, Reinforcement Learning methods have been used to solve this problem and have achieved satisfactory results. This work presents the use of Deep Reinforcement Learning for the task of path planning for autonomous vehicles through trajectory simulation, to define routes that offer greater safety (without collisions) and less distance for the displacement between two points. A method for creating simulation environments was developed to analyze the performance of the proposed models in different difficult degrees of circumstances. The decision-making strategy implemented was based on the use of Artificial Neural Networks of the Multilayer Perceptron type with parameters and hyperparameters determined from a grid search. The models were evaluated for their reward charts resulting from their learning process. Such evaluation occurred in two phases: isolated evaluation, in which the models were inserted into the environment without prior knowledge; and incremental evaluation, in which models were inserted in unknown environments with previous intelligence accumulated in other conditions. The results obtained are competitive with state-of-the-art works and highlight the adaptive characteristic of the models presented, which, when inserted with prior knowledge in environments, can reduce the convergence time by up to 89.47% when compared to related works.

Keywords: Autonomous Vehicles; Deep Reinforcement Learning; Path Planning; Trajectory Simulation.

1. Introduction

The evolution of mobile robotics ensures the creation of technology for automating everyday tasks [1], from robots for domestic use, as presented in [2], often based on reactive control [3], to autonomous land vehicles [4], air vehicles [5] or water vehicles [6] and self-guided vehicles in Industry 4.0 [7], based on advanced control and automation techniques or artificial intelligence. The fundamental task performed by an autonomous vehicle, regardless of the environment in which it operates, is the ability to move around [8], whether in a controlled or an uncontrolled environment. An autonomous vehicle must be able to receive data from the environment, process it for decision-making, and take action through actuator devices.

According to [9], the main challenges offered regarding the development of autonomous vehicles are: Path Planning and Collision Avoidance. Path Planning is the system's ability to decide a good route to be taken by the vehicle [4]. The quality of the chosen path can be assessed through metrics such as: travel time; path distance; and the number of collisions [10]. Collision Avoidance [11] refers to the necessity for the determined route to be free of collisions with possible obstacles. Furthermore, being essentially important in this context, as it represents the safety of a path, Collision Avoidance is directly related to Path Planning, so there is a demand for a system able to find a satisfying route in terms of safety and distance [12].

Figure 1 shows a high-level architecture for an autonomous vehicle, in which its main modules are observed. Sensing & Mapping and Acting are interface modules with the environment. Sensing & Mapping is the autonomous vehicle module that receives inputs from the environment, usually through sensor networks [13], aiming to process them to be understood, by the vehicle, of the environment in which it operates, in other words, to perform mapping and auto localization concerning the environment. For this processing, the Simultaneous Localization and Mapping (SLAM) technique [14] is shown to be robust in several situations using different forms of interaction with the environment. In [6], for example, SLAM is applied to an autonomous underwater vehicle that senses the environment from sonar signals, whilst in [15] SLAM is implemented using signals and video camera images.

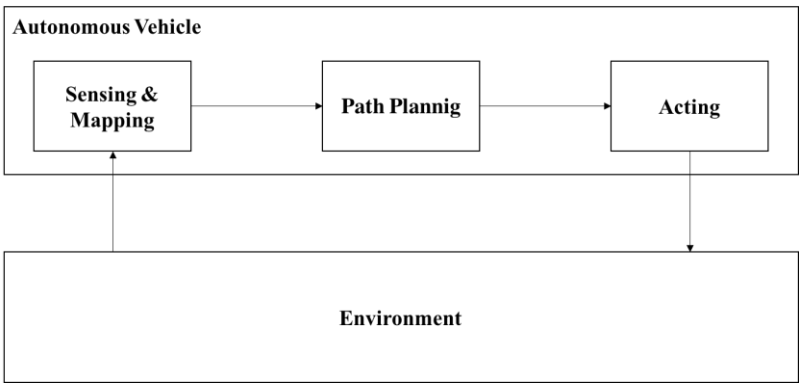

Figure 1: A High-level architecture of an Autonomous Vehicle System.

Nevertheless, the Acting module is responsible for applying to the environment the actions decided by the autonomous vehicle, such as traction and rotation of the engine and emergency stop, for example, through

peripherals called Actuators. In this segment, many works present applications of techniques based on the Theory of Classical and Modern Control [16], as in [17], which presents a system of variation of buoyancy based on the Proportional Integral Derivative controller (PID) applied to robotics autonomous navy, and in [18], which presents a PID controller for electric vehicle traction motors. In various recent works, these controllers are equipped with artificial intelligence, as in [19], [20] and [5], in which the authors use, respectively, artificial neural networks with online training, genetic algorithms and Fuzzy inference to optimize the parameters of PID controllers, which add an adaptive feature to the controller, in which the parameters are adjusted in real-time, thus increasing the robustness of the control system for possible disturbances in the input variables.

The Path Planning module may be compared to an autonomous vehicle data processing center. It is the module responsible for planning and (re) defining, in real-time, a route to be determined by the vehicle, from the mapping data, and transmitting this information to the Acting module. For this activity, artificial intelligence techniques, especially reinforcement learning, have been applied, as is the case in [21], in which models based on two Deep Reinforcement Learning techniques are presented called Deep Deterministic Policy Gradient (DDPG) and Multiple Experience Pools DDPG (MEP-DDPG) for planning autonomous movement of aerial unmanned vehicles (AUVs). Likewise [22] presents the application of DDPG for planning land vehicle routes.

Therefore, a Path Planning method for autonomous vehicles based on Trajectory Simulation using Deep Reinforcement Learning is proposed. Given a mapped environment, Artificial Neural Networks will be used to define the quality of the actions to be taken by an autonomous vehicle. This decision-making process will be based on rewards obtained from simulations of trajectories carried out in the environment, it means that the model becomes capable of evaluating actions based on experience acquired by simulations in the environment. As the intelligent model and the implementation pipeline of the artificial intelligence system is based on reinforcement learning, the idea is that simulations are accomplished until the model finds the route that offers the best rewards, which represent, for the model, safety and cost conditions until reaching the predetermined objective, thus performing Collision Avoidance and Path Planning, respectively.

Section 1 presented the Introduction to the theme, the concepts and the problem addressed by this work, as well as a contextualization concerning the related works observed in the literature. Section 2 presents the materials and methods employed for the development, in which it describes, minutely, the machine learning approach used as well as the components created to conduct the experiments and presents the methods of choosing the architecture of the smart models tested and evaluation of the results obtained. Section 3 presents and analyzes the results obtained regarding the proposed method and compares the performance of the system to related research. Lastly, in Section 4, final considerations and perspectives for future work are presented.

2. Materials and Methods

This section describes the materials and methods used for the development and analysis of the experiments conducted. The subsections contain: (2.1) Description of Machine Learning Approach, which indicates an

overview of how machine learning was applied in this work; (2.2) Reinforcement Learning Components, which presents in details all the components that integrate the reinforcement learning system; (2.3) Neural Network Architecture, which exposes the methodology of defining the neural network architecture used; and, eventually, (2.3) Model Evaluation, which informs how the performance evaluation of the models proceeds for the task in question.

2.1 Description of Machine Learning Approach

This work presents Reinforcement Learning (RL) [23] with the task of simulating trajectory for autonomous vehicles, with the purpose of planning routes in previously mapped environments. The experiments were conducted in a computer-simulated environment. Figure 2 presents the architecture of a RL system where the system components interaction can be conceived.

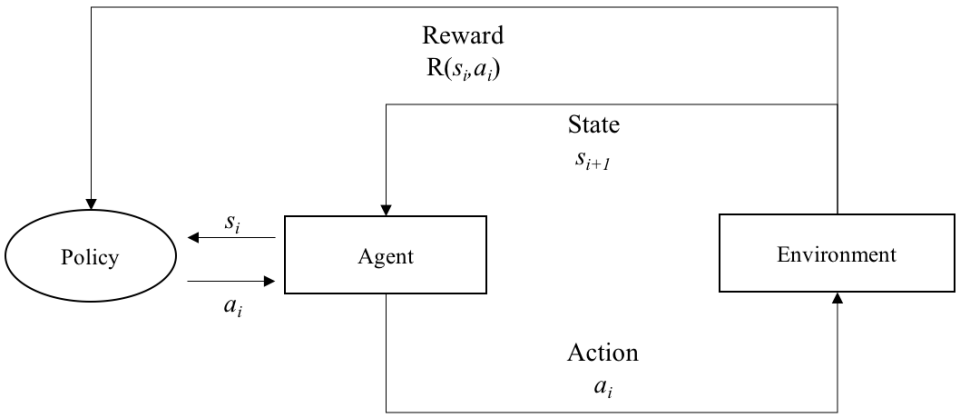

Figure 2: Reinforcement Learning System architecture.

The interaction dynamics of the components of a RL system, as illustrated by Figure 2, consists of: an Agent (actor of the system) that from a state s_i (situation proposed by the environment), chooses an Action a_i (an activity that the Agent can perform to interact with the Environment) based on a Policy (decision-making strategy) and, according to this interaction with the environment, the Agent assumes a new State s_{i+1} and the policy is updated by a Reward $R(s_i, a_i)$ received by the action taken from the previous state, which can be positive or negative (also called Penalty). Therefore, an epoch of reinforcement learning ends. Thereafter the new state s_{i+1} becomes the current state s_i and the process is repeated until learning is reached.

In the context of this work, the Agent is represented by an autonomous vehicle, which has a constant velocity and its possible actions are associated with the direction of the route. The simulation environment created computationally presents arbitrary obstacles and a determined point of origin and destination. Whether a contact of the agent with the environment obstacles occurs, it signifies the agent achieves an obstacle state, thereby receiving a negative reward, as well as when happens excessive steps before the destination. Hence, the agent's purpose is to establish a trajectory between the points of origin and destination with the greatest possible reward, promptly and without collisions. The decision policy is based on the Deep Q-Learning approach [24], which considers the classic Q-Learning algorithm [25] in which, from the Q function:

$$Q(s,a) = R(s,a) + \gamma \cdot (\delta(a,s,s') \cdot max_{a'}(Q(s',a'))) \quad (1)$$

originated from the general equation from Bellman [26], a table of qualities is created that relates the agent's actions to the states to be achieved through the defined actions by a Markov Decision Process [27]. Concerning the function, it assumes: s the current state; a the executed action to reach the state s; R the rewards function; γ discount factor; and δ the state transition function (which defines the probability of reaching the state s', once it was in s and a was executed, having $P(s'|(s,a))$. In other words, the Q equation may represent, mathematically, Figure 2. Deep Q-Learning, otherwise, approximates the quality values for each action from Artificial Neural Networks [28] (ANN), thus it creates an intelligent model capable of deciding the actions to be taken by the agent in the environment.

2.2 Reinforcement Learning Components

The components of the Reinforcement Learning System presented in this work will be fully detailed in the following topics, divided respectively into: Environment and States; Agents and Actions; Rewards; and Policy and Exploitation / Exploration.

2.2.1 Environment and States

The work was performed in a graphical environment developed in Python version 3.7.4 through the Kivy framework, in its version 1.11.1, which uses OpenGL version 4.5 resources as a back-end. An environment may be abstracted as a 600x800 dimension matrix, so 600 rows and 800 columns. Every position in this matrix represents a state, which may be achieved by the agent.

A state may contain an obstacle or not. Considering the idea is to simulate a real environment, which does not have a specific pattern of obstacle disposition, it is settled to randomly generate obstacles following some rules of degrees of difficulty, as it appears in [21]. Therefore, the RL model will be prepared and assessed in environments with degrees of difficulty: Easy; Medium; Difficult. These difficulties were established in relation to the number of obstacles and their respective sizes, whilst their position was established utterly casually. Toward this purpose, the lower and upper limits of quantity and size of obstacles were empirically set, which assisted as references for random generation. Table 1 presents these intervals.

Table 1: Intervals of values of quantity and size of obstacles for each degree of difficulty.

Difficulty Level	Number of Obstacles		Size of Obstacles	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Easy	10	20	10	60
Medium	20	30	20	80
Hard	30	40	30	100

Thus, from these intervals, the generation of obstacles is arranged:

1. The difficulty level of the environment is defined;
2. A random value $n \in [n_i, n_s]$ is generated, with n_i, n_s, respectively, the lower and upper limit of the number of obstacles according to the degree of difficulty. This process will determine the number of obstacles in the environment;
3. Repeat steps 4 and 5 n times;
4. A random value $s \in [s_i, s_s]$ is generated, being s_i, s_s, respectively, lower and upper limit of the number of obstacles according to the degree of difficulty. This process determines one of the n obstacles that will be created;
5. An obstacle is created from a point of origin $p_o = (x_o, y_o)$ to an end point $p_f = (x_f, y_f)$, in that x_o, y_o and x_f, y_f are randomly defined, with $x_o, x_f \in [0,800]$, $y_o, y_f \in [0,600]$, and $(x_f - x_o)^2 + (y_f - y_o)^2 = s^2$, it means, p_f distances s from p_o.

Also, the regions of origin and destination of the agent were defined, being located in the upper and lower central part of the environment. As the proposed task is to obtain a trajectory, and not to find a final state, as is the case with most RL systems, it was decided to alternate the regions of origin and destination, in other words, when the agent assumes a state in the region of destination, this becomes the region of origin and the region of origin becomes the new region of destination, so the agent travels several routes between the two regions until it discovers the one that offers the greatest possible reward.

2.2.2 Agents and Actions

The agent simulates a vehicle that can move around in the environment. It has constant velocity and degrees of freedom regarding possible directions, choosing to go forward or perform a 45° inclination both to the right and to the left. These operations define the set of actions that the Agent may take, denoted by $A = \{0^o, 45^o, -45^o\}$.

Figure 3 exemplifies some states that the agent may be in, the possible actions to take and the resulting states from each action. The colored circles simulate sensors that identify possible states to reach for each action.

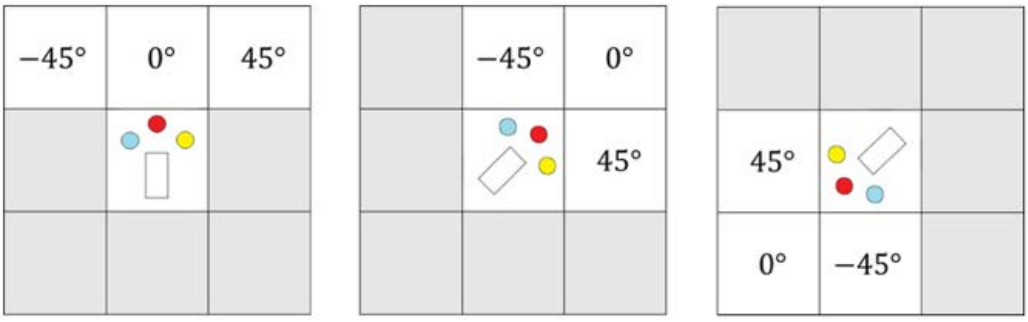

Figure 3: Examples of possible actions to take by the agent and the respective resulting states for each action.

2.2.3 Rewards

Possible cases have been raised based on the actions occasionally taken by the agent. One case represents the situation of the agent regarding its aim of finding a rapid trajectory and without collisions between the defined points of origin and destination. According to the proposed task, the importance of each case is rated as: Strong Positive, when the case has strong representativeness in favor of the wanted purpose; Weak Positive, when the case has weak representativeness in favor of the wanted purpose; Strong Negative, when the case has strong representativeness contrary to the purpose; and Weak Negative, when the case has weak representativeness contrary to the purpose.

The reward values were defined in the range of $[-1, +1]$ from tests based on empirical results presented in [29]. For cases with a Strong Positive rating, a reward of $+1$, was assigned, for cases with a Weak Positive rating, a reward of $+0.2$, for cases with a Strong Negative rating, a reward of -1, and for cases with a Weak Negative rating, a reward of -0.2. Table 2 presents the raised cases and their respective ratings and rewards.

Table 2: Table of rewards based on the cases in which the agent may be in the environment.

Case	Rating	Reward
Collision with Obstacles	Strong Negative	-1
Collision with limits of the environments	Strong Negative	-1
Distance to destination has decreased since the last iteration	Weak Positive	+0.2
Distance to destination has not decreased since the last iteration	Weak Negative	-0.2

It is observed from 2, the “Strong Positive” rate was not attributed to any case, because as the assignment is to find a trajectory between the regions of origin and destination, to offer the agent a very high reward for a proximity to the destination can create a tendency in the model, in addition to a misleading analysis

in the rewards graph, which would present very high values even before a supposed ideal path was found. Another classic option would be to repay the agent with high rewards when the destination region is reached, which is appropriate when the task of RL is to discover a state, which is not the case, therefore, doing so, an error in the analysis of the rewards graph would also occur: average high rewards even if Weak Negative cases happened, so the model would have its learning influenced by a high reward having neglected important small penalties.

Hence, it is reasonable to affirm the task is dictated by negative rewards and the agent holds the main purpose of not to suffer penalties, which is suitable for the model, since the importance of not having collisions on the route is greater than the one to find the shortest path. In this case, the analysis of the rewards graph will happen explicitly: high negative values will appear when there are collisions, otherwise, the values should fluctuate around zero, tending to stabilize as the proximity to the ideal trajectory happens, that is, the shortest path without collisions.

2.2.4 Policy and Exploitation / Exploration

The decision-making policy used is based on artificial neural networks of the Multilayer Perceptron (MLP) type [30] with online training [31], that is, the weights are continuously adjusted as experience is being acquired by the agent. This experience is a result of the input interaction, processing and neural network output. At the end of each interaction, also called a step, the reward value is presented to the network that performs weight adjustment in order to maximize the reward values, reinforcing the weights of the neural connections that have the greatest influence on an output that led to a positive reward and penalizing the connections with the greatest contrary influence, thus realizing an approximation to the Q function, presented in equation (1). Figure 4 illustrates this learning process of the neural network from the reinforcement resulting from the actions taken.

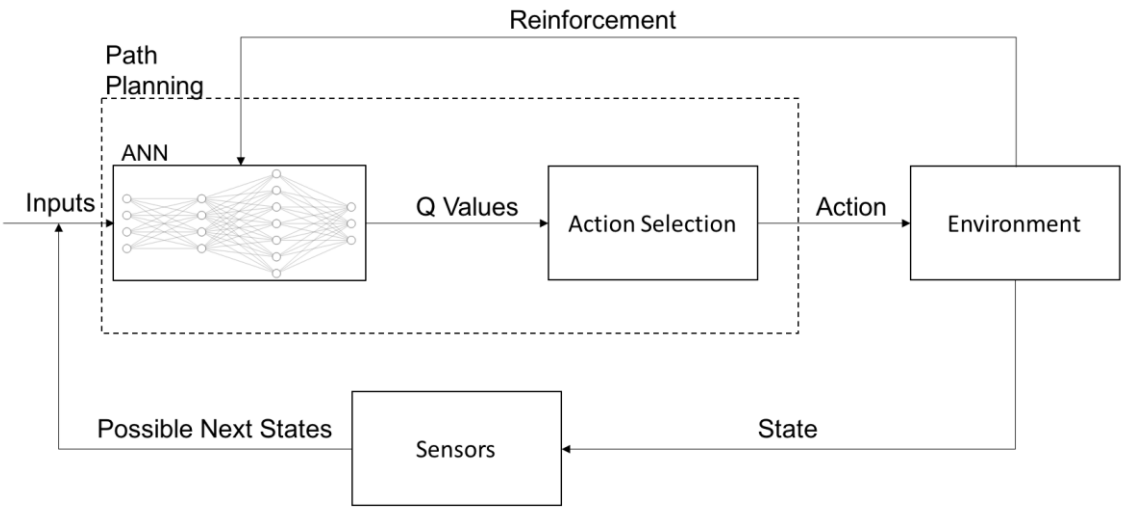

Figure 4: Process of online training of the neural network from the reinforcement resulting from the actions taken.

ANN entries represent the situation the agent is in at a certain time. Thus, the network receives data from the sensors, which correspond to the possible states to reach through an action, and receives the rotation of

the agent concerning the environment, which can be seen in Figure 3, in which the agent appears with an inclination $0^o, 45^o$ and 135°, respectively from left to right. The network processes this data in the hidden layers, and returns, in the output layer, the approximation to the Q value for each action, it means, for each neuron in the output layer, and the neuron with the highest Q value corresponds to the suggested action for the exact instant.

An important issue in Reinforcement Learning is the Exploitation / Exploration dilemma [32]. Exploitation is when decision-making is fulfilled from experience, that is, from the learning the model has had until then, while Exploration consists of decision-making, usually random, aiming to increase the model's experience. The use of neural networks, which weights are started randomly, means that, until a certain moment, decisions are made with the intention of exploration, since the network does not have, or has little, prior knowledge regarding the environment. When experiences are created by the model, there is a risk that decision-making will become tendentious, which means the model always chooses to follow paths already taken, even if these are not the shortest ones. Given the dilemma, it was decided to manage the dynamics of Exploitation / Exploration randomly with probabilities of occurrence of 0.9 and 0.1 respectively, which is illustrated by Figure 5 through a Probabilistic Finite Automaton (PFA) [33].

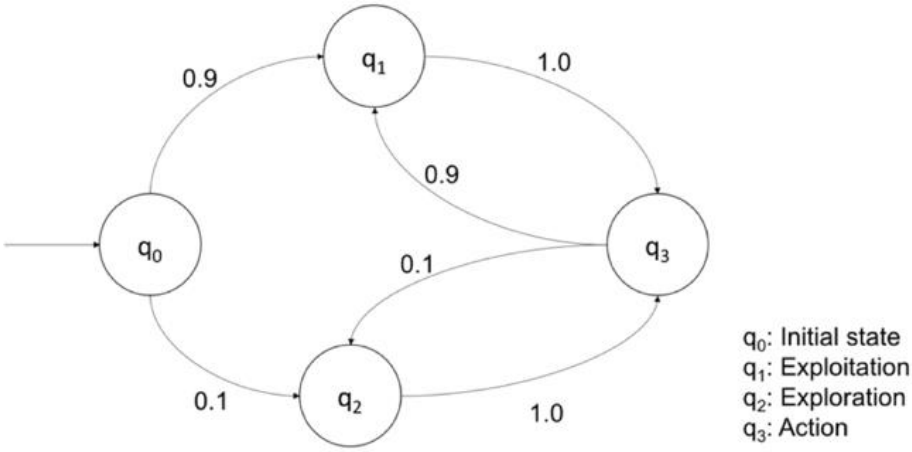

Figure 5: Probabilistic Finite Automaton of Exploitation / Exploration.

Figure 5 indicates that, from the initial state q_0, the next state reached is the decision-making Exploitation or Exploration, represented respectively by q_1 and q_2, with the Exploitation state being reached in 90% of the cases, in which the neural network decides which action to take, and the Exploration state in 10% of the cases, in which the action is decided randomly. After the decision-making stage is completed, that is, after states q_1 or q_2, the state reached is q_3, that corresponds to the state in which the action is performed. Once the determined action is performed, one of the decision-making states q_1 or q_2 is reached again respecting the same probabilities as before. This cycle defines the policy used for RL.

2.3 Neural Network Architecture

The architecture of the multi-layer Perceptron network applied for the agent's decision-making process was established through a grid search, as described below, to optimize the search for its best parameters and hyperparameters. The grid search consists of training all possible combinations of parameters and hyperparameters previously established [34]. For this, an environment of each degree of difficulty was generated and each network generated was used, without prior learning, in the agent's policy that was

inserted in the environments. The final metric used to describe the best network architecture was the average, for the performance of the models in the 3 environments, from the number of steps to the convergence of the rewards graph.

The pre-defined parameters and hyperparameters for the grid search were: number of hidden layers, number of neurons per hidden layer, batch size, learning rate, activation function and optimizer. The number of hidden layers was fixed at 2, since, with two hidden layers, a neural network can implement any function [30]. The number of hidden neurons was obtained by the Geometric Pyramid Rule (GPR) [35], given by:

$$N_h = \left\lceil \alpha \cdot \sqrt{N_i \cdot N_o} \right\rceil \tag{2}$$

where N_h is the total number of hidden neurons, N_i the number of neurons in the input layer, which corresponds to the number of predictive attributes, N_o the number of neurons in the output layer, which corresponds to the number of classes, and α a constant arbitrary. All combinations of two layers were admitted, formed by the total of hidden neurons obtained by GPR when $\alpha = 1;\ 1.5;$ and 3. The batch size was $16, 24$ and 32. The determined learning rates were 0.0001 and 0.0005. While the tested optimizers [37] were the Adam algorithm; Stochastic Gradient Descent (SGD); and Limited-Memory Broyden–Fletcher–Goldfarb–Shanno (LBFGS) [36]. Ultimately, the activation functions were ReLU:

$$ReLU(x) = max(0, x) \tag{3}$$

Sigmoidal:

$$Sig(x) = \frac{1}{1+e^{-x}} \tag{4}$$

Hyperbolic Tangent:

$$tanh(x) = \frac{senh(x)}{cosh(x)} = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}} \tag{5}$$

and Identity:

$$Ident(x) = x \tag{6}$$

2.4 Model Evaluation

The evaluation metric used to assess the models is the Rewards Graph [38], which consists of a rewards curve according to the steps, where it is possible to observe, mainly, the learning evolution in each environment and the number of steps until convergence, that indicates the number of interactions required till the model finds a satisfactorily short and collision-free path. The evaluation of the models will be performed in two phases: Isolated Evaluation and Incremental Evaluation, which will be detailed in the following topics.

2.4.1 Isolated Evaluation

The isolated assessment consists of analyzing the performance of the models in each environment without any prior knowledge. Thus, the testing routine will be displayed as follows: for each degree of difficulty, 100 environments will be generated, according to the proposed methodology, and in each environment, an agent without prior knowledge will be included. Hence, the final performance metric will be the average reward curves of the 100 models referring to the environments of each degree of difficulty.

2.4.2 Incremental Evaluation

The incremental assessment consists of analyzing the performance of the models in environments from the lowest to the highest level with an accumulation of knowledge between the environments. Therefore, the testing routine will be performed as follows: for each degree of difficulty 100 environments will be generated, according to the proposed methodology, then an agent will be inserted in an environment of easy degree, after the convergence of the curve, the same agent will be inserted in an environment of medium degree until convergence, and, finally, inserted in a difficult-grade level.

The final performance metric will be the average curve of the agent's performance in medium environments, holding previous knowledge of an easy environment, and the agent's performance in difficult environments, having preceding data of an average environment. Through these reward curves generated by a model with acquired information, it will be feasible to analyze, in comparison with the results of the isolated assessment, the adaptive nature of the models, that is, when a model with experience is inserted in a new and, by the time, unknown environment.

3. Results and Discussions

This section describes the results achieved from the proposed methodology for simulating the trajectory of autonomous vehicles through deep reinforcement learning. The subsections include the following topics: (3.1) Environments Generation, which presents the results from the proposed method for the creation of RL environments; (3.2) Neural Network Architecture, which presents the best network architecture found from the grid search; (3.3) Isolated Evaluation; and (3.4) Incremental Evaluation, which present the metrics obtained for the respective forms of evaluation of intelligent models.

3.1 Environments Generation

The environments were developed respecting the proposed methodology and divided between the degrees of difficulty: Easy; Medium and Difficult. Figure 6 displays an example of each degree of difficulty from the environments. It is observed that the parameters of quantity and size of obstacles defined for the creation of the environments were properly adjusted, making it clear the levels of difficulty that each environment must intend to the agent. The difficulty increases from left to right, the environment on the left being easy, the middle environment, medium and the right environment, difficult. At the upper and lower edges in the center of each of the environments, the regions of destination and origin of the agent are marked in red, which delimit the path that the agent will take in search of the trajectory that offers it better rewards.

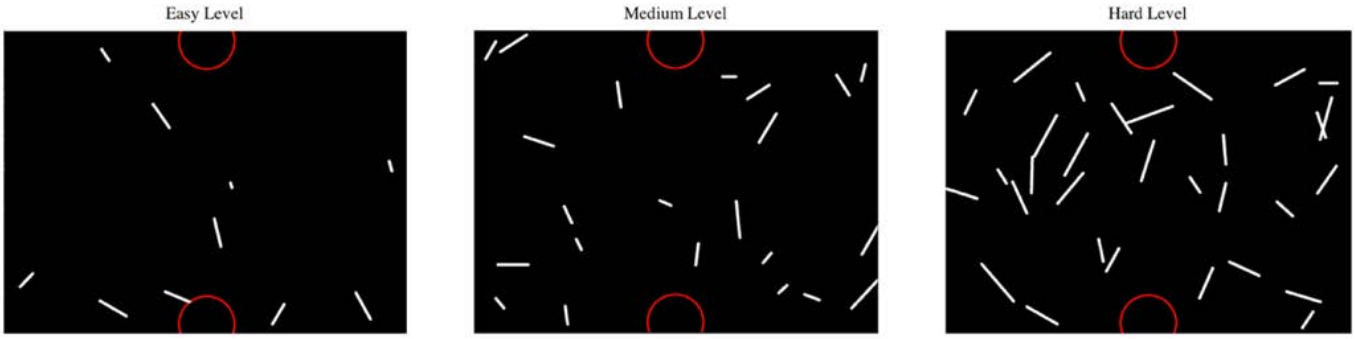

Figure 6: Examples of environments created to perform the proposed RL task.

3.2 Neural Network Architecture

According to the proposed methodology, the neural network adopted for the proposed task was based on the result of a grid search. The network has 4 neurons in the input layer, referring to data from 3 sensors and rotation of the agent concerning the environment, and 3 neurons in the output layer, referring to possible actions to be taken. Amidst these data and with values of $\alpha = 1;\ 1.5$ and 3, from GPR, equation (2), the amounts of hidden neurons $N_h = 2;\ 6$ and 11 were obtained for each value of α. With these values, 16 combinations of neurons are possible, sorted into 2 hidden layers. Table 3 presents the defined parameters and hyperparameters for the grid search.

Table 3: Parameters and Hyperparameters defined for the grid search.

Parameter/ Hyperparameter	Amount of Values	Values
Number of Hidden Layers	1	2
Neurons of Hidden Layers	16	Defined by equation (2)
Batch Size	3	16, 24, 32
Learning Rate	2	0.0001, 0.0005
Optimizer	3	Adam, SGD, LBFGS
Activation Functions	4	ReLU, Sigmoidal, Hyperbolic Tangent, Identity

Therefore, the product of the quantities of values results in the number of combinations between parameters and hyperparameters of neural networks. As a result, 1,152 tests with neural networks were performed. It is noteworthy that in this phase of the experiments, the selection of the neural network was made through the performance of the models in 3 environments, one of each degree of difficulty. These procedures were performed trying to find the combination with the lowest average number of steps until the convergence of the reward charts for the environments where the agents were inserted. Table 4 shows five networks with the best grid search results. Finally, the network ranked first in the grid search was defined as the standard

network used in the agent's policy.

Table 4: Results obtained from the grid search.

Classification	Hidden Layers	Activation Function	Optimizer	Learning Rate	Batch Size	Mean of Steps
1	**(4,7)**	**ReLU**	**Adam**	**0.0005**	**16**	**1,998.67**
2	(2,9)	Identity	Adam	0.0005	16	2,005.33
3	(3,3)	Identity	SGD	0.0001	24	2,042.00
4	(4,7)	ReLU	Adam	0.0001	16	2,101.67
5	(2,4)	Sigmoidal	Adam	0.0005	24	2,133.33

3.3 Isolated Evaluation

In the isolated assessment, for each environment, an agent without prior learning was inserted and their rewards graph was analyzed. Altogether, the environments were tested, being divided equally between the three levels of difficulty. Figure 7 shows the performance of the intelligent model proposed for the respective degrees of difficulty according to the average reward curve achieved throughout the conducted experiments.

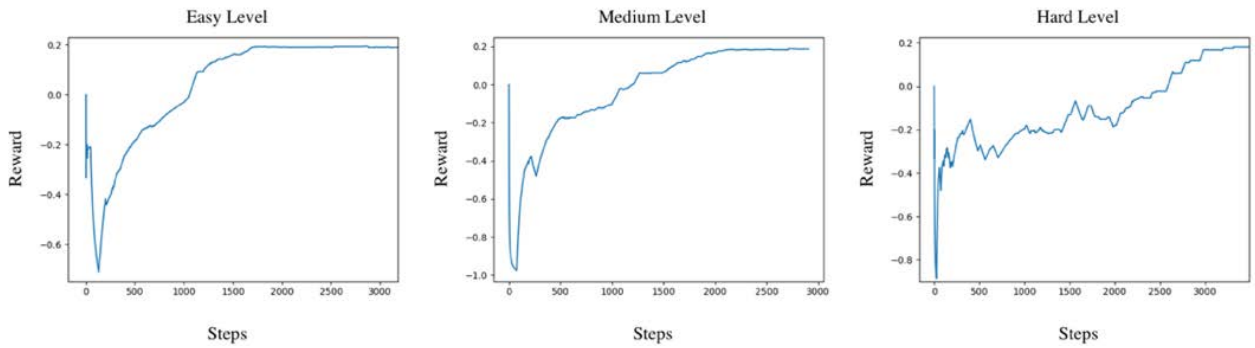

Figure 7: Graphs of average rewards obtained by the models in environments with three degrees of difficulty.

Figure 7 shows a standard behavior in the curves making possible to observe: from the initial moment, the agent has a random behavior, which causes collisions with obstacles, so there are, initially, the presence of some negative peaks. With the increase in steps, the experience is acquired by the agent and the curves tend to converge to a constant reward of 0.2, as expected. This convergent behavior implies that the model has learned from the environment and is capable of drawing a route without penalties, that is, a short path and without collisions.

Furthermore, from Figure 7, it is observed that, in fact, the difficulties of the environment directly affect the number of required interactions until convergence. It is noticed that the graph referring to rewards in environments of easy degree showed convergence around the step 1500, that is, fewer interactions than the

graphs referring to rewards in environments of medium and difficult degrees, which reached convergence, respectively, around steps 2000 and 2900.

Figure 8 exemplifies a case in which an agent finds a satisfactory path, that is, after its reward chart has converged at 0.2. In the figure, the path from the lower to the upper region was found by the agent after 2100 steps and represented in 6 frames. Visually, it is noted that the agent did not cause any collision as well as having chosen a short path for the execution of the task, which indicates that the approach and the evaluative analysis on the performance of the task are valid for the context of trajectory simulation of autonomous vehicles.

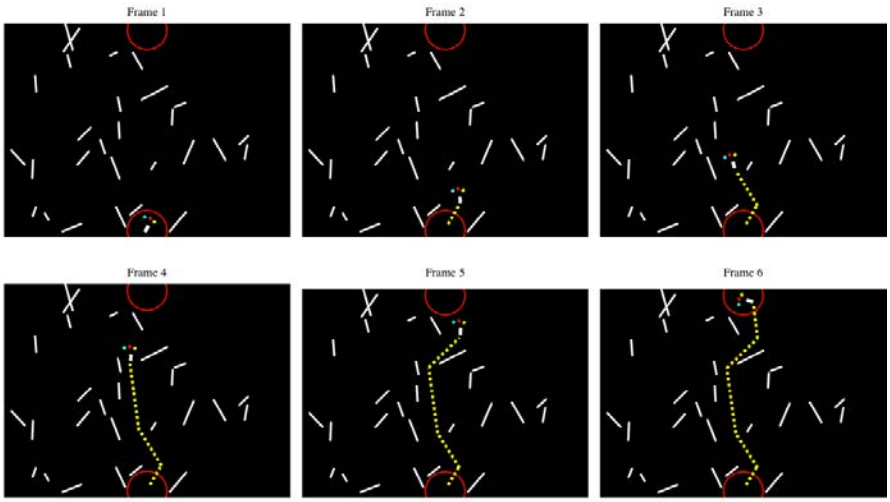

Figure 8: Frames sequence representing the trajectory taken by the agent after the learning has been performed.

3.4 Incremental Evaluation

Also, in the incremental evaluation, 300 testing environments were used in total, divided equally between the 3 degrees of difficulty. For each easy grade environment, an agent was inserted, which after obtaining experience until finding convergence in its rewards graph, this agent was inserted in a medium grade environment until its rewards curve also reached convergence and, finally, each agent was introduced in a difficult environment. At the end of the procedures, the average graphics of rewards obtained by the agents in the environments to where they were inserted with previous learning (that is, medium and difficult environments) were obtained, as presented in Figure 9.

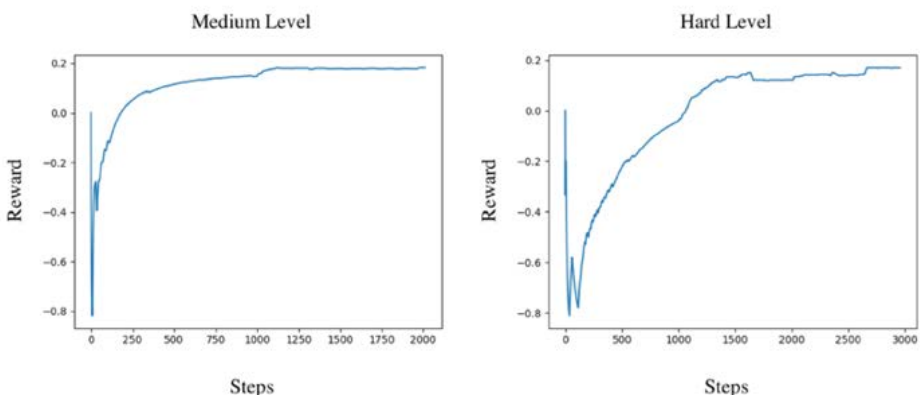

Figure 9: Graphs of average rewards obtained in environments of medium and difficult difficulties by models with prior knowledge.

In comparison with the graphs displayed by Figure 7, it is observed that the graphics in Figure 9 present curves with convergences in fewer steps. In this case, the negative peak regions on the graphic represent the adaptation interactions of the model for the environment where inserted. This region proved to be very small for medium-grade environments. The graphic shows that the agent reaches a positive convergence after approximately 300 steps, still increases the level of convergence around step 1000. What reduces half of the necessary interactions in the environment until confirmed learning compared to the model without prior knowledge. The same is true for the performance of agents in difficult environments, where the number of steps required until positive convergence was around 1200, less than half of the result obtained by the isolated evaluation, which was about 2900 steps, it means, a reduction of upon 58.62% in the number of steps to convergence. This behavior proves the adaptive capacity the proposed model has. It means that actions taken despite adverse conditions are quickly adjusted. Therefore, the model is proved robust to disturbances in the environment.

The validation of the importance of this work was made from a comparative analysis with the performance of related works. Additionally, Table 5 presents the results obtained by the works that most resemble the experiments conducted by this one. Hence, the results obtained by [21] which consist in the application of Deep Reinforcement Learning in the planning of AUVs movement with an evaluation methodology very close to that presented in this work: simulated environments were created for testing in different difficulty levels and the average reward curves are analyzed according to the steps. The results obtained in [22] are also presented, which also proposes the application of Deep Reinforcement Learning for route planning for land vehicles. The main difference between the evaluation methods of the models presented in [22] and in this model is the fact that the reference does not present evaluations of the models due to the degree of difficulty of the tested environments, however, the reward curves are analyzed according to the steps, as in this work, which allows performance comparisons to be made. For comparison purposes, the metric adopted to assess each model is the number of average steps required before the convergence of their respective average reward curves.

Table 5: Comparison between obtained results and related works.

Model	Method	Level	Steps to Convergence
[37]	DDPG	Easy	~2,500
		Medium	~2,800
		Hard	~2,900
	MEP-DDPG	Easy	~2,750
		Medium	~2,900
		Hard	~3,000

[38]	DDPG	Unique	~3,600
Proposed	MLP without previous learning	Easy	~1,500
		Medium	~2,000
		Hard	~2,900
	MLP without previous learning	Medium	~300
		Hard	~1,900

From Table 5 it is observed that the results obtained by the experiments conducted presented results that were competitive with the state of the art. The method using MLP without prior learning surpassed all the results of the related works concerning the Easy and Medium levels and had a similar performance, for the Hard level, to the DDPG method presented by [21]. The proposed model using prior knowledge demonstrated a very large evolution about the results presented by the other models. This means that the model has a fast adaptive capacity even when inserted in a higher-level environment. Thus, the models showed an average reduction in the number of steps until the convergence of 2,550 and 2,500 for the medium and difficult levels respectively (the model presented in [22] was considered a difficult level for this analysis). So, there was a reduction of 89.47% regarding the performance in the medium level and of 64.29% about the difficult level when compared with the related works. Therefore, this approach to path planning through trajectory simulation using an MLP-based policy with prior knowledge has proven to be state of the art for the present task.

4. Conclusion

Two Deep Reinforcement Learning approaches were presented for the path planning task through trajectory simulation. The first approach was about an intelligent agent with a policy based on MLP neural networks that was inserted in environments of different degrees of difficulty without any prior knowledge. The second model went to the first environment, however with previous data in lower degrees of difficulty. The first model obtained competitive results, surpassing the performance of related jobs at the easy and medium levels and conferring similar performance at the difficult level. The second approach, on the other hand, presented a great advance for research in this segment, proving the adaptive capacity of MLP-based models. The results presented show an average reduction in the number of steps up to 76.88% about related works. It is suggested, for future work, the application of the proposed model in an embedded system to a prototype to perform tests in a real environment. Moreover, there must be a concern with the hardware performance, since the system response must be in real-time, thereby suggesting to implement in hardware to optimize the system performance time.

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Analysis of The Role of The Government and Ventural Capital On the Development of Startup in Indonesia: Study on Assistantku.Com and Qiwii.Id

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ABSTRACT

This study aims to analyze the role of the Government and Venture Capital in the development of startups in Indonesia. Research was conducted on startup companies in 2017 - 2020, analysis from the startup side comes from Qiwii.id which represents successful startups to date and failed Assistantku.com. On the other hand, analysis also comes from the Government and venture capital. The data search method uses direct interviews to data sources, then strengthened by analysis of research data from various parties such as dailysocial.id, Global Startup Genome, Techinasia.com, MIKTI, and various other parties. The research results prove that the Government does not play a direct role in the development of startups in Indonesia, but through the ecosystem, marketing support and regulations. Meanwhile, the taxation aspect of startups does not really have an impact on startups, because the majority of startups do not have income above IDR
4.8 billion (not including the taxpayer category). In terms of Venture Capital, it actually plays an active role in the development of startups because the nature of venture capital which also owns startup shares makes the commitment of both parties to develop their startups high. These various conditions are consistent with the balanced scorecard review in each startup.

Keywords: Startup, Government, Venture Capital, Startup Development

PRELIMINARY

The development of startup companies in the world shows an increasing trend. Even some startup companies have convincingly succeeded in changing the conventional business landscape to become internet-based. Various startup developments in the world, cannot be separated from the assistance and role of the Government in each country. Startup growth is not only determined by the Ecosystem factor created by the Government, but also support from Venture Capital

For countries with an established ecosystem, the role of the Government is not too many except as a regulator and executor of policies. However, for countries whose ecosystems are just beginning to develop, the role of the Government is very important. The government is expected to become a facilitator and

promoter of the ecosystem through supportive policies. Because without the role of the Government there is an imbalance in business processes in the ecosystem. And this can be bad for the sustainability of the ecosystem.

Based on the comparison with the 8 study object countries, if it is described there are several key factors that must be met for the emergence of a complete and established ecosystem. Because this key factor exists in all countries with established ecosystems and countries in almost the same condition as Indonesia. If it is described it will be like this:

Table 2.2. Comparison of Government Policies to *Startups*

No.	Country	Policy
1	America	early phase. The government budgeted US $ 75 billion or more to finance research carried out by the founders in 1970 After Bayh-Dole came into effect, nearly all of the research that was set up by the technology transfer office was aimed at becoming a patent hub for innovation from universities and startups
2	English	Various incentive programs for *startups* have been rolled out for a long time. The UK government often collaborates with friendly countries to promote their success in growing *Startups* and provide guest mentors for incubation programs.
3	German	Being involved in venture capital incentives to create an independent ecosystem, together with involving talents and mentors from abroad and spreading it through incubators in Germany German venture capital in cooperation with international venture capital funds
4	Korea	Injects around US $ 2 billion per year into the startup ecosystem to boost entrepreneurship, digital technology industry ventures and foster international cooperation A new department, Science and Future Planning was created and allocated significant amounts of resources to fostering the startup ecosystem and negated the barriers and restrictions surrounding these industrial ventures
5	Singapore	Programs such as University Innovation Financing (UIF), Proof of Concept Assistance (POC), Early stage Venture Capital (ESVF) and Technology Incubation Scheme (TIS) have helped to create a virtual cycle of entrepreneurship for several years supported by various other initiatives. from the Media Development Authority (MDA), the Infocomm Development Authority (IDA) and SPRING Singapore

6	Malaysia	Supported by the Malaysian Digital Economy Institute (MDEC) which reports directly to the Kingdom of Malaysia The government also established MaGIC, or Malaysia Global Innovation and Creativity Center, a startup technology accelerator affiliated with the Malaysian Government.
7	Vietnamese	The Vietnamese government launched Vietnam's Silicon Valley, and disbursed no less than USD110 million in funds from the World Bank through the Vietnam Ministry of Science and Technology Science and Technology Research Innovation Development Agency (FIRST) and the National Agency
8	Thailand	Established the Ministry of Digital Economy and Society and the National Digital Economy and Society Committee chaired by the prime minister of Thailand In 2015, the Government of Thailand created an “Endowment Fund” scheme of 500 million baht for the startup ecosystem, “Endowment Fund” scheme for the startup ecosystem, as well as forming an asset management company to manage the fund. In 2015, the Government of Thailand created a 500 million baht 'Endowment Fund' scheme for the *startup* ecosystem , as well as forming an asset management company to manage the fund. A law is made so that startups there have access to Research & Development funds to the local research ministry. There is a tax incentive for 10 years for venture capital investing in local startups

Source: Creative Economy Agency (2017)

On the other hand, venture capital firms invest funds in startup businesses with a professional outlook. Due to the nature of equity financing, venture capital investors are exposed to the risk of corporate failure. As a result, venture capitalists should look to invest in startups that have the ability to grow very successfully and provide higher than average returns to compensate for risk. Thus, not many startups have access to funding from venture capital.

Venture capital also has a capitalist management approach that is different from that of lenders or banks. When venture capitalists invest in a startup business, they usually direct and guide the business so that it leads to capital gains. They are an important part of corporate decision making and occupy a place on the board of directors. various management, sales, and technical issues to help the company develop its full potential.

Silalahi (2017) in his research found the challenges of national startup companies, both from within and outside the country. The challenges faced by start-up companies are inseparable from the cycle of business development that the company has to go through until it reaches a stable stage in terms of providing profit

and generating positive cash flow (cash inflows are greater than cash outflows for investment or operational needs, in other words. the company is already making a profit)
Domestic challenges stem primarily from the lack of available capital to fund company development in order to reach the middle-upper level. In this stage of development, the company needs funds of 5-20 million USD, most of which is needed to expand the market and strengthen technology infrastructure. Most of the sources of capital in the form of venture capital are still limited to early stage funding where start-up companies are starting to build with a limited market segment. (Silalahi, 2017)

Based on data submitted by Singh (2018), the risk of startup failure is so high with an increase in the percentage every year. The first year the percentage of failure is 25%, second 36%, third 44%, fourth 50%, fifth 55%, sixth 60%, seventh 63%, eighth 66%, ninth 69%, tenth 71%. Based on the description above, it can be concluded that on the one hand, the potential for economy and startups in Indonesia is so high. But on the other hand, the risk of failure is also very high. Therefore, the importance of the ecosystem formed by the Government and the strong support from venture capital is felt by the digital creative industry players.

There are many types of startups in Indonesia. Assistantku.com and Qiwii.id are two startups that have a similar business model, namely online queuing services. However, the difference between the two is the difference in location, background of the founders, differences in the attitude of the Government to the startup ecosystem in both. Assistantku.com is located in Lampung, while Qiwii.id is in Bandung. The background of the founder of Assistantku.com is that he is a graduate of international law degrees who has many jobs in the construction sector, while Qiwii.id is mostly engaged in software houses, which is a service sector that serves the manufacture of IT operational systems. Of course, with a variety of different conditions, make Assistantku.com and Qiwii.id interesting for further research. Moreover, various conditions cause the roles of the Government and venture capital to differ from one another.

The formulation of the problem in this study is to analyze the role of government and venture capital in the development of startups in Indonesia, especially Assistantku.com and Qiwii.id. The purpose of this study is to determine the role of the Government in the development of startups in Indonesia and to determine the role of venture capital in the development of startups in Indonesia.

RESEARCH METHODS

The type of research used is descriptive research with qualitative methods in the phenomenological research approach, not grounded theory (Creswell, 2015). In this study, after the researcher has collected data in the form of interviews and documentation, then the data will be analyzed in more depth so as to form a scientific-natural conclusion that can be accepted by various groups, especially in this case the Government and venture capital itself as the object of research in this thesis and startup activists as parties who get the effect of the role of the Government and venture capital.

The descriptive - qualitative research method is considered to be the right method for researching startups in Indonesia. Moreover, there are very few previous research results on startups in Indonesia, because startups tend to keep various internal data secret. On the other hand, because the time of the research was the Covid-19 pandemic. So, many startups refuse to be interviewed. As a result, only two startups of this kind are possible, namely Assistantku.com and Qiwii.id. Only the Chief Executive Officer (CEO) of each startup is willing to do this. With consideration, all understanding, data, experience, and various information needs can be provided by the CEO who is also the founder of the startup.

Secondary data is obtained from literature study of statutory regulations as official documents and other literatures related to the issues discussed in this thesis, such as: Presidential Regulations, Minister of Finance Regulations, documents and research from related official government agencies. with startup. In addition, documents from various national and international media such as dailysocial.id, Techinasia.com, katadata.com, startupranking.com, social enterprise platforms (PLUS) and from other literatures such as guidebooks, newspapers, seminars, internet, and others

RESULTS AND DISCUSSION

Analysis of the Role of Government

The Indonesian government has basically made a regulation on Startups, namely on July 21, 2017, it signed Presidential Regulation (Perpres) Number 74 of 2017 concerning the Roadmap for the Electronic-Based National Trade System (SPNBE) / Road Map for e-commerce startups 2017-2019.

Some of the programs that are the objectives of the Perpres include funding programs, taxation, consumer protection, education and human resources, communication infrastructure, logistics, cybersecurity, and the establishment of implementing management for the 2017-2019 SPNBE road map. This policy package was initiated because in previous years, there was no national e-commerce road map that encouraged the development of e-commerce and startups in Indonesia.

In addition to the National Electronic-Based Trading System (SPNBE) Road Map / e-commerce startup Road Map for 2017-2019. The government also issued Government Regulation Number 80 of 2019 concerning Trade Through Electronic Systems (PMSE) which has officially taken effect since it was promulgated on November 25, 2019. This PP consists of 82 articles, explaining the implementation of transactions from the side of business actors, consumers to product.

There are many interesting points discussed, one of which is contained in article 15, which basically states that business actors (in this case including traders) are required to have a business license to carry out PSME activities. Whereas according to data from the Indonesian E-commerce Association, 95% of SMEs are still selling on social media and only 19% are already using the marketplace. (dailysocial.id, 2020)

Fintech has also become a startup with a digital business model that has received special attention from

regulators amid the emergence of various types of supporting applications. Specifically, the Financial Services Authority (OJK) acts to protect the loan, investment and insurance-based platforms. Meanwhile, Bank Indonesia (BI) is more focused on transaction and payment platforms.

In 2016 the OJK inaugurated POJK Number 77 / POJK.01 / 2016 concerning Information Technology-Based Borrowing and Lending Services, which became the main legal umbrella for p2p lending services which in quantity became dominant in the digital financial sector. Seeing the existing market conditions, in 2018 BI updated the rules regarding e-money in PBI Number 20/6 / PBI / 2018, tightening the criteria for companies that operate platforms.

Unfortunately, Fintech is not just an online payment or loan application. Thus, to get around the continuing innovation in the financial sector, around 2017 a "regulatory sandbox" was introduced, which is a limited trial space for products or services that have not been accommodated by regulations. (dailysocial.id, 2020).

Other startups such as ride-sharing, such as Gojek, Grab and the like, also receive special regulations. At the beginning of 2015-2016, there were no special regulations covering it, and there were often conflicts with established transportation because they were disturbed by the presence of online transportation services. However, this is due to the shift in people's habits that increasingly depend on digital applications. The government finally issued a regulation for online taxis through Permenhub Number 118 of 2018 concerning the implementation of Special Rental Transportation. The Permenhub regulates tariff limits, operational areas, and specifications of the vehicles used. Even for online motorcycle taxis, the Government takes a discretionary path, namely rules to overcome concrete problems faced in the administration of the Government. This is because basically two-wheeled motorized vehicles are not included in public transportation based on Law no. 22 of 2009 concerning Road Traffic and Transportation.

Thus, it can be concluded that Indonesian Government regulations have always lagged a few steps behind technological innovation. In addition, technological innovation in the public sector without the protection of proper regulations will cause uproar and issues among the public. Looking at the development trend of startups in Indonesia, it seems that regulations cannot stand alone to regulate certain business categories. There is a need for synchronization between regulatory agencies.

An example of the need for synchronization between institutions is when regulating digital health services (healhtech), in addition to the Minister of Health regarding telemedicine, it is also necessary to pay attention to Kominfo regulations regarding electronic transactions, even regarding digital signatures. In other words, the "regulatory sandbox" model needs to be applied in every ministry, to anticipate the birth of a new platform that will present certain business process disruption. This is because basically, regulators also need time to study and study a variety of new mechanisms before actually making regulations.

Synchronization also needs to be held to accommodate the needs of various parties, in this case startup businesses, conventional business players, consumers and the Government. The ecosystem step in forming

associations in each startup business vertical is a positive effort to assist regulators in reviewing any regulations that have an impact on related businesses.

The effectiveness of synchronization has been proven, enabling it to balance the perspective of the regulator from an industry point of view. It has been proven in many ways, for example the Ministry of Finance finally canceled the proposed regulation requiring online merchants to have a NPWP, because according to the e-commerce association many of whose income is still below PTKP. This is also what AFPI did to help OJK manage the legality of the Fintech lending business. (dailysocial.id, 2020).
Especially when talking specifically about Blockchain technology that is currently developing, there are no definite rules yet. Even though Blockchain is starting to be widely used for the needs of data transactions and digital assets. An example of its application is to move legal documents such as letters or certificates from one party to another more safely. However, the risks in case of failure, data duplication, document damage, and various other misuses have not been accommodated by the Government.

Regardless of the respective rules in the respective startup fields. Basically, all startups have the same rules that need to be obeyed, namely regarding taxation.

Taxation

As with conventional trading, the Government has the authority to ensure tax compliance for startup players in Indonesia. The perpetrators of conventional transactions have so far imposed tax regulations. This economic activity in startups has not been recorded by the Government. For this reason, the Ministry of Finance in collaboration with several other ministries has formulated a startup tax regulation in the form of a Minister of Finance Regulation (PMK).

If up to one month in the fiscal / calendar year the turnover from the delivery of taxable goods or services exceeds Rp. 4.8 billion, the startup actor is required to report his business to become a taxable entrepreneur. As a taxable entrepreneur, the obligation of startup entrepreneurs is to collect VAT on every transaction of delivery of taxable goods or services by issuing a tax invoice (e-invoice). The startup tax rate for Value Added Tax (VAT) is 10%.

Types of startup transactions conducted through the website and subject to Value Added Tax include (1) Electronic order processing for intangible goods; (2) Electronic ordering and downloading of digital products; (3) Electronic ordering and downloading of digital products for the purpose of commercial exploitation of copyright; (4) Activities to update and add completeness of a software; (5) Granting of free licenses to utilize software within a certain period of time; (6) The transaction which the buyer obtains one-time right to use software or other digital products; (7) The right to post software and technical assistance; (8) Agreement with the copyright owner provider to access a software; (9) ASP transactions; (10) License fee for ASP; (11) Providing a place on the server to host the website; (12) Software maintenance; (13) space utilization services to store databases; (14) online technical assistance; (15) Submission of information to customers; (16) Product delivery in the form of additional information with customer data

analysis; (17) Payment of advertising fees that appear; (18) Professional services consulting; (19) Confidential technical information; (20) Information sent to customers; (21) Access to certain websites; (22) Catalog placement by merchants online; (23) Online auction; (24) Sales referral program; (25) Content purchase transactions; (26) Broadcast-based streaming; (27) Payment made by a Content Provider to a website operator so that the content is displayed on the website; and (28) Subscription to websites that allow downloading of digital products.

The startup business tax is no different from conventional business. The taxes that startups will receive are Value Added Tax (VAT) and Income Tax (PPh). Every startup with an income below Rp. 4.8 billion can also choose not to be confirmed as a Taxable Entrepreneur (PKP). However, they are still subject to Final Income Tax of 0.5% of their gross income.
If we observe again, PPh is certainly burdensome for most startups because the tax is imposed from gross income. The solution, startups that are still losing money are given the option to be confirmed as PKP. With PKP status, you will be subject to PPh 25% of your net income and you don't need to pay taxes when you lose money. Although this condition is not an ideal solution. This is because with PKP status, you will automatically be subject to the obligation to pay Value Added Tax (VAT). VAT is not completely detrimental. Startups can receive back the difference between the VAT paid and the VAT received from consumers. VAT imposition on customers will certainly be complained because the price applied is higher.

Startups with turnover below Rp. 4.8 billion have actually been given generosity to be free from VAT payments. But as a consequence, startups still have to pay income tax of 0.5% of gross income. The startup tax will be imposed if it gets income from other parties. If the startup still provides free services, it is still required to pay taxes. The tax officer will charge a tax of 10% of the server maintenance costs incurred by the startup.

Capital

Government policy is not only taxation, but there are other policies that are intensely implemented, namely funding. There are various forms of development programs, funding from the Government either comes from Ministries, SOEs, and state-owned companies. The following is a table of the forms of funding programs provided by the Government, namely:

Ministry of Research and Technology / National Agency for Research and Innovation

From 2015-2019 the Ministry of Research and Technology / the National Research and Innovation Agency (Kemenristek / National Agency for Research and Innovation / National Agency for Research and Technology / National Agency for Research and Innovation) issued a pre-startup and startup stage coaching program called Technology-Based Startup Companies (PPBT). Then in 2020 it changed its name to the Innovation Startup. Through this program, Kemenristek will focus more on developing the upstream side. The Ministry of Research and Technology has a special directorate called the Directorate of Technology-Based Pioneer Companies, tasked with producing as many startups as possible. The selected startups will receive a number of incentives and coaching.

The PBBT program is divided into three stages. First, CPPBT (Prospective Technology-Based Startup Companies) or currently changing its name to pre-startups, is tasked with finding technology-based startups that are ready to be commercialized. Funding of up to IDR 250,000,000, proposed by the incubator of higher education institutions, already has a prototype and the coaching will be focused on product validation and market validation.

Second, PBBT (Technology-Based Startup Company) or currently changing its name to startup, namely the incubation program. Funding for startups of up to IDR 500,000,000, proposed independently by startups from anywhere, with commercially ready products. Coaching startups will focus on market access and business development.

Third, PLBT (Advanced Technology Based Company) or currently known as scale up. This stage is intended for post-incubation and external funding, with funding of up to IDR 1,000,000,000,000 (one billion rupiah). With a note that startups proposed alumni of the Kemenristek / National Agency for Research and Technology incubation funding program. The focus at this stage is to expand the selected startup market and increase production capacity so that startups can partner with investors.

Apart from the PPBT program, the Ministry of Research and Technology / National Agency for Research and Innovation also has several potential "Science Techno Parks (STP) that are scattered in several regions in Indonesia. So that the resulting innovations can be commercialized into mass products. Fostered startups are supported by the availability of business incubations at various STPs.

The source of coaching funds comes from the state budget. The startup focus targeted by the Ministry of Research and Technology is foodtech, transportation, healthtech and medical technology, energy, resilience and security, materials, advanced materials and ICT. Based on data from the Ministry of Research and Technology, from 2015 to 2020 the PBBT program has fostered 1,307 startups and pre-startups, with details of 558 pre-startups and 749 startups. The total budget that has been given by the Ministry of Research and Technology for startup funding reaches IDR 371.71 billion. In total, 13 startups have generated revenues of IDR 102,000,000,000 (one hundred and two billion) in a year and pocketed IDR 4,500,000,000 in funding. (Dailysocial.id, 2020)

Ministry of Communication and Information

Since June 2016, the Government through the Ministry of Communication and Informatics (Kemkominfo) has implemented the 'National 1000 Digital Startup' Movement. The movement was carried out in 10 implementation cities, with more than 300 activists from various sectors, more than 400 mentors from various fields, 78,000 registered startup founders and more than 1000 startups started. (1000startupdigital.id, 2020)

The various facilities that will be obtained by selected startups are mentor and industry connections, a platform to find a co-founder, an office in a co-working space, feedback from mentors, and mentoring for

3-6 months. All facilities provided by the organizers are covered by the Ministry of Communication and Information Technology.

Incubator and Accelerator

The role of the Government in developing startups in Indonesia is currently overshadowed by the Ministry of Research and Technology / National Agency for Research and Innovation and the Ministry of Communication and Information. However, there are also many other incubators and accelerators originating from State-Owned Enterprises such as providers, banks, pawnshops and so on. Even though the two terms have the same vision, it does not mean that there is no difference between them. The incubators and accelerators initiated by the Government in supporting startup development include:

a. Bekraf for Pre-Startup

This program is designed to mature the integration of the startup ecosystem from start to finish. The Bekraf for Pre-Startup Program was initiated by the Ministry of Tourism and Creative Economy of the Republic of Indonesia (Kemenparekraf). This program includes the maturation of prospective human resources who can later build startups in Indonesia. There are workshops held, both on business management and technical product development.

b. IDX Incubator

Is an incubation program from the IDX or the Indonesia Stock Exchange in collaboration with Bank Mandiri. This program itself has a vision to develop Indonesian digital startups. Whether it's from a legal, business perspective, to helping startups register their companies on the stock exchange.

When choosing this program, there are various things you will get, such as access to capital, business development, co-working space facilities, workshops or other useful events. Of course this program is assisted by several mentors who are experienced and ready to coach

c. Indigo Creative Nation

An incubator coaching program organized by Telkom. This program aims to build a digitalpreneur ecosystem in Indonesia. In this program, startups will have the opportunity to realize businesses that have generated revenue, businesses that need acceleration or funding.

The role of venture capital

Various assistance and support for startups does not only come from the Government, but also from Venture Capital Companies. The legal basis for the existence of venture capital financing in Indonesia is regulated by Presidential Decree (KEPRES) No. 61 of 1988 concerning Financing Institutions and Decree of the Minister of Finance (KEPMENKEU) Number 1251 / KMK.013 / 1988 concerning Provisions and Procedures for Implementing Financing Institutions. The definition of venture capital is contained in Article 1 paragraph (11) of the KEPRES, namely a venture capital institution is a financing business in the form of capital participation in a company that receives financing assistance for a certain period of time.

Funding

Based on dailysocial.id's research (2019), throughout 2019, of the 59 announced nominal funds from

venture capital, the total obtained reached $ 2.8 billion or the equivalent of 40.2 trillion rupiah. Meanwhile, there are 44 other funding transactions whose nominal value is not stated to the public. In addition, there are several other interesting trends, one of which is that the financial sector still attracts a lot of attention from investors

Based on data, there are 110 funding transactions announced by Indonesian startups and / or investors. Of these, financial sector startups received the largest portion with 23 funding transactions from venture capital, followed by SaaS startups with 9 transactions, e-commerce startups with 8 transactions, and logistics startups with 6 transactions.

The reason for the financial sector to be the most funded sector is first seen from the market potential. The poor households in the country still dominate, coming from tier one to three cities. Second, regulations that are increasingly open to business actors. Third, people are easy to adapt to the digital approach (Dailysocial.id, 2019).

In 2019 there were also many funding transactions as shown in the following table which shows that the majority of startup funding in Indonesia in 2019 was the seed funding stage, followed by Series A funding. Initial funding (seed funding) still gets the largest portion, followed by series A funding. In general, the investment is given by investors to new startups that have successfully validated their products to the market, thus generating traction. In 2019, the categories are quite diverse, starting from startups based on artificial intelligence services, investment platforms, health, and others.

In an advanced stage, Indonesian startups also still get quite a lot of transactions for series B and above, with 27 transactions being recorded. The financial sector and startups each get 5 stage transactions. Continued car marketplace and education 2 transactions each.

Gojek dominates the achievements of funding transactions. After obtaining from the Cool Japan Fund, Gojek's F series funding has reached $ 2 billion from the target of $ 3 billion in 2019. This achievement, apart from strengthening the company to become the first local decacorn, is also the largest nominal funding transaction obtained by Indonesian startups

Kredivo continued, which received funding in two rounds, namely series C and debt funding. Mirae Asset-Naver Asia Growth Fund, Telkomsel Mitra Inovasi, MDI Ventures, Cathay Innovation, Partners for Growth are some of the investors involved. Most transactions in the third quarter

Management Assistance

Management coaching is the most likely form of assistance. PMV can apply a combination form of direct and indirect coaching. Direct coaching is carried out with regular visits to Startups, and can also be done by providing suggestions according to the Startup's needs, for example if the company does not have adequate financial management, PMV will facilitate it by showing ways that can be done. use Startup.

Indirect coaching can be provided in the form of information regarding training and exhibitions that can be participated in by Startups in their marketing efforts for Startup products.

In addition, monitoring is another form of assistance and guidance that can be carried out by venture capital companies, in contrast to banking institutions that provide credit, where the bank's responsibility to supervise the use of capital loans is not carried out. Although currently there are efforts from banks to begin to involve themselves in efforts to develop small and medium industries which are a form of social responsibility (CSR), however, this form of assistance as applied to venture capital is difficult for banks to do. Thus, this is an advantage as well as an added value for venture capital companies, even though this is also a form of PMV's efforts to interfere in managing the business.

Whatever form of financing is chosen, whether it is the profit sharing scheme or the inclusion of shares and convertible bonds, it is no less important to prepare the Startup to be independent and it all really depends on the responsibility of the startup founders in particular and PMV in general. Basically, the discussion about venture capital and partner companies in their position as companies cannot be separated from Law Number 40 of 2007. About Limited Liability Companies. These regulations can be the basis for answering various problems in venture capital, such as company management that can be controlled by PMV, the form of shares and so on, especially if the form of financing chosen is the investment in shares and convertible bonds and the possibility of divestment. Indeed, interpretations are needed to suit venture capital as a financing institution.

***Startup* Development**

The effect of the role of the Government, if observed by the regions, will differ depending on each region. Like Assistantku.com in Metro City, Lampung, which lacks local government support between 2017 - 2019, because they don't really understand the role of startups in society. On the contrary, startups tend to be hindered by various bureaucracies that occur in local governments. Constrained by the fears of some parties who think that startups also create conflicts, especially because of various media reports about the conflict between online transportation startups and conventional transportation. Especially in 2017, the Government has not yet established regulations related to online transportation service

The founders of Startup Assistantku.com have also held audiences with the Mayor of Metro, the Regional Representative Council (DPRD) of Metro City, the City of Metro Transportation Service, to introduce the startup Assistantku.com and ask for help from the Government. However, according to Anita Usari Dewi, the government did not really understand the digital business or startup at that time. In addition, information on startups that reaches the public and the lack of regulations makes the Regional Government feel foreign to the existence of startups. Under these conditions, startup Assistantku.com indirectly does not get support from the government, both for the online pedicab and online queue features.

On the other hand, when my startup Assistant founders decided to manually run the queuing system and conduct trials in various offices that required long queues. There was resistance from many parties, from

the office owner to the local community. However, Assistantku.com received positive support from the Yogyakarta Government, because it was considered to be very supportive of the development of Yogyakarta and improve the standard of living of the people of Yogyakarta. Various forms of support provided by the Yogyakarta City Government at that time were the initiation to form a Group Discussion Forum (FGD) to gather various agencies that would be involved or directly in contact with Assistantku.com. These agencies are the Department of Transportation, the Office of Tourism, the Local Government, the Yogyakarta Tour & Travel Association and the pedicab association throughout Yogyakarta. In addition to the FGD, the Yogyakarta City Government also facilitates intense communication with pedicab owners along with the horse cart. This is done in order to form a clear management system in the management of online pedicabs and online carts in Yogyakarta.

Access to information and the Startup Ecosystem created by the Government will greatly assist the growth of the Startup itself. The Metro City ecosystem has not yet formed a Startup ecosystem so that there is resistance from the Government, there are high doubts from the public to accept Startup products and the absence of an expert IT team in the area. As a result, Startup growth has experienced obstacles. In contrast to areas with high and good startup ecosystem levels such as Yogyakarta and Bandung. Of course, this has an impact on a good Startup Ecosystem, the availability of experts, to high public acceptance of innovative products that appear in the region. Likewise with Yogyakarta, which has a fairly good understanding of startups, resulting in the acceptance of innovations carried by startups that are immediately captured as positive opportunities. Although these innovations did not come from residents in Yogyakarta themselves, but from Lampung residents.

The difference in government support basically also has an impact on the financial strategies of the two startups. Because Assistantku.com does not get support in their hometown, and if they have to develop a system in other areas, it requires additional funds. This makes Assistantku.com have to struggle with their own funds or the term in Startup is known as bootstrapping.

Based on the results of interviews and analysis of various data, it can be seen that venture capital has a greater role in the development of startups in Indonesia. This can be seen from the various data above, each year venture capital provides funding to startups that are considered feasible. Even in covid-19 conditions, when the world economy looks weak. Venture capital continues to issue various forms of funding. Thus, it can be concluded that from the aspect of startup funding, it is more helpful than venture capital. However, this condition tends not to apply to all startups in Indonesia.

Assistantku.com , which is also a startup from Lampung, failed to get funding from venture capital. At that time, Assistantku.com had passed the selection period from Orbit Ventura, a venture capital company owned by Ilham Habibie. However, after the second interview, Assistantku.com failed to get funding. The factors causing failure also vary, starting from the start-up considered immature, to small transaction values. This condition is reasonable because basically startups are technology-based start-ups. Like a company in any field, the company has a profit view because it aims to make a profit. If the company has

not achieved a good profit, of course, from venture capital will really consider it.

A venture capital firm invests funds in any business with a professional outlook. This is because of the nature of equity financing, venture capital investors are exposed to the risk of corporate failure. As a result, venture capitalists should look to invest in companies that have the ability to grow very successfully and provide higher than average returns to compensate for risk.

Qiwii.id *startup* development

Slightly different from Assistantku.com, Qiwii.id actually received special treatment from the Regional Government of Bandung City. This is due to the initiative of the City of Bandung to form the Bandung City Smart City Development Council. This council is tasked with providing input to regional heads regarding the progress of smart cities. Among them are smart governance, smart economy, smart branding, smart living, smart environment, and smart society. With the incorporation of the founder of Qiwii.id in the Smart City Development Council, it makes Qiwii.id easier to apply in society. This is because the idea of an online queue originated at the initiation of the Smart City Development Council and was then applied directly to Bandung City Government Offices.

Access to information and the Startup Ecosystem created by the Government is also very helpful for the growth of the startup itself. Bandung has high access to information, so that the Regional Government has high initiatives to form a Smart City. Of course, this has an impact on a good Startup Ecosystem, the availability of experts, to high public acceptance of innovative products that appear in the region.

The difference in government support basically also has an impact on the financial strategies of the two startups. Because Qiwii.id startup has access to various marketing networks and government ecosystems that are better prepared, this makes it easier for Qiwii.id to do marketing by minimizing the need for funds. In fact, some of Qiwii.id's products are ordered and modified according to the needs of Bandung City Government Services in collaboration with Qiwii.id.

Apart from the support of the Bandung City Government, Qiwii.id also received support from various ministries of the Republic of Indonesia. The Ministry of Foreign Affairs has invited Qiwii.id several times to be able to display its startup products at various national and international exhibitions. In fact, Qiwii.id was also introduced to various agencies / strategic partners of the Ministry of Foreign Affairs to explore the expansion of Qiwii.id in various cross-country agencies. The Ministry of Tourism and Creative Economy (Kemenparekraf) has also provided capital assistance to Qiwii.id. In fact, make Qiwii.id as a speaker at various training events, coming from successful startups. In addition, the Indonesia Stock Exchange (IDX) is also providing assistance to Qiwii.id with the hope that in the future Qiwii.id can register its company on the Indonesia Stock Exchange.

As for taxes, even though Qiwii.id has a legal entity, it does not have an income of up to 4.8 billion in a year. Therefore it does not include PKP. Thus, taxes have no impact on Startups. This condition had less

impact when growing startups chose not to have a legal entity at the start. Many startups choose to start their startups without having a legal entity status, because based on the consideration that their startup focus is on running a business.

When viewed from the aspect of the role of venture capital in the development of startup Qiwii.id, Qiwii.id tends to find it easier to get funding from both angel investors and venture capital. This is because from a business aspect, Qiwii.id is more mature and ready to develop. Qiwii.id already has high customers and transactions every month. Under these conditions, venture capital is more interested in providing funding. Moreover, the venture capital approach is different from the approach of a lender or bank. The bank does not participate with management and eschews ties from business management, operations and other decision making.

The different forms of venture capital with its management approach result in different effects experienced by startups. Qiwii.id for example, because it has received funding, Qiwii.id is required to experience Startup growth. The meaning of growth means broad, starting from the expansion of the marketing coverage area, to product innovations that Qiwii.id must always come up with. However, this does not mean that this condition makes Qiwii.id more free to move. In fact, Qiwii.id feels that its management has become a little less flexible. As a result, Qiwii.id prefers to postpone funding entering again in the next period until it is really needed for product development. This is when venture capitalists invest in a business, they usually direct and guide the business so that it leads to capital gains. Venture capital is an important part of corporate decision making and occupies a place on the board of directors. Various management, sales and technical issues to help the company develop its full potential.

Venture capital plays a very important role when a startup wants maximum growth without considering the initial profit. This is because venture capitalists tend to focus on startup growth, increasing transactions and growing the number of users. These various conditions lead to an increase in the valuation value of the Startup. The more users and the higher the transaction makes the value Startup valuation is getting higher

III. CONCLUSIONS AND SUGGESTIONS

Conclusion

This study aims to determine the role of the Government and Venture Capital in the development of startups in Indonesia. The research was conducted at startups with similar product categories, namely Assistantku.com and Qiwii.id. Both are online queuing startups, with a research time period between 2017 - 2020. On the other hand, this study uses various supporting data from the Government, Venture Capital, National Media side to strengthen the results of this study.

Based on the description in the discussion, several conclusions can be drawn that:

1. Based on the research results, it can be seen that the role of the Government nationally has made various efforts since 2015 until now. These efforts consist of making regulations, incubation and acceleration programs to capitalization. Meanwhile, venture capital has had a positive impact on the

development of startups in Indonesia, even during the Covid-19 pandemic. Apart from funding, venture capital also plays a big role in startups because it provides management assistance.

2. The role of the central government tends to be different from the role of the Regional Government in each region. Like my Assistant in Metro City, Lampung, which lacks support from the Regional Government between 2017 - 2019, because they don't really understand the role of startups in society. However, my Assistant received positive support from the Yogyakarta Government, as it was considered to be very supportive of the development of Yogyakarta. Meanwhile, Qiwii.id received special treatment from the Bandung City Government. The difference in the role of the Government causes different impacts on Startups. Startups that get government support, develop well, have good access to marketing, good internal business processes, and good financial growth.
3. Venture capital has a high role in startup development because of funding support and management assistance. For startups that get funding support, it will be easier to carry out product development and marketing expansion. Meanwhile, startups that do not get funding support tend to fail in certain years. This is because funding is the key to startup development, especially in the early stages. In addition, management assistance support, on the one hand, limits the startup movement due to the entry of investors into the Board of Directors. But on the other hand, management assistance support makes the learning and growth of startup organizations better.

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Identification of phenolic compounds and their relationship to the natural resistance of wood from *Dipteryx polyphylla* Huber and *Acacia mangium* Willd

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Abstract

*Flavonoids are the phenolic compounds that are predominant in the Fabaceae family, and isoflavonoids are especially recognized for their contribution to the natural resistance of wood from species of this family. Herein, we investigated the phenolic compounds from extracts of wood residues from the Fabaceae species Dipteryx polyphylla Huber and Acacia mangium Willd. A phytochemical study of D. polyphylla led to isolation and identification of isoflavans such as 3',7-dihydroxy-4'-methoxy-isoflavan (**1**), 2',8-dihydroxy-4',7-dimethoxy-isoflavan (**2**), 2',7-dihydroxy-4'-methoxyisoflavan (**3**) and 3',8-dihydroxy-4',7-dimethoxy isoflavan (**4**). Compounds **1** and **4** are new findings. A. mangium gave monocyclic phenolics, such as ferulic acid (**6**), methylparaben (**7**) and 4-hydroxybenzaldehyde (**8**); flavonol melatoxetin (**9**) as well as fatty acid esters of spinasterol (**5**). The phenolic compounds that were identified contribute to the knowledge regarding the natural resistance of its woods, thus aggregating value for solid residues and plantation species recommended for reforestation*

Keywords: Isoflavonoids; monocyclic phenolics; Fabaceae; spectroscopic techniques.

1. Introduction

Phenolic compounds constitute a broad group of aromatic compounds that range from simple phenols to highly polymerized compounds that are of interest to researchers due to their extensive natural occurrence in plants, the variety in chemical structures and potential biological properties. According to their chemical structure, phenolic compounds are classified into phenolic acids (hydroxybenzoic and hydroxycinnamic acids), flavonoids, stilbenes, lignans, cou marins, and tannins, among other subgroups.

Flavonoids that are widely found in plant vascular tissues perform several functions, such as protection against ultraviolet B radiation, as constitutive antifungal agents (phytoalexins), and they also

play a role in plant-herbivory interactions (Harbone and Willians, 2000). These compounds are predominant in the Fabaceae (Leguminosae) family, and are distributed in its three subfamilies (Faboideae = Papilionoideae), Caesalpinioideae and Mimosoideae. lsoflavonoids are a distinctive subclass of flavonoids with a characteristic structure in which a phenyl group is attached to C-3 of the pyrone ring (skeleton II) instead of C-2, as in other flavonoids (skeleton I), and these are restricted almost entirely to Papilionoideae, the largest of its three subfamilies (Veitch, 2013). There are many reports about the important role of isoflavonoids as precursors for the development of phytoalexins during plant microbe interactions (Harbone and Willians, 2000).

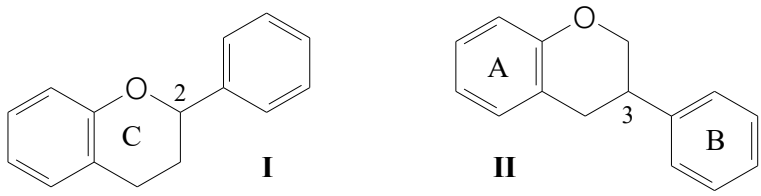

Figure 1. Basic skeletons of flavonoids and isoflavonoids

Natural resistance to decay is one of the most important properties of wood, and this is affected by wood density and the content and composition of extractives. Schultz and Nicholas (2000) proposed that extractives can protect the wood against colonization and subsequent degradation by a double mechanism, in other words, the extracts have some type of fungicidal activity and are also free radical scavengers (antioxidants). Studies have evidenced that flavonoids from Fabaceae present an important effect on the natural durability of its wood (Reves-Chilpa e*t al.*, 1998; Barry e*t al.*, 2005; Morimoto e*t al.*, 2006; Pizzo e*t al.*, 2011; Martínez-Sotres e*t al.*, 2012). The correlation between density and extractive content of wood with the biological resistance of Amazonian woods was verified by Costa e*t al.* (2019) and Abreu and Silva (2000), and including some species of Fabaceae.

The Fabaceae species, *Dipteryx polyphylla* (Papilionoideae subfamily) and *Acacia mangium* (Mimosoideae subfamily), occur in the Amazon region. *Dipteryx polyphylla* Huber [synonym *Coumarouna polyphylla* (Huber) Ducke] (Tropicos, 2020) is popularly known in the Amazon region as *cumarurana*. Its wood has a high density (0.74 g/cm^3) (Castro e*t al.*, 2015), and the tests of susceptibility to xylophagous organisms carried out with this species has evidenced its natural resistance (Jesus e*t al.*, 1998), however, there are no reports on its secondary metabolites. *Acacia mangium* Willd. [syn. *Racosperma mangium* (Willd.) Pedley] (Tropicos, 2020) originates from Australia and Malaysia, and has easily adapted to the tropical Brazilian soil and climatic conditions (Luz *et al*., 2010). The commercial plantations of this species in Brazil extract tannins obtained from bark, which are used in the tannery industries, and the wood is used by the cellulose industry, as well as for generating energy and the production of wood panels (Attias *et al*., 2013). The literature reports the potential of *A. mangium* for reforestation and recovery programs of areas with poor or degraded soils (Attias *et al*., 2013; Schiavo and Martins, 2003; Tulod *et al*., 2017). The wood of a specimen from the Amazon showed a basic density of 0.58 g/cm^3 (Barros *et al* 2012) and studies report the existence of three flavonoids (Barry *et al*., 2005; Pietarine *et al*., 2005).

In this study, we investigated the secondary metabolites from extractives of wood residues obtained from *Dipteryx polyphylla* and *Acacia mangium* and we discussed their relationship with the natural resistance of their wood.

2. Materials and Methods

2.1 General

Nuclear Magnetic Resonance (NMR) spectra were measured using spectrometers (Bruker Fourier-300, DRX 400 and Avance III, 14.1 Tesla/600 MHz) with tetramethylsilane (TMS) as the internal standard. LC-HRMS measurements were obtained using mass spectrometer (MicroTOF-QII, Bruker Daltonics) connected to a chromatograph (Prominence UFLC, Shimadzu). Mass spectra were acquired using an ion trap spectrometer (LCQ FleetTM, Thermo Scientific) equipped with an electrospray source, operating in positive mode. Melting points were determined on a melting-point apparatus (Fisatom 430D). Chromatographic fractionations by medium pressure liquid chromatography were performed on Sepacore® Buchi. Column chromatography was performed with silica gel 60 (Merck), microcrystalline cellulose (Merck), Sephadex LH-20 (Sigma) and Amberlite XAD-2 (Supelco). Analytical TLC was performed with silica gel 60 F254 (0.25 mm) pre-coated alumina sheets (Merck), and visualized using UV light (254 and 365 nm), vanillin-sulphuric acid and NP/PEG reagent spray.

2.2 Wood Residues and Extraction

Samples of wood residues from *Dipteryx polyphylla* were obtained from the *Estação Experimental* de Silvicultura *Tropical (*53 km north of the city of Manaus, Amazonas State), at the Instituto Nacional de Pesquisas da Amazônia (INPA) and *Acacia mangium* was obtained from a plantation located in the city of Iranduba (29 Km from the city of Manaus). The identification of the wood samples was done through macroscopic comparisons with standard samples from the xylotheque at INPA. The largest residues were previously evaluated for their technological properties, the smallest resulting from these procedures became available for phytochemical studies. Extraction was performed by macerating the samples with hexane followed by methanol at room temperature.

2.3 Chromatographic Fractionation of Dipteryx polyphylla Extract

The hexane extract of *D. polyphylla* showed a predominance of a triterpene known as lupeol. The methanolic extract (8.35 g) was fractionated on a silica gel chromatographic column (70-230 mesh; h X Φ =28.5 X 4.7 cm), eluted with hexane, hex-EtOAc (8:2 and 1:1), EtOAc and EtOAc-MeOH (9:1) to yield twenty-two fractions and then fractions 5 and 7 were subjected to new chromatographic fractionations. The fractionation of fr. 5 on a silica gel column (230-400 mesh; h X Φ = 29.3 X 1.0 cm), when eluted with hex-EtOAc (8:2-100%), gave compounds **1** (3.0 mg), **2** (1.0 mg) and **3** (2.0 mg). Fr. 7 was fractionated on a silica gel column (70-230 mesh; h X Φ = 27.5 X 3.6 cm), eluted with CH_2Cl_2 and CH_2Cl_2-EtOAc (9:1-1:1), followed by a Sephadex LH-20 column eluted with MeOH to yield compound **4** (7.0 mg).

2.4 Chromatographic Fractionation of Acacia mangium Extract

Fractionation of the hexane extract (1.15 g) over silica gel in the column (230-400 mesh; h X Φ = 29.0 X 3.8 cm), eluted with hexane, hex-EtOAc (5-50%), EtOAc and EtOAc-MeOH (1-10%), yielded twenty-four fractions. The grouped fractions 8-24 were subjected to a new chromatographic fractionation in a silica gel

column (230-400 mesh, h X Φ = 24.5 X 2.0 cm) eluted with hex-EtOAc (5-20%) to give compound **5** (25 mg). Methanolic extract (13.0 g) fractionated over silica gel in a column (230-400 mesh; h X Φ =24.0 X 4.7 cm), eluted with hexane, hex-EtOAc (10-50%), EtOAc and EtOAc-MeOH (10-50%), yielded twenty-nine fractions. The grouped fractions 7-11 (fr. ACM-7; 468 mg) and 14-16 (fr, ACM-14; 2.79 g) were submitted to the new chromatographic procedures.

ACM-7 was fractionated over silica gel in the column (230-400 mesh; h X Φ = 29.0 X = 2.8 cm), eluted with hexane, hex-EtOAc (3-50%) and EtOAc, and provided twenty-nine subfractions, compounds were purified after the following chromatographic procedures: compound **6** (3 mg) was purified from subfractions 13-17 by medium pressure liquid chromatograph over silica gel (230-400 mesh) eluted with hex-EtOAc (98:2-95:5); a mixture (20 mg) of β-sitosterol and stigmasterol was obtained from subfr. 19; compounds **7** (1.0 mg) and **8** (3.0 mg) were obtained from subfr. 20 and 21, respectively, using a microcrystalline cellulose column eluted with hexane and hex-EtOAc (9:1). ACM-14 (3.7 g) over Amberlite XAD-2 in a column (h X Φ = 25.0 X 3.6 cm), eluted with H_2O, MeOH-H_2O (1:1), MeOH and MeOH-EtOAc (1:1) gave compound **9** (3.0 mg).

2.5 Spectroscopic Data of Phenolic Compounds

3',7-Dihydroxy-4'-methoxy-isoflavan (**1**). Yellow solid, mp 87-89ºC. HRMS m/z 273.1133 $[M+H]^+$. ^1H NMR (600 MHz, Acetone-d6, J/Hz) and ^{13}C NMR (150 MHz, Acetone-d6): Table 1. HMBC (Acetone-d6): H-2 → C-3, 4, 9, 1'; H-3 →C-2, 4, 1', 2', 6'; H-4 → C-2, 3, 5, 9, 10, 1'; H-5 → C-4, 9; H-6 → C-7, 8, 10; H-8 → C-6, 8, 10; H-2' → C-3, 4', 6'; H-5' → C-1', 3'; OMe → C-4.

2',8-Dihydroxy-4',7-dimethoxy-isoflavan (**2**). White solid, mp 105ºC. ^1H NMR (600 MHz, Acetone-d6, J/Hz): 7.06 (d, J = 8.5, H-6'), 6.66 (d, J = 8.3, H-6), 6.51 (d, J = 2.5, H-3'), 6.42 (dd, J = 8.5, 2.5, H-5'), 6.40 (d, J = 8.3, H-5), 4.35 (ddd, J = 10.1, 3.5, 2.1, H-2eq), 4.03 (t, J = 10.1, H-2ax), 3.76 (s, 7-OCH_3), 3.72 (s, 4'-OCH_3), 3.49 (m, H-3), 2.99 (ddd, J = 15.5, 11.0, 0.7, H-4ax.), 2.81 (ddd, J = 15.5, 5.2, 2.1, H-4eq), ^{13}C NMR (150 MHz, Acetone-d6): 159.5 (C-4'), 156.1 (C-2'), 148.6 (C-8), 147.6 (C-9), 135.7 (C-7), 127.5 (C-6'), 123.6 (C-6), 119.8 (C-1'), 114.7 (C-10), 107.2 (C-5), 104.6 (C-5'), 101.3 (C-3'), 69.3 (C-2), 59,4 (7-O$\underline{C}H_3$), 54,2 (4'-O$\underline{C}H_3$), 31.5 (C-3), 30.3 (C-4). HMBC (Acetone-d6): Text.

2',7-Dihydroxy-4'-methoxy-isoflavan (vestitol) (**3**). Yellow solid, mp 157-158ºC. ^1H NMR (600 MHz, Acetone-d6, J/Hz): 7.05 (d, J = 8.5, H-6'), 6.89 (d, J = 8.3, H-5), 6.50 (d, J = 2.5, H-3'), 6.42 (dd, J = 8.5, 2.5, H-5'), 6.36 (dd, J = 8.3, 2.5, H-6), 6.27 (d, J = 2.5, H-8), 4.23 (ddd, J = 10.2, 3.5, 2.1, H-2eq), 3.98 (t, J = 10.2, H-2ax), 3.72 (4'-O$\underline{C}H_3$), 3.47 (m, H-3), 2.96 (dd, J = 15.5, 11.0, H-4ax), 2.80 (ddd, J = 15.5, 5.1, 2.1, H-4eq). ^{13}C NMR (150 MHz, Acetone-d6): 160.5 (C-4'), 157.6 (C-7), 156.8 (C-2 '), 156.2 (C-9), 131.1 (C-5), 121.0 (C-1'), 114.3 (C-10), 108.8 (C-6), 105.7 (C-5'), 103.7 128.8 (C-6'), (C-8), 102.5 (C-3'), 70.6 (C-2), 55.4 (4'- O$\underline{C}H_3$), 32.75 (C-3), 31.1 (C-4). HMBC (Acetone-d6): text.

3',8-Dihydroxy-4',7-dimethoxy-isoflavan (**4**). Yellow solid, mp 143ºC. HRMS m/z 303.1247 $[M+H]^+$. ^1H NMR (400 MHz, Acetone-d6, J/Hz) and ^{13}C NMR (100 MHz, Acetone-d6): see Table 1. HMBC (Acetone-d6): H-2 → C-3, 4, 9, 1'; H-3 → C-2, 4, 10, 1', 2', 6'; H-4 →C-2, 3, 6, 9, 10, 1'; H-5 → C-7, 10; H-6 → C-

5, 7, 8; H-2' → C-3, 4', 6'; H- → C-1', 3', 6'; H-6' → C-3, 2', 4'; OMe → C-7; OMe → C-4'.

Ferulic acid (**6**). Amorphous solid. ^{1}H NMR (400 MHz, $CDCl_3$, J/Hz): 7.61 (d, J = 15.9, H-7), 7.08 (dd, J = 8.2 and 1.9, H-6), 7.03 (d, J = 1.9, H-2), 6.91 (d, J = 8.2, H-5), 6.29 (d, J =15.9, H-8), 5.82 (s, O<u>H</u>), 3.93 (s, OMe). ^{13}C NMR (estimated by HMBC and HSQC): 166.7 (C- 9), 146.2 (C-3), 146.1 (C-4), 143.9 (C-7), 126.5 (C-1), 122.4 (C-6), 115.1 (C-8), 114.0 (C-5), 108.7 (C-2), 55.43 (OMe-3).

Methylparaben (**7**). Amorphous solid. HRMS m/z 153.0548 $[M+H]^+$. ^{1}H NMR (400 MHz, $CDCl_3$, J/Hz): 7.94 (d, J = 8.8, H-2 and H-6), 6.84 (d, J = 8.8, H-3 and H-5), 3.87 (s, $OC\underline{H_3}$). ^{13}C NMR (100 MHz, $CDCl_3$): 166.7 (C-1'), 159.5 (C-4), 131.7 (C-2 and C-6), 122.8 (C-1), 115.0 (C-3 and C-5), 51.7 ($O\mathbf{C}H_3$).

4-Hydroxybenzaldehyde (**8**). Amorphous, yellow solid, strong sweetish flavor HRMS m/z 123,0450 $[M+H]^+$. ^{1}H NMR (400 MHz, $CDCl_3$, J/Hz): 7.79 (d, J = 8.8, H-2 and H-6), 6.93 (d, J = 8.8, H-3 and H-5), 9.86 (s, C<u>H</u>O).

Melatoxetin (**9**). Crystalline, yellow solid, mp 279-280ºC. HRMS m/z 285.0383 $[M+H]^+$. ^{1}H NMR (600 MHz, MeOD, J/Hz): 7.59 (J = 8.8, H-5), 6.99 (d, J = 8.8, H-6), 8.29 (d, J = 8.9, H-2' and H-6'), 6.97 (d, J = 8.9, H-3'and H-5'). ^{13}C NMR (150 MHz, MeOD): 174.9 (C-4), 160.5 (C-4'), 151.6 (C-7), 147.8 (C-9), 147.7 (C-2), 138.25 (C-3), 134.2 (C-8), 131.0 (C-2'and C-6'),124.3 (C-1'), 116.6 (C-5), 116.3 (C-10, C-3' and C-5'), 115.1 (C-6), HMBC (MeOD): text.

3. Results and Discussion

3.1 Identification of Compounds 1-4 from Dipteryx polyphylla

The compounds **1-4,** which were isolated from the methanolic extract (Figure 1), were analyzed using ^{1}H, and ^{13}C NMR spectra (Table 1), which showed shifts that are indicative of isoflavans due to characteristic signals of a heterocyclic ring between δ 4.36-4.20 (ddd, H-2eq), 4.04-3.96 (t, H-2ax), 3.49-3.03 (m, H-3), 2.99-2.87 (dd, H-4ax) and 2.90-2.80 (ddd, H-4eq). The HSQC experiments showed the correlations of these hydrogens with C-2 (δ 71.5-69.3), C-3 (38.8-31.5) and C-4 (32.80-30.3), respectively. The oxygenation pattern of the A and B rings was based on the multiplicities, the coupling constants and the correlations observed in the HMBC.

The ^{1}H NMR spectra of compounds **1** and **3** showed the same oxygenation pattern of ring A. The nuclear overhauser effect spectroscopy (NOESY) of **1** presented a spatial interaction of the methoxyl hydrogens and the aromatic hydrogen H-5' (δ 6.91), which confirmed the position of the methoxyl of ring B at C-4'. These spectral data, combined with those of ^{13}C NMR, allowed us to identify compound **1** as a new 7,3'-dihydroxy-4'-methoxy-isoflavan and **3** as a known vestitol (8,2'-dihydroxy-7,4'-dimethoxy-isoflavan) for which the ^{1}H and ^{13}C NMR data were identical to those in the literature (Zhao *et al*., 2011). The ^{1}H NMR spectra of **2** and **4** showed similarity in the signals attributed to ring A. NOESY of **4** indicated spatial proximity between the methoxy hydrogens (δ 3.77) and the aromatic hydrogen (δ 6.66) of ring A and δ 3.83

with 6.91 (ring B) that confirm the methoxyl groups at C-7 and C-4. Thus, compound **2** was identified as 2',8-dihydroxy-4',7-dimethoxy-isoflavan and **4** compound as 8,3'-dihydroxy-7,4'-dimethoxy-isoflavan, for which there are no previous reports. Thus, isoflavans **1** and **4** are new findings. Compounds **2** and **3** have been previously identified from the Papilionoideae subfamily, but are reported for the first time from *Dipteryx*. Vestitol (**3**) has been found this subfamily with clear evidence of its action as a phytoalexin (Masai *et al*., 2013), and it is also indicated as a free radical scavenger (Kaducová, *et al*., 2019).

3.2 Identification of Compounds 5-9 from Acacia mangium

Chromatographic fractionation of the hexane extract from *A. mangium* gave **5** and the methanolic extract yielded compounds **6-9** (Figure 1). The ^{1}H and ^{13}C NMR data of **5** showed signs of olefins, which is compatible for spinasterol (Ragasa & Lim, 2005). The presence of the signal at δ 173.5 in the ^{13}C NMR spectrum and the correlation of hydrogen at δ 4.70 with the carbinolic at δ 73.2 (HSQC) suggested esterification in C-3, thus identifying them as fatty acid esters of spinasterol, which has not been previously reported from Fabaceae.

The ^{1}H NMR spectrum of **6** showed signals referring to three aromatic hydrogens, two olefinic hydrogens, methoxyl and hydroxyl groups. These data associated with those analyzed by HMBC and HSQC permits the identification of **6** as ferulic acid. The ^{1}H NMR spectra of **7** and **8** showed an aromatic region indicative of a type AA'BB' system, as well as a methoxy group at δ 3.87 for **7** and aldehyde hydrogen at δ 9.86 for **8,** thus identifying these benzoic acid derivatives as methyl *p*-hydroxybenzoate (methylparaben) and 4-hydroxybenzaldehyde, respectively. The ^{1}H and ^{13}C NMR data for **9** were similar to those published by Ponce *et al*. (2009) for melatoxetin. The HMBC experiment confirmed the oxygenation pattern of the aromatic rings.

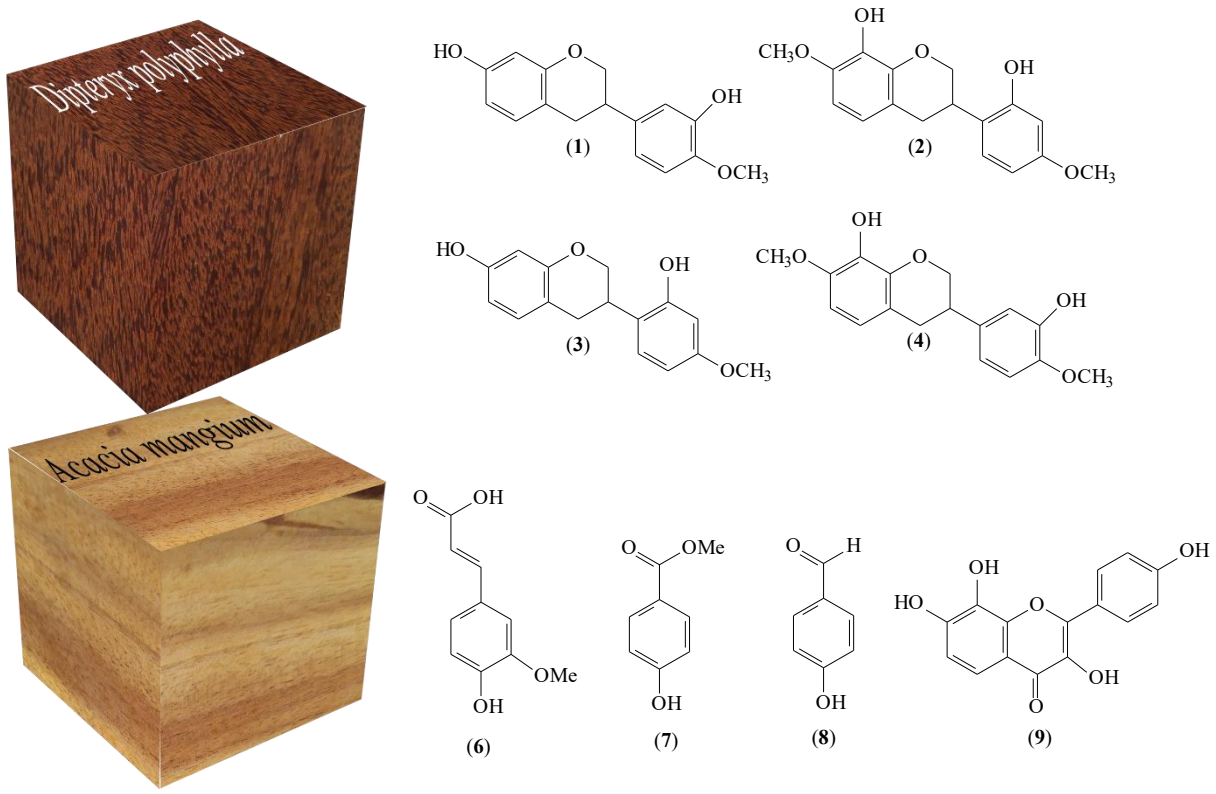

Figure 1. Phenolic compounds from *D. polyphylla* and *A. mangium*

Table 1. ^{1}H and ^{13}C NMR data for isoflavans **1** and **4** (δ ppm, *J*/Hz) in Acetone-d6)

Position	δ H (**1**)	δ H (**4**)	δ C (**1**)	δ C (**4**)
2	3.94 t (10.5, H-ax.)	3.98 t (10.4, H-ax)	70.6	70.5
	4.20 ddd (10.5, 3.6, 2.0 H-eq)	4.31 ddd (10.4, 3.6, 1.8 H-eq)		
3	3.04 m	3.10 m	38.1	37.8
4	2.89 m (H-ax)	2.93 m (H-ax)	31.7	31.8
	2.87 m (H-eq)	2.90 m (H-eq)		
5	6.90 d (8.2)	6.66 d (8.3)	130.1	124.8
6	6.36 dd (8.2, 2.5)	6.40 d (8.3)	107.9	108.8
7			156.7	136.6
8	6.28 d (2.5)		102.7	149.6
9			155.0	148.7
10			113.0	114.3
1’			134.8	134.6
2’	6.81 d (2.2)	6.82 d (2.2)	114.2	114.1
3’			146.7	147.6
4’			146.4	147.3
5’	6.91 d (8.2)	6.91 d (8.2)	111.8	111.7
6’	6.75 dd (8.2, 2.2)	6.77 dd (8.2, 2.2)	118.2	118.2
7-OMe		3.77 s		59.6
4’-OMe	3.83 s	3.83 s	55.4	55.3

3.3 Natural durability of wood from *D. polyphylla and A. mangium*

The presence of isoflavonoids from *D. polyphylla,* allied with the extractive content (secondary metabolites), and which was significantly higher than in the extract of *A. mangium* (Table 2), contribute to the greater biological resistance of the wood of this species, since these are recognized to be the most important factors in determining the natural durability of wood.

The basic density is a property of wood that also contributes to its natural resistance. In fact, previous studies on Amazonian species showed that *D. polyphylla* wood (0.74 g/cm^3) (Castro *et al*., 2015) has a higher density than *A. mangium* (0.58 g/cm^3) (Barros *et al*., 2012).

Table 2. Extractive content of wood residues

Species	(%)	
	Hexane extract	Methanolic extract
D. polyphylla	0.35	3.26
A. mangium	0.14	1.51

4. Conclusion

In this study, the phenolic compounds identified are probably important as defense mechanisms of the two species evaluated. Isoflavonoids from *D. polyphylla* (Papilionoideae) must act as phytoalexins, which are well known for existing in this subfamily, while *A. mangium* (Mimosoideae) gives other phenolics that are also important for the defense of the timber species. Thus, this phytochemical study adds to knowledge in relation to the natural resistance of its woods and increases the value of woody residues and plantation species indicated for reforestation.

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Lavender as treatment of Alzheimer's disease: literature review

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Abstract

Neurodegenerative diseases affect the grey matter of the brain and secondarily the functions related to the white matter, with aging being one of the main responsible for their development. Among neurodegenerative diseases, dementia stands out, which has been considered by the World Health Organization (WHO) as a public health priority since 2012 due to its high prevalence. It is believed that degeneration of the cholinergic system in the hippocampus and cortex is closely related to cognitive deficits in dementia. Among the forms of treatment for dementia, aromatherapy stands out, which is part of phytotherapy and uses extracts and essential oils extracted from different organs of aromatic plants, and frequently administered via inhalation or topical application. Lavender is one of these plants and has traditionally been used to treat memory dysfunction. Thus, the present study sought to verify in the literature research using Lavandula as a form of treatment for neurodegenerative diseases, especially Alzheimer's disease. The search for the studies took place in January 2020, in the electronic database Web of Science. 42 articles were found, of which 13 adequately met the inclusion criteria. It can be concluded with this review, that both the extract and the essential oil of different lavender species have positive influences on memory formation, as well as on the improvement of cognitive function, especially in patients with Alzheimer's disease.

Keywords: *Dementia; Alzheimer's disease; Phytotherapy; Lavandula.*

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1. Introduction

Neurodegenerative diseases are a group of conditions characterized by the gradual and progressive loss of cells in the brain and spinal cord, caused by the accumulation of pathological proteins.[1] Thus, they affect the grey matter of the brain and secondarily the functions related to the white matter.[2] Aging is considered one of the main responsible for the development of neurodegenerative diseases,[3] where inflammatory mediators,[4] defects in cholinergic transmission,[5] glutamate-induced neurotoxicity[6] and oxidative stress[7] involved in the pathogenesis of these diseases.[8]

Among neurodegenerative diseases, dementia stands out, which has been considered by the World Health Organization (WHO) as a public health priority since 2012 due to its high prevalence.[9] WHO data confirm the aforementioned information and highlight that as the world population ages, the number of people with dementia is expected to triple from 50 million to 152 million by 2050, with about 10 million

people developing dementia each year, and 6 million of them are in low and middle income countries.[10]

Based on the cholinergic hypothesis, the degeneration of the cholinergic system in the hippocampus and cortex is closely related to cognitive deficits in dementia. [11,12] Acetylcholinesterase (AChE) is an enzyme responsible for the hydrolysis of acetylcholine (Ach), and its high activity promotes the formation of beta-amyloid (Aβ) that can contribute to the loss of spatial memory.[13-15] Ach is vital for cognitive functions, but it is a neurotransmitter with low amounts in patients with Alzheimer's disease (AD).[17] Thus, increasing the level of Ach in the brain can be an effective therapy for the treatment of AD.[8]

There are different forms of treatment for dementia, which can be through the use of medications or through non-pharmacological therapy. However, the effects of drugs are limited to the delay in the natural evolution of the disease, allowing only stabilization or temporary improvement of the patient[17] without the ability to cure dementia or change its progressive course,[9] in addition to having significant adverse effects, thus hampering patient compliance.[18]

In this context, another form of treatment for dementia that is growing worldwide is aromatherapy, which is part of phytotherapy and uses essential oils and extracts extracted from different organs of aromatic plants, and frequently administered via inhalation or topical application.[19] The genus *Lavandula*, belonging to *Lamiaceae* family, is one of these plants, has small purple flowers that are used to produce aromatic extracts,[20] which have been traditionally used in the treatment of memory dysfunction.[21] Lavender is composed of more than 100 constituents, whose major components are linalool, linalyl acetate, 1,8-cineole and camphor.[22] Several pharmacological properties are attributed to its extract, including anti-inflammatory and antimicrobial activity,[23] as well as in cancer treatment.[20] The ethanolic extract of *Lavandula officinalis* also demonstrated an improvement in spatial learning and memory, as well as in motor coordination and passive avoidance learning in an animal model.[24] Inhibitory effects of different concentrations of *Lavandula* extract on the AChE enzyme have been proven through various tests on cell lines.[14,22,25]

In addition to the extract, *Lavandula angustifolia* essential oil has shown sedative,[26] anxiolytic[27,28] analgesic effects,[29] and melatonin production.[30] A decrease in neurological deficit, infarct size, carbonyl and reactive oxygen species was also observed in rats submitted to ischemia and reperfusion, demonstrating a strong neuroprotective effect.[31]

Considering the high prevalence, the economic and social importance of neurodegenerative diseases, the difficulty of effective treatments and the potential of products of natural origin, such as essential oils and extracts, the objective of present study was to investigate in the literature research that uses *lavender* as a form of treatment for neurodegenerative diseases, especially Alzheimer's disease.

2. Materials and Methods

This study is characterized as exploratory, of the literature review type. The search for the studies took place in January 2020, in the electronic database Web of Science. The descriptors and keywords used were: lavender, lavandula, neurodegenerative diseases, central nervous system, dementia, Alzheimer, followed by the Boolean operators AND; OR.

Complete articles were included in this literature review, which addressed the use of lavender as a

treatment for neurodegenerative diseases of the central nervous system, especially Alzheimer's disease. Literature review studies and pilot studies were excluded from the sample, as well as studies that approached the use of lavender with another therapeutic approach. All stages of the methodological quality analysis of the articles were carried out by two independent and blind evaluators.

After searching the database, titles and abstracts were evaluated and studies that met the inclusion criteria were selected for full reading. The following characteristics of the publications were recorded: year of publication, name of the author (s), species and form used, as well as the purpose of the study.

3. Results and Discussion

The search in the Web of Science database resulted in the collection of 42 articles, where 13 adequately answered the inclusion criteria, 12 were literature reviews and 17 were outside the proposed theme. The publications that comprised the sample of the present study were published between the years 2009 to 2019 as shown in Table 1.

Table 1 - Studies that used Lavender to treat dementia.

Author (Publication Year)	Study model	Species used	Objective of the study
Jimbo *et al.* (2009)[32]	*In vivo* (human)	Essential oils of rosemary, lemon, lavender and orange (species not reported)	To investigate the healing effects of aromatherapy on dementia in elderly people with Alzheimer's disease (AD)
Kashani *et al.* (2011)[8]	*In vivo* (Wistar rats)	Aqueous extract of *Lavandula angustifolia*	To evaluate the effects of aqueous lavender extract on the spatial performance of rats with AD
Hritcu; Cioanca; Hancianu, (2012)[33]	*In vivo* (Wistar rats)	Essential oils of *Lavandula angustifolia* and *Lavandula hybrida*	Investigate the effects of two types of lavender essential oils on neurological capacity in a model of dementia
Costa *et al.* (2013)[34]	*In vitro*	*Lavandula viridis* extracts	To evaluate the neuroprotective effect of extracts against oxidative damage
Hancianu *et al.* (2013)[34]	*In vivo* (Wistar rats)	Essential oils of *Lavandula angustifolia ssp. Mill angustifolia.* and *Lavandula hybrida* (lavandin)	Investigate the relationship between the antioxidant and anti-apoptotic action of lavender essential oils and their neuroprotective properties in a dementia model

Videira *et al.* (2013)[36]	*In vitro*	*Lavandula luisieri* essential oil	To evaluate lavender essential oil as a possible inhibitor of the enzyme beta-secretase 1 (BACE 1).
Soheili; Tavirani; Salami (2015)[37]	*In vivo* (Wistar rats)	Aqueous extract of *Lavandula angustifolia*	To evaluate the effect of aqueous lavender extract on induction of LTP (long-term potentiation) in the CA1 area of the hippocampus
Zali *et al.* (2015)[38]	*In vivo* (Wistar rats)	Aqueous extract of *Lavandula angustifolia*	To evaluate the protective effect of lavender on the hippocampus of rats in an AD model, studied by proteomic techniques
Xu *et al.* (2017)[39]	*In vivo* (mice)	*Lavandula angustifolia* essential oil	To investigate the effects of lavender essential oil and its active component, linalool (LI), against cognitive impairment in an AD model
Mushtaq Anwar; Ahmad (2018)[40]	*In vivo* (mice)	Methanolic extract of *Lavandula stoechas*	Explore the pharmacotherapeutic role of lavender in the management of dementia
Oskouie *et al.* (2018)[16]	*In vivo* (Wistar rats)	Aqueous extract of *Lavandula angustifolia*	Investigate the therapeutic effects of aqueous lavender extract on Alzheimer's models of rats
Soheili *et al.* (2018)[41]	*In vitro*	*Lavandula angustifolia* essential oil	Assess whether lavender essential oil influences aggregations of beta amyloid (Aβ) plaques
Qneibi et al. (2019)[42]	*In vitro*	Essential oils of *Lavandula dentata* and *Origanum syriacum L.*	Investigate the depressive properties of these oils in AMPA receptors

Source: Elaborated by the authors.

Jimbo et al.[32] examined the effects of aromatherapy on dementia in 28 elderly people, 17 of whom had Alzheimer's disease (AD). The therapy took place for 28 days, where the participants were exposed to the aroma of lemon essential oil (0.04 mL) and that of rosemary essential oil (0.08 mL) in the morning, from 9:00 am to 11:00 am, as well as lavender essential oil (0.08 mL) and orange essential oil (0.04 mL) at night, from 7:30 pm to 9:00 pm. The oils were placed on a piece of gauze in diffusers with an electric fan. Two

diffusers were installed in each room where the patients were transferred. To determine the effects of aromatherapy, patients were assessed using the Gottfries, Brane, Steen scale (GBSS-J), Functional assessment of Alzheimer's disease staging (FAST), Hasegawa's Dementia Scale (HDS-R) and the Scale evaluation of Touch Panel dementia (TDAS).

The study authors observed that all patients showed significant improvement in personal orientation related to cognitive function in GBSS-J and in TDAS after therapy. In particular, patients with AD showed a significant improvement in total TDAS scores. The results of routine laboratory tests did not show significant changes, suggesting that there were no side effects associated with the use of aromatherapy. Thus, they concluded that aromatherapy, through the use of essential oils of lemon, rosemary, lavender and orange, is an effective non-pharmacological therapy for the treatment of dementia and can be a strong potential to improve cognitive function, especially in patients with AD.[32]

In the study by Kashani et al.[8] the effects of *Lavandula angustifolia* aqueous extract on the spatial performance of 80 male Wistar rats with AD were observed. Animal model of AD was established by intracerebroventricular, 20 day prior to the administration of the lavender extract. All animals received lavender intraperitoneally at a volume of 0.4 mL/kg of body weight and were divided into a control group (distilled water) and an experimental group (aqueous extract of *L. angustifolia*), in doses of 50, 100, and 200 mg/kg. The treatment was carried out once a day for 20 consecutive days. The authors observed an improvement in the performance of animals with AD at doses of 100 and 200 mg/kg and believe that the protective effect of lavender extract can be attributed to its anti-inflammatory property, as well as, they believe that the suppression of glutamatergic neurotoxicity may also be responsible for the relief of cognitive deficits in AD.

Researchers Hritcu, Cioanca and Hancianu[33] conducted a survey of 50 male Wistar rats with scopolamine-induced dementia and investigated behavioral recovery after chronic exposure to *Lavandula angustifolia Mill*. and *Lavandula hybrida* essential oils. The animals were exposed to oil vapor (4 drops of oil = 200 μL) for a period of 60 min before conducting behavioral tests, daily, for 7 consecutive days. A significant reduction in anxiety-like behavior and inhibition of depression was observed, suggesting that lavender essential oils have anxiolytic and antidepressant activity. In addition, the performance of spatial memory has also been improved, suggesting positive effects on memory formation. Thus, lavender essential oils can effectively reverse deficits in spatial memory induced by dysfunction of the cholinergic system in the brain of rats and can be considered an opportunity to treat neurological abnormalities in dementia conditions. [33]

The neuroprotective effect of *L. viridis*, an important aromatic plant, as well as its main component, rosmarinic acid, was evaluated in the study by Costa et al.,[34] in relation to the neurotoxic effect, intracellular production of reactive oxygen species (ROS) and activity of the antioxidant enzyme catalase (CAT). The authors carried out an in vitro study on the human astrocyte cell line (A172) and observed that the *L. viridis* extract protected the astrocytes (A172) against oxidative damage. In addition, the protective effect was not caused by CAT modulation, suggesting that other intracellular mechanisms are involved in the neuroprotective effect. Thus, the researchers point out that *L. viridis* extracts, as well as their main

component, rosmarinic acid, have beneficial effects against oxidative damage associated with neurodegenerative diseases, however, they suggest new investigations to fully understand the mechanisms behind the neuroprotective effect of *L. viridis*.[34]

In the study by Hancianu et al.[35] the antioxidant and anti-apoptotic activities of the essential oils of *Lavandula angustifolia ssp. Mill.* and *Lavandula hybrida* were investigated, through the specific activities of superoxide dismutase (SOD), glutathione peroxidase (GPX) and catalase (CAT). The total content of reduced glutathione (GSH), level of malondialdehyde (MDA) (lipid peroxidation) and DNA fragmentation assays were also evaluated in 50 male Wistar rats, submitted to scopolamine-induced dementia model. The animals were exposed to lavender oil vapors for a period of 60 minutes, daily, for 7 continuous days. The authors observed that treatment with lavender oils significantly increased the activities of antioxidant enzymes (SOD, GPX and CAT), reduced the total GSH content and reduced lipid peroxidation (MDA level) was also observed in the temporal lobe of the animals rats, suggesting strong antioxidant potential. In addition, it was noted that DNA cleavage patterns were absent in the lavender groups, suggesting anti-apoptotic activity. Following, the authors suggest that the antioxidant and anti-apoptotic activities of lavender essential oils are the main mechanisms for their neuroprotective effects against oxidative stress induced by scopolamine in the brain of rats. [35]

According to Videira et al.[36] one of the most important characteristics in AD is the generation and deposition of neurotoxic β-amyloid (Aβ) peptide. Inhibition of BACE-1, a key enzyme in the formation of Aβ, is considered a promising therapeutic alternative for this disease. Thus, the authors screened several essential oils for their inhibitory activity in BACE-1 and chose to evaluate *Lavandula luisieri* essential oil as a possible enzyme inhibitor. The essential oil was characterized and demonstrated high levels of monoterpenes containing oxygen, mainly derived from necrodane. According to the study's authors, the main inhibitory activity was attributed to monoterpenic ketone 2,3,4,4-tetramethyl-5-methylene-cyclopent-2-enone, one of the distinguishing components of the essential oil of *L. luisieri*. These results showed that this essential oil and its components inhibited BACE-1 activity, both in enzymatic and cellular assays, presenting the ability to permeate cell membranes, which can be considered a possible treatment for AD.[36]

In the study by Soheili, Tavirani and Salami[37] the effect of the aqueous extract of *Lavandula angustifolia* on LTP (long-term potentiation) of synaptic transmission in the CA1 area of the hippocampus in an Alzheimer's model was evaluated. For the development of this model, the animals received an intracerebroventricular injection of 1 micrograms Aβ1 - 42. Thirty-two male Wistar rats participated in the study, who received intraperitoneally, distilled water or 200 mg/kg of *L. angustifolia* extract. The administrations were carried out for 20 days and the volume of injections was adjusted to 0.4 ml / kg of body weight for all groups of animals. The authors noted that the herbal extract was ineffective in basic synaptic activity in the hippocampus circuits; however, it had a positive impact on the synaptic transmission mediated by the tetanized NMDA receptor, both in normal animals and, mainly, in animals with AD.

The aqueous extract of *L. angustifolia* (200 mg) was also used in the study by Zali et al.[38] in which 30 Wistar rats received treatment administered intraperitoneally once a day, for 20 consecutive days. The animals were divided into two groups, the control group that received distilled water and the experimental

group, which received the treatment with *L. angustifolia* extract. The authors investigated the hippocampus of mice injected with beta-amyloid (Aβ) and treated with *L. angustifolia* by proteomics techniques. The study showed that the lavender extract improves the spatial performance in an animal model of AD, decreasing the production of Aβ, proven through histopathology of the hippocampus.

In addition to the extract, *L. angustifolia* essential oil was also of interest to researchers Soheili, Tavirani and Salami[41] who developed a study to verify whether the oil has an influence on the aggregations of beta amyloid plaques (Aβ) through the measurement technique thioflavin T and atomic force microscopy (AFM). Different doses of *L. angustifolia* essential oil (1, 10 and 100 µg/mL) were used and the results demonstrated that the effectiveness of essential oil in reducing the formation of Aβ aggregates is dose dependent. The dose of 1 µg/mL did not indicate a significant difference, however when the concentration of the herbal medicine increased to 10 µg/mL, the formation of Aβ fibrils occurred, however, the changes were not statistically significant. An additional increase of *L. angustifolia* oil to 100 µg/mL gave rise to real polymerization and induced considerable Aβ aggregates, thus demonstrating that lavender essential oil influences Aβ fibrillation at a dose of 100 µg/mL.

In a previous study, the same researchers observed that the aqueous extract of *L. angustifolia* has an important potential in removing Aβ plaques from the brain of animals with Alzheimer's disease.[43,8] Contrary to the histological evidence of the aqueous extract, the essential oil of *L. angustifolia* polymerized the Aβ peptides in the study by Soheili, Tavirani and Salami.[41] The authors believe that the discrepancy between the two forms of lavender may be due to the different composition of extracts and essential oil. While the essential oil of *L. angustifolia* has linalool and linalyl acetate as its main component, the aqueous extract has rosmarinic acid as its main component[41-37] which according to Ono et al.[45] inhibits Aβ polymerization, confirming the anti-aggregative effect of aqueous lavender extract.[41]

Another recent study was developed to investigate the effects of *L. angustifolia* essential oil and its main component, linalool, on cognitive impairment induced by D-galactose (D-gal) and AlCl3 in male mice. Ninety animals received treatment via intraperitoneal for 8 weeks. The authors observed that *L. angustifolia* oil and linalool significantly improved the cognitive impairment induced by D-gal and AlCl3 in the mice. The results indicated that these effects were related to the relief of oxidative stress, reversing AChE activity and increasing weakened synaptic plasticity. The authors suggest that *L. angustifolia* oil, especially its main linalool component, may have a strong potential to be developed to prevent or improve cognitive deficits in AD.[39]

Oskouie et al.[16] evaluated the effects of aqueous extracts of *L. angustifolia* on the improvement of memory and cognition in an animal model of Alzheimer's, for this, the disease was induced in rats using Aβ, and the serum metabolic investigations were performed using spectroscopy Nuclear Magnetic Resonance (NMR). Forty male Wistar rats were treated with aqueous extract of *L. angustifolia*, at a dosage of 200 mg/kg, intracerebroventricularly, once daily, for 20 days at a volume of 0.4 mL/kg of body weight. Ten metabolic markers, including alanine, glutamine, serine, isoleucine, valine, carnitine, isobutyrate, pantothenate, glucose and asparagine were reversed to control values after treatment with lavender extract. The results revealed that the pathways most affected during the treatment with *L. angustifolia* extract

belonged to the metabolism of carbohydrates and amino acids. As the lavender extract reversed the direction of changes in some metabolites involved in the pathogenesis of AD, the authors concluded that *L. angustifolia* extract may play a role in improving the disease and serve as a potential therapeutic option for the treatment of AD. In addition, the metabolites found in AD mice can serve as a potential panel of markers for the disease; however, more research is needed to validate the results.[16]

It is noticed that medicinal plants, especially those of the *Lamiaceae* family, specifically the genus *Lavandula*, have been widely used as memory enhancers and in the treatment of dementia. Among the forms of use, we highlight the aqueous extracts and essential oils, which due to their low molecular weight and the high hydrophobicity of the terpenoids have a high probability of crossing the cell membranes and the blood-brain barrier.[36] However, some studies have used the extract of *L. angustifolia*, as they believe that due to its components being different from oils, such as rosmarinic acid, it may have some effects not found in essential oil.[44,41]

In the present literature review, it was observed that of the 13 studies included in this research, 7 used lavender essential oil and 6 opted for lavender extract. Since most studies used lavender of the species *L. angustifólia*, two used *L. hybrida*, and only one study used *L. viridis*, as well as *L. luisieri*, *L. stoechas* and *L. dentata*. Of the 13 studies, only one did not report the type of lavender used. Most of the research was carried out in an animal model, four were in vitro studies and one study was carried out in a human model.

Regarding the main effects promoted by lavender essential oil, studies highlight its antioxidant and anti-apoptotic activities, reversing AChE activity and increasing synaptic plasticity. The authors believe that lavender can effectively reverse deficits in spatial memory induced by dysfunction of the cholinergic system, as well as being a strong potential to improve cognitive function, especially in patients with AD, due to its positive effects on memory formation.

Studies using lavender extract have also found positive effects against oxidative damage associated with neurodegenerative diseases, and believe that the aqueous extract of *L. angustifolia* has an important potential in removing Aβ plaques from the brain of animals with Alzheimer's and that suppression glutamatergic neurotoxicity may also be responsible for alleviating cognitive deficits in AD.

5. Conclusion

It can be concluded with this review that there is scientific evidence about the use of lavender essential oil in the formation of memory and in the improvement of cognitive function in an Alzheimer's animal model. Evidence is also found in relation to the antioxidant and anti-apoptotic activities of lavender essential oil, with the ability to reverse AChE activity and increase synaptic plasticity. Regarding lavender extract, it can be concluded that it has positive effects against oxidative damage, as well as in the removal of Aβ plaques from the brain in an Alzheimer's animal model. Thus, it is believed that lavender has a promising activity both in the prevention and in the treatment of cognitive deficits in neurodegenerative diseases, especially Alzheimer's disease.

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