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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-9, ISSUE-05 of IJIER*** which is scheduled to be published on **1st May 2021.**

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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Perceptions of students about Problems in Computing Higher Education

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Abstract

Female students face various problems in the undergraduate computer science environment. In this paper we investigate undergraduate computer science students' perceptions of discrimination, harassment, drop out intention, gender devaluation, sense of belonging, gender stereotype, and self-efficacy. It also collects information about unpleasant facts that happened to students. A questionnaire was applied to two hundred and fifty students from undergraduate computer science courses from more than twenty universities in Brazil. Data from the questionnaire were analyzed using statistical methods. A comparison between men and women experiences is provided. In addition, we examine correlations between issues reported by the female students and their intentions to leave university. The results show that the majority of students in both sexes have a low sense of belonging and also that men bear some of the problems. Nevertheless, women suffer more from discrimination and gender stereotype than men.

Keywords: undergraduate computer science; students' perceptions; gender discrimination; statistical analysis;

1. Introduction

There are many studies on problems faced by female undergraduate computer science students. The percentage of women attending computing science courses in higher education is dramatically lower when compared to men, being among the lowest rates in higher education. STEM disciplines have traditionally been male-dominated, with computer science having one of the lowest proportions of female degree recipients among STEM disciplines (National Science Foundation, 2019). In addition, the number of women interested in computing is dropping (Misa, 2011). According to the newspaper of the University of São Paulo (USP), in the last five years, only 9% of students trained in the Computer Science course at the Institute of Mathematical and Computer Sciences (ICMC) at USP in São Carlos were women; in the Bachelor of Information Systems, 10% and Computer Engineering, 6%.

Computer science is seen as a male gendered subject. Concerning women, there are gender stereotype misconceptions regarding physical appearance, personality type, and digital ability. Females who choose to study computing are seen as having low self-worth as well as being different, atypical and unattractive. These myths can influence their academic decisions resulting in poor women' uptake of computing science as a career (Berg et al., 2018). The "geek" is another stereotype that may interfere with women's lower sense of belonging that could be traced to lower feelings of fit with computing stereotypes (Master et al., 2016).

Some harassment can potentially affect negatively women' psychological states during undergraduate computer science. The Federal Court of Justice of Brazil created a harassment and discrimination guidance

guide. In this guide there are the terms mansplaining, gaslighting, manterrupting and bropriating. Mansplaining occurs when a man undermines a woman's knowledge, and devotes his time to explain something obvious to her, as if she couldn't understand by virtue. Gaslighting corresponds to emotional violence through manipulation which leads the woman and everyone around her to think she has gone mad or is incapable. Manterrupting occurs when women cannot finish her ideas because of unnecessary interruptions made by men. Bropriating occurs when a man appropriates the idea of a woman, and takes the credits in her place.

Other potential psychological obstacles inhibiting women' computer usage are their personal feelings of low or missing computer self-efficacy. Women attribute the failures more internally, to their own inability. Men attributed the failures more externally, to the faulty from the technical equipment (Koch et al., 2008). Also, associations between heavy digital media use and low psychological well-being are larger for adolescent girls than boys (Twenge, 2020). Additionally, regardless of the gender, parental support is one factor that has been strongly associated with both boys' and girls' computer self-efficacy and value beliefs (Vekiri et al., 2008).

According with the literature, stereotype and gender discrimination affects female students more than affects male students in computing. Furthermore, women's sense of belonging is generally lower than men's in computer science education (Casad, 2019). Concerning the evasion from computer science higher education, it is important to highlight what problems affect and influence women the most.

Many works attempt to establish the problems suffered by women who pursue a computing career and propose solutions to keep them in the field. However, there are few works that show student's perceptions respecting problems previously validated, testing whether gender issues really happen more with women in university computing environments (García-Holgado et al., 2018). With respect to the Brazilian context, there are few studies that answer whether a certain category of problem influences women's intention to evade.

In order to unveil what problems are present in the Brazilian scenario, this present research collected data from computer science students from twenty-three Brazilian universities all over the country, through an online questionnaire. We developed the questions according to problems pointed out by the international studies. We performed descriptive and inferential statistical analysis to clarify and provide insights on the students' perspectives. Understanding this scenario is very important for educators to have the endowment to make changes in the classroom. Teachers should gain knowledge that can aid for further actions concerning students' wellbeing. According to Li (2006), the majority of the harassment victims and bystanders did not report the incidents to professors because they think nothing will be done about it.

2. Related Works

According to García-Holgado et al. (2019), it is important to develop actions to encourage diversity in the educational framework. Gender studies are considered the starting point to propel actions to decrease the gender gap in computer science. Education programs should broaden its foundations to provide equal education for both genres, by including the influence of social stereotypes and dominant culture. However, few works provide insight into potential causes of inequity in computer science undergraduate courses, aiming to enlighten future educational policies.

García-Holgado et al. (2018) elaborated and validated a questionnaire on gender perspectives, in order to capture the students' perceptions of what changes could be carried out to reduce the gender gap. Their work is part of a teaching innovation project entitled "Inclusion of the gender perspective in Software Engineering: Module 1", funded by the University of Salamanca (Spain) in the 2016/2017 academic year.

In Cheryan et al. (2019) study, the relationship between women's expression of interest in computer science and identity expression threat is examined. Women who intend to graduate in computer science report greater identity expression threat from their peers outside computer science than from those inside the field. Also, women report greater identity expression threat in computer science than do men. These reports were acquired through questionnaires applied to US university students.

Women and men have different motives and expectations for choosing computer science, and usually evaluate their strengths and abilities in different ways. The paper Volkel et al. (2018) provides an analysis of current motives for male and female choosing computer science as a subject of study. Data were obtained through interviews and questionnaires applied to computer science students in Germany. The study found out that the most crucial motive determining participants' choice to pursue a computer science career was interest in the contents. Other interesting findings are that male have often developed an interest very early as children, while women encounter computer science in high school or later. Female high school students often do not enter programs in computing due to a lack of interest and confidence. This situation could be attributed to women's beliefs that a computer scientist has a large expertise in programming and technology. Furthermore, women are less interested in innovative technologies than men.

According to Michell et al. (2018), in Australia the under-representation of women in computer science reflects the under-representation of women at the highest levels of government and business. The authors argue that interest and engagement in computer science is influenced by teachers, peers and parents. The survey aimed to collect quantitative and qualitative data on some aspects of teaching digital technologies in secondary schools. Among these aspects are existing policies and resources in schools to support digital technology learning, whether gender diversity in teaching is perceived by teachers and, if so, what teachers do to address this problem. A majority of survey respondents reported they were inadequately trained to teach a diverse group of students, and those who invested in diversity strategies were unaware of the ways in which they could overcome gender stereotypes. The results of the work point that teachers require support in terms of material resources and sustainable workloads to reduce the gender gap.

The survey Cheryan et al. (2015) points out that computer science and engineering are stereotyped in modern American culture as male oriented fields that involve social isolation, an intense focus on machinery, and inborn brilliance. Those stereotypes steer girls away from choosing to enter these fields. However, broadening the representation of the people who do this work, and the environments in which it occurs, significantly increases a girl's sense of belonging and interest in the field. Also, statistical analyses indicated that gender disparities in interest and anticipated success in the stereo-typically designed classroom were mediated by women's lower sense of belonging in that environment (Cheryan et al., 2011). However, providing them with an educational environment that does not fit current computer science stereotypes increases their sense of belonging in computing courses, helping reduce gender disparities in these fields (Master et al., 2016).

According to Ruthotto (2020), the unwelcoming, "chilly" climate that female science students experience in the traditional classroom is equally prevalent in online environments, for example, online discussion boards include linguistic cues that expose gender anonymity, considering the presence of male person. One factor contributing to the persistent underrepresentation of women in STEM is this stereotypical environment that perpetuates the image of a geeky, nerdy culture in which women do not fit. Stereotypical judgments can lower women's self-efficacy and increase self-blame in situations of failure. Stereotypes have also been linked to undermining women's sense of belonging in the computer science

field and classroom.

Another very serious problem faced by girls in computing is cyberbullying, which is nothing but traditional bullying virtualized. The critical variable which predicts the difference in cyberbullying experience between males and females is affective empathy. Males tend to bully others more than females did because males seem to be less empathetic than females (Topcu et al., 2012). Another survey with high school students shows that close to half of the students were bully victims and about one in four had been cyber-bullied. The majority of the victims and bystanders did not report the incidents to teachers (Li, 2006). Cognitive and affective empathy are important for both traditional bullying and cyberbullying, independent of gender, age and nationality (Del Rey et al., 2016).

Students who experience uncertainty and distress about their belonging are left with less time to spend on their academics as the time and energy they could put into learning and building connections is spent on concerns that they do not belong in their field or major. Sense of belonging is a known predictor of success in college. Women and underrepresented minorities are more likely to feel less belonging to STEM fields (Sax et al., 2018).

In summary, computer science has been diagnosed as a field with an expressive gender gap despite the crescent pervasiveness of computing. Several factors along with attitudes and exposure to computer science, computer programming proficiency, and self-reliance in using computers are understood to be linked with the low participation of women in this field (Hinckle, 2020). Nonetheless, some explanations have been posed to this gender gap, encompassing varying degrees of evidence, proving evidence that there is no single or small set of reasons to interpret this gap and pointing to the necessity for supplementary investigations (Duncan et al., 2020). Thus, there is a demand for further work concerning the intricate issues involving the gender gap in computer science education.

3. The Study

Given the importance of solving the problem of gender gap, the main contribution of this work is to offer clues regarding the students' perceptions of the problems suffered by undergraduate computer science female students. Our aim is to provide a statistical analysis in regard to the perceptions of both female and male students, answering what difference can be expected from women's and men's perceptions. In addition, we intend to provide information on what kind of bad college experiences they report. Also, we intend to provide insights into what problems from literature are the worst and if women really suffer from them more than men. Finally, we attempt to reveal if there is a correlation between problems reported by women and problems reported by men as well as the correlation between perceptions and facts.

Our justification for focusing students' perceptions is to verify if problems previously validated in the scientific literature are recurrent in undergraduate computer science in Brazil and how are the students' perceptions related to them. With this information we can help educators and who else may be interested in understanding the real scenario in computing higher education in Brazil. The information revealed in the results could help educational institutions to take steps to increase students' sense of belonging and reduce evasion.

3.1 Method

To obtain the data, a questionnaire was created to be answered by computer science undergraduate students from all over Brazil. The questionnaire contains twenty questions to validate the main problems suffered by women mentioned in several bibliographies. Thirteen questions (1—13) are about students' perceptions about the university environment and seven questions (14—20) are about negative facts that

have occurred. The questionnaire was released to groups of women in computing, such as the Digital Girls Program that helped to recruit the female students. We also sent the questionnaire digitally to several universities in Brazil, using the e-mail boxes of the Headers of the Computer Science Departments, that asked for IT employees to forward the questionnaire to the students. This research was approved by the ethics committee of the Federal University of Goiás. The questionnaire is described as follows:

1. Do you think that people of your gender that work in computing are valued by others?
2. Do you think that your gender will influence in getting a good job in the field of computing?
3. Do you feel discriminated against for studying computer science?
4. Does gender stereotype bother you?
5. Do you worry about people that draw conclusions about your performance based on your genre?
6. How well do you think you would be working with computing?
7. How good a student do you think you are?
8. How similar do you think you are to your colleagues who also study computing?
9. How close are you to the people in your college?
10. Do you think you would fit into the field of computing?
11. Do you worry about being negatively labeled for studying computing?
12. What are the chances of you NOT completing the undergraduate computer science?
13. What are the chances that you will NOT pursue a career in the computing field?
14. Have your peers or teachers provoked you (negatively) by studying computing? For instance: They gave you derogatory nicknames.
15. Have your colleagues or teachers already interrupted you while you spoke, not allowing you complete your reasoning?
16. Have your colleagues or teachers implied that you were losing reason by giving any opinion different from theirs?
17. Have your colleagues ever underestimated you? For example, they have explained something obvious with some intonation that bothered you.
18. Have your colleagues ever appropriated an idea of yours as if they were theirs and took credit?
19. Have you ever been harassed within the educational institution?
20. Has anyone in the institution made jokes, innuendos or embarrassed you in any other way?

The answers are multiple choice and follow the Likert scale (Faleiros et al., 2016). For the answers to the questions about sensations, the Likert scale followed the standard 1 = nothing, 2 = little; 3 = neutral, 4 = reasonably, 5 = a lot. For the answers to the questions about facts, the Likert scale followed the standard 1 = never, 2 = once, 3 = two or three times, 4 = four times, 5 = more than four times. For data analysis, 250 student responses from 27 computing courses from 23 higher education institutions were considered. Before the release of the questionnaire to the public, a pre-test was conducted with a test group containing ten female students of computing. Through the pre-test, it was possible to improve the questions to make them clearer.

Descriptive statistics were applied to reaffirm the problems faced by students and also to compare which ones affect women the most and which ones affect men the most. Through this statistical analysis it

was also possible to rank which problems occur most. We obtained the median of the answers because in the Likert Scale the variables are ordinal and qualitative, it makes median more interesting than mean or mode, that are used for interval variable and nominal variable, respectively.

Some interesting correlation and difference tests were also made. In the case of this study, the design context is inter-subject with two groups, one for each genre. The dependent variable is ordinal, represented by the responses on the Likert scale. We used Spearman's correlation coefficient to check the associations between answers of men and answers of women. To verify differences detected in the data sample (answers of men and women) we used Mann-Whitney test. Spearman's correlation coefficient is an association test that explores whether two (or more) ordinal variables (or one ordinal and one interval) are associated. The correlation coefficient of Spearman allows the evaluation of the strength and direction of this association, varying between +1 and -1. The Mann-Whitney test is applied to compare differences among two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed (Martins, 2011).

In statistical tests there is no absolute certainty. If the probability is too high then the results are statistically not significant. Otherwise they are significant. In this study the null hypothesis is represented by H0 (the result found is due to chance) and the alternative hypothesis is represented by H1 (the result found is not due to chance). The variable p represents the probability for correlation or difference, is a probability that measures the evidence against the null hypothesis. If $p > 0.05$ the result is not significant. If $p \leq 0.05$ the result is significant.

4. Results

The present study approaches the gender issues underneath undergraduate computer science courses. Understanding students' perceptions and concerns is an important addition to experimental studies in the computer science education field to broaden our understanding concerning gender limitations. Students' perceptions can be useful when it comes to designing future educational approaches. The results of the questionnaire statistical analysis are as follows.

3.1 Descriptive Statistics

Among the 250 students who answered the questionnaire 40.4% were women, 58.8% were men, and 0.8% identified themselves as having another gender. The fact that the questionnaire was first released to groups of women explains the equivalent proportion of responses from girls and boys. We will keep information from people who have declared themselves non-binary for future research, as the focus of this survey is on women in relation to men. Non-binary people can have different and even more serious problems.

Table 1 shows the median of each response for both sexes (general column) as well as the median of the options chosen by women and men in the Likert Scale for all twenty questions. We refer to each question as Q_x, where 'x' represents the question number.

Table 1. Median of Likert scale for general, women and men

	General	Women	Men
Q_1	4	2	5
Q_2	4	4	4
Q_3	2	3	1
Q_4	3	4	2
Q_5	3	5	2
Q_6	4	4	4
Q_7	4	4	4
Q_8	3	3	3
Q_9	4	4	4
Q_{10}	4	4	4
Q_{11}	1	2	1
Q_{12}	2	2	2
Q_{13}	2	2	2
Q_{14}	1	1	1
Q_{15}	2	3	2
Q_{16}	1	1	1
Q_{17}	2	3	2
Q_{18}	1	1	1
Q_{19}	1	1	1
Q_{20}	2	2	1

Median of each response for both sexes (general column) as well as the median of the options chosen by women and men in the Likert Scale for all twenty questions.

The disproportion between the perceptions of women and men are more noticeable in the answers of questions 1, 3, 4, 5, and 11, as shown in Table 1. The median of the answers to Q_1 is 4 for all students, 2 for women and 5 for men, a 3-point difference between women and men, as shown in Figure 1. Answers to Q_3 have a median 2 for the entire sample, 3 for women and 1 for men, difference in 2 points between girls and boys, as depicted in Figure 2. The answers to Q_4 have a median 3 for all students, 4 for women and 2 for men, a 2-point difference between women and men, as described in Figure 3. The answers to Q_5 have a median 3 for all students, 5 for women and 2 for men, difference between 3 points between women and men, as shown in Figure 4. Figure 5 shows the answers to Q_{11}, which has a difference of only 1 point between the responses of men and women. The bar graphs in Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5 also show how many students chose each answer in Q_1, Q_3, Q_4, Q_5, and Q_{11}, and the gender of each student are presented, the bar representing men's responses is to the left of the bar representing women's responses. For instance, 75 men choose answer 5 = a lot for Q_1 - *Do you think that people of your gender that work in computing are valued by others?*, and only 3 women choose answer 5 = a lot for Q_1.

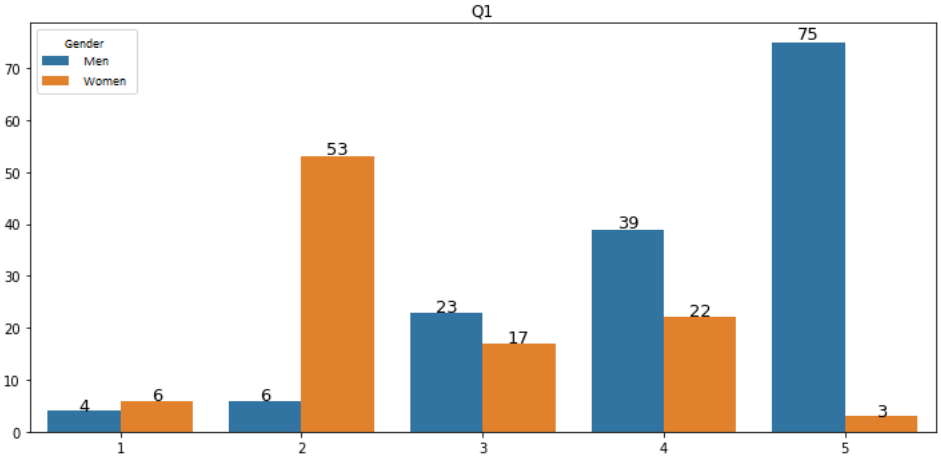

Figure 1. Answers to Q1.

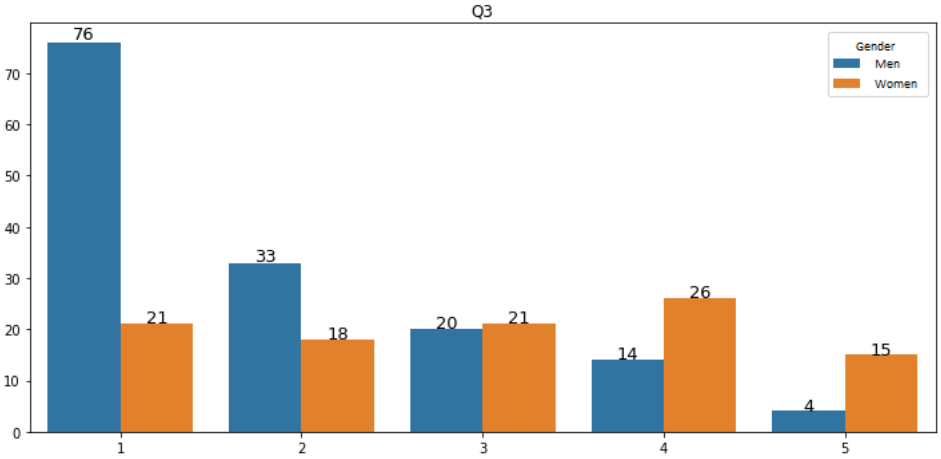

Figure 2. Answers to Q3.

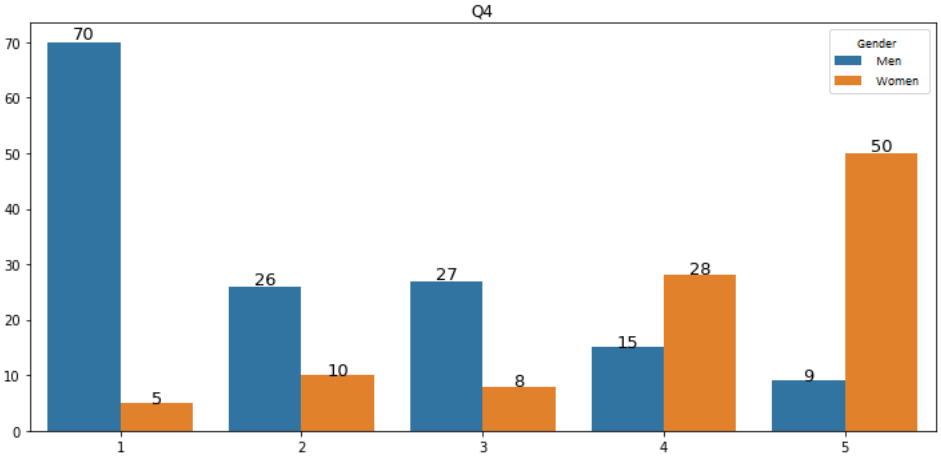

Figure 3. Answers to Q4.

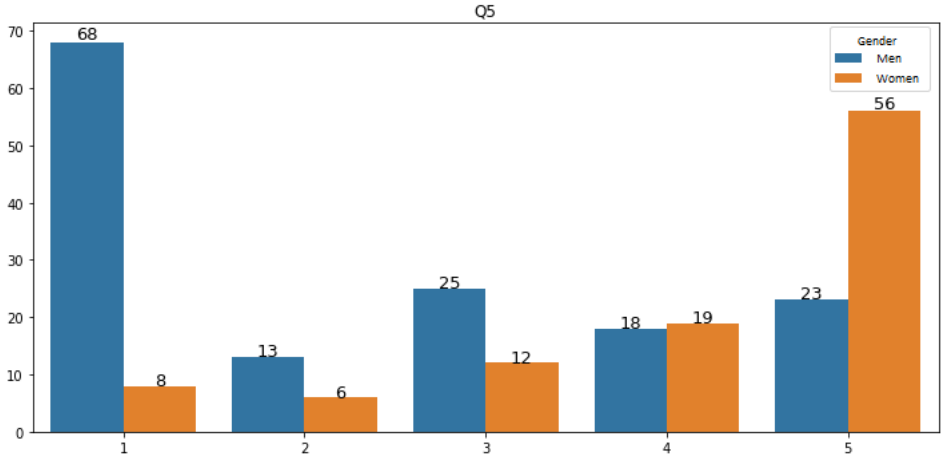

Figure 4. Answers to Q_5.

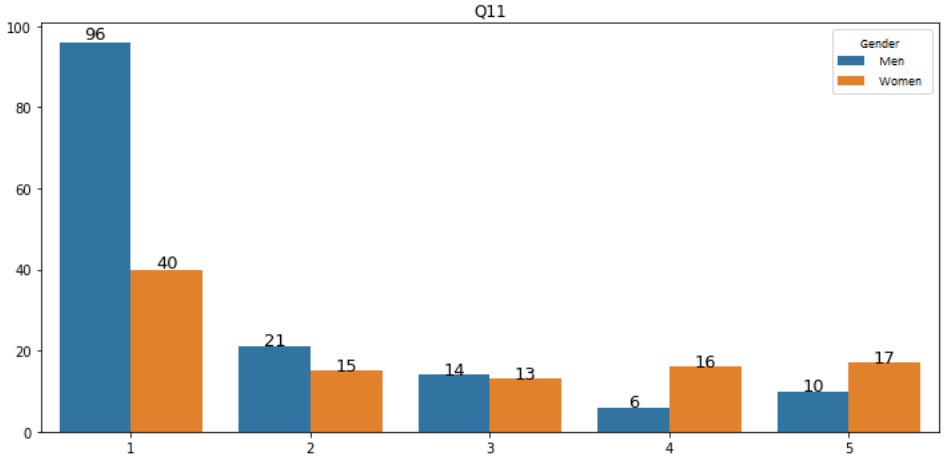

Figure 5. Answers to Q_{11}.

The disproportion between the facts occurred with women and men are noticeable in Q_{15}, Q_{17} and Q_{20}, as shown in Table 1. However, the difference in the responses of men and women to these three questions is no more than 1 point. This is not to say that adverse events with girls are substantially higher or lower. Therefore, in addition to the tests of association and difference, future work consists of analyzing the students' reports in discursive responses, as shown in Figure 6, Figure 7, and Figure 8.

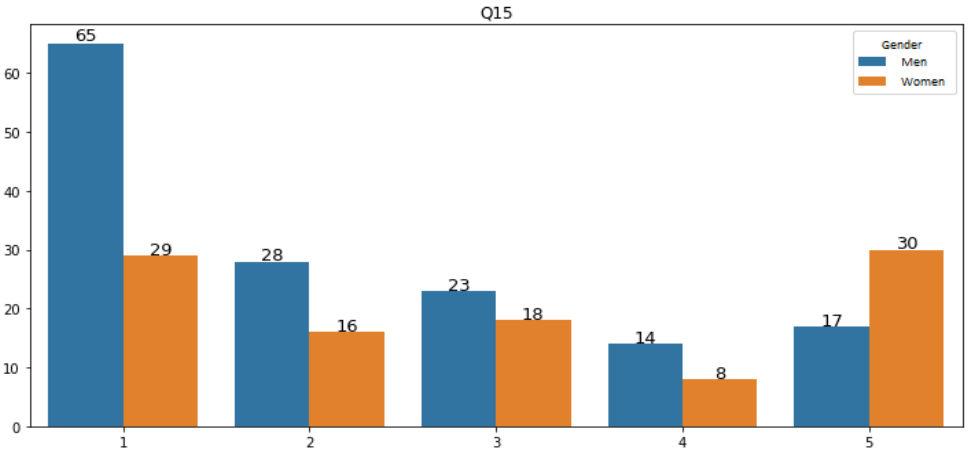

Figure 6. Answers to Q_{15}.

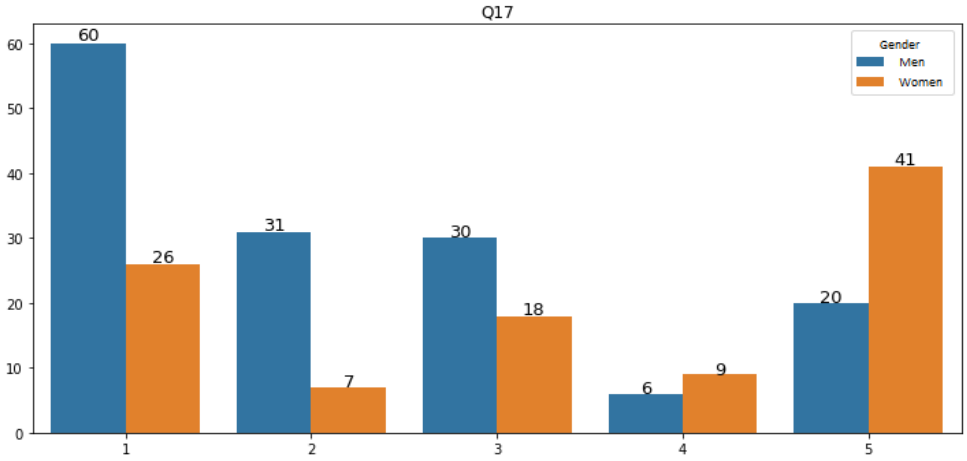

Figure 7. Answers to Q_{17}.

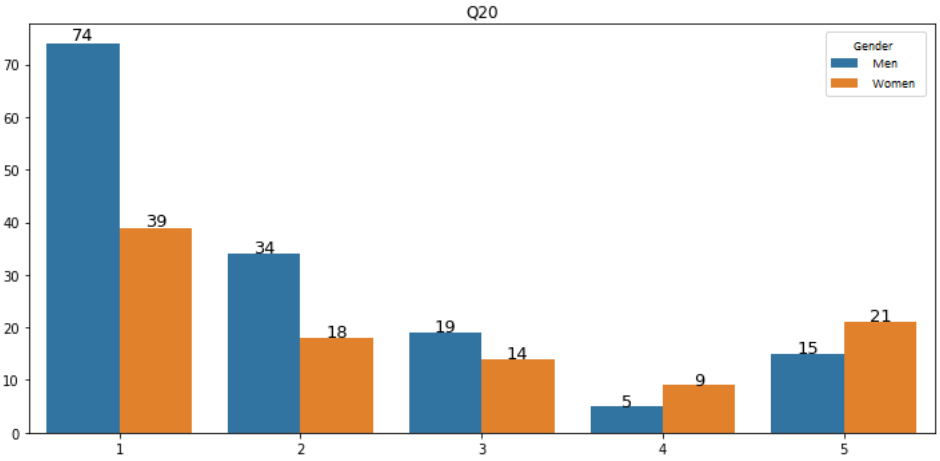

Figure 8. Answers to Q_{20}.

3.1 Inferential Statistics

Correlations between women1 intention to evade and self-efficacy, sense of belonging, perspective of working with computing, difficulty to find a good job, gender devaluation in computing, and manterrupting

were done. The most interesting are presented below in order of most significant to least significant correlation.

In Figure 9, the investigation question and hypotheses were:

- Investigation question: Women's intention to evade are correlated with self-efficacy in studies? H0: There is no correlation between intention to evade and self-efficacy in studies.
- H_1: There is a correlation between intention to evade and self-efficacy in studies.

Figure 9. Correlation test between Q_7 and Q_{12}.

In Figure 10, the investigation question and hypotheses were:

- Investigation question: Women's intention to evade are correlated with their sense of belonging?
- H_0: There is no correlation between intention to evade and sense of belonging.
- H_1: There is a correlation between intention to evade and sense of belonging.

Figure 10. Correlation test between Q_8 and Q_{12}.

In Figure 11, the investigation question and hypotheses were:

- Investigation question: Women' intention to evade are correlated with their perspective of working with computing?
- H_0: There is no correlation between intention to evade and perspective of working with computing.
- H_1: There is a correlation between intention to evade and perspective of working with computing.

Figure 11. Correlation test between Q_6 and Q_{12}.

In Figure 12, the investigation question and hypotheses were:

- Investigation question: Women's intention to evade are correlated with their difficulty to find a good job?
- H_0: There is no correlation between intention to evade and difficulty to find a good job.
- H_1: There is a correlation between intention to evade and difficulty to find a good job.

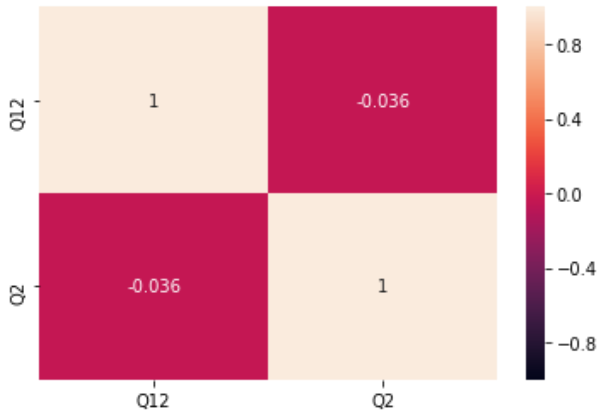

Figure 12. Correlation test between Q_2 and Q_{12}.

In Figure 13, the investigation question and hypotheses were:

- Investigation question: Women's intention to evade are correlated with the gender devaluation in computing?
- H_0: There is no correlation between intention to evade and gender devaluation.
- H_1: There is a correlation between intention to evade and gender devaluation.

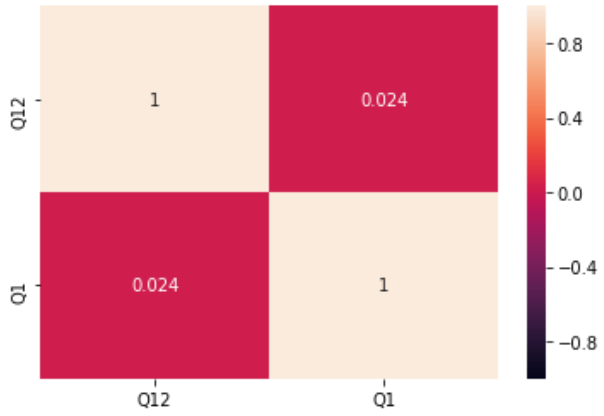

Figure 13. Correlation test between Q_1 and Q_{12}.

In Figure 14, the investigation question and hypotheses were:

- Investigation question: Women's intention to evade are correlated with manterrupting?
- H_0: There is no correlation between intention to evade and manterrupting.
- H_1: There is a correlation between intention to evade and manterrupting.

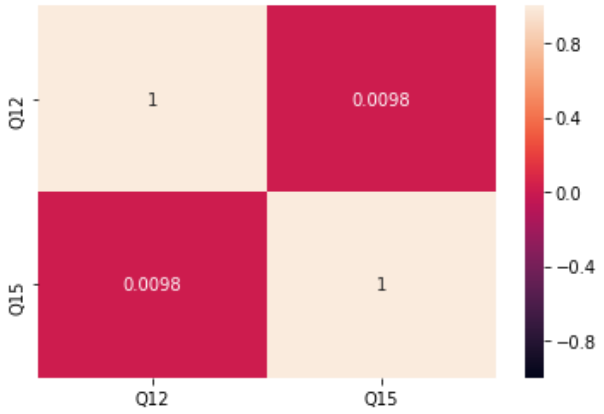

Figure 14. Correlation test between Q_{15} and Q_{12}.

For all six correlation tests described above one must accept the alternative hypotheses.

The Mann-Whitney difference test is non-parametric, inter-subject, and suitable for ordinal variables. Some difference tests have been done, but only one has significant difference, presented below.

- Investigation question: Is there a difference between the women's intention not to pursue a computing career and the men's intention not to pursue a computing career?
- H_0: There is no difference between the women's intention not to pursue a computing career and the men's intention not to pursue a computing career.
- H_1: There is a difference between the women's intention not to pursue a computing career and the men's intention not to pursue a computing career.
- We have to accept the alternative hypothesis, since $p = 0.0056$.

5. Discussion

Q_1, Q_5 and Q_{20} address the problem of gender devaluation, Figure 1, Figure 4 and Figure 8. Q_1 asks if

people of the same gender that work in computing field are valued by others. Median of women responses to this question are 4 = reasonably. Men's replies median to this question are 5 = a lot. Q_5 asks regarding concern about others' opinions on gender-based performance. Median of women responses to this question are 5 = a lot. Men's replies median to this question are 2 = little. These responses show that men feel more valued and are less bothered by what others think about their choice of profession, as expected according to the aforementioned bibliographies. Unfortunately, women who study computer Science University do not have the feeling of recognition coming from teachers and colleagues. Often when teachers spend activities that are considered difficult, they hope that girls will not succeed or will only succeed with the help of a male colleague.

Q_3 addresses the problem of discrimination, as well as Q_{15} and Q_{17}. Q_3 asks about the perception of being discriminated against for studying computing. Median of women responses to this question are 3 = neutral. Men's replies median to this question are 1 = nothing, Figure 2. These responses prove that what the literature cited said about gender discrimination is true. Women are discriminated against for studying computing, while boys who study computing are praised and admired. Q_{15} is about manterrupting, when the woman is interrupted by peers and teachers, unable to conclude any reasoning. Although manterrupting is a term used as aggression suffered by women, men also answered this question to ascertain their perceptions. Median of women responses to this question are 3 = two or three times. Median of men responses to this question are 2 = once, Figure 6. Girls are interrupted by boys more often than boys interrupt other boys. This intimidates girls to expose their ideas and even influences them to prevent them from asking questions, for fear and fear that they will be interrupted and even humiliated. Q_{17} is about mansplaining, when women are underrated by men. Women and men answered whether colleagues or teachers already underestimated them. Median of women responses to this question are 3 = two or three times. Men's replies median to this question are 2 = once, Figure 7. With all this underestimation that girls suffer, it is common that even those who have some courage to ask something, are again humiliated when they hear explanations of the obvious, for example, they can ask about some specific tool of the Java language and hear as answers what is Java, even though she has already created several software by herself.

The stereotype pointed by many studies as the biggest problem faced by undergraduate computer science females is confirmed from the answers to Q_4 and Q_{11}, Figure 3 and Figure 5. The question asks about the stereotype of discomfort within the university environment. Median of women responses to this question are 4 = reasonably. Men replies median to this question are 2 =little. Even if there is a stereotype of boys who study computing, it is not so unpleasant, because they are considered very intelligent boys who will earn a lot of money. However, the stereotype of girls who study computing is that they have an undesirable appearance, introverted personality, and will not receive good salaries.

Another interesting answer was from Q_8, regarding the similarity with colleagues who also study computing. Both genders have a median 3 = neutral, Table 1. It may mean that students' sense of belonging is average overall. Probably, the reason for the low sense of belonging of boys is different from that of girls. All discrimination, devaluation of gender and stereotype lead girls to feel isolated and frustrated, sometimes they see the dropout as an escape.

The six correlation tests show that women's intention to evade the undergraduate computer science correlates significantly with various problems they face. It is the case of the perception of low self-efficacy,

low sense of belonging, the lousy perspective of working with computing, challenging to find a good job, and gender devaluation in computing.

Several problems found in universities in other countries were mapped to universities in Brazil. To alleviate these problems, Brazilian universities need to adopt educational models to reduce the issues reported by female students in this work. The practical implication of this work is to direct educational policies, drawing attention to the possible problems that most contribute to the evasion of women from undergraduate computer science courses in the Brazilian scenario.

6. Conclusion

Some research works report problems suffered by female computer science undergraduate students. In this work, we consider some of these works as a base to a questionnaire to collect information about the students' perceptions of problems and unpleasant facts that occurred with them inside and outside the educational Brazilian institutions.

We made a descriptive statistics analysis using data collected from 250 questionnaire responses applied to 23 computer science education institutions. The questionnaire addresses the issues of discrimination, harassment, and drop out intention, gender devaluation, and sense of belonging, gender stereotype, and self-efficacy.

By means of the students' replies, we conclude that women feel more undervalued than men studying computing. Also, there is a vast disparity regarding concern about others' opinions on gender-based performance. Women are much more concerned with the views of others. The perception of being discriminated against is much higher in women. As well as negative facts about discrimination were more pointed by women. Women reported more unpleasant facts about being interrupted when talking and underestimated. We conclude that they suffer more discrimination. Also, stereotyping bothers more women than men. Additionally, through the correlation tests, we conclude that various problems faced by women are significantly correlated to their intention to evade.

The current scenario demands attention to the problems faced by computer science students of both sexes. The sense of belonging of the undergraduate computer science students is low, and something has to be done about it. Universities and other educational institutions need to make efforts to mitigate the issues reported by the students. This work calls attention to the possible issues that most contribute to the dropout of women from higher education courses and contributes to understanding what problems that most disturb students.

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Tan Dun and Water Passion after St. Matthew

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Abstract

Tan Dun created Water Passion after St. Matthew, written to commemorate the 250th anniversary of the death of J. S. Bach. Not only Tan follows the western tradition to use the texts from the Gospel of Matthew, but he also wrote some texts by himself in this piece, for example, the opening words, "A sound is heard in water, in darkness, the tears are crying for rebirth." This innovation reflects his respect for tradition and oriental philosophy which is there is no beginning and end of life.

Keywords: Tan Dun, Passion, Chinese music

Tan Dun could be considered as one of the most influenced international composers in the 21st century. The world-renowned artist and UNESCO Global Goodwill Ambassador Tan Dun has made an indelible mark on the world's music scene with a creative repertoire that spans the boundaries of classical music, multimedia performance, and Eastern and Western traditions. A winner of today's most prestigious honors including the Grammy Award, Oscar/Academy Award, Grawemeyer Award, Bach Prize, Shostakovich Award, and most recently Italy's Golden Lion Award for Lifetime Achievement, Tan Dun's music has been played throughout the world by leading orchestras, opera houses, international festivals, and on radio and television. Most recently, Tan Dun was named as Dean of the Bard College Conservatory of Music. As dean, Tan Dun will further demonstrate music's extraordinary ability to transform lives and guide the Conservatory in fulfilling its mission of understanding music's connection to history, art, culture, and society.[1]

Tan Dun created *Water Passion after St. Matthew*, written to commemorate the 250th anniversary of the death of J. S. Bach. The duration of this piece is about ninety minutes, Tan sets this piece with a mixed chorus (minimum six sopranos, six altos, six tenors, and six basses or more (also play water, stones and Tibetan finger bells[2]), one high soprano (requires high E and overtone singing and playing ancient ceramic wind instrument Xun[3]), one vocal bass (requires low C and overtone singing and playing ancient ceramic wind instrument Xun), one violin, one cello, one sampler player (Yamaha A 3000), one sound designer/ controller for electronic sound processor (minimum 24 channel mixer and Lexicon Effect Processor are needed), and three percussionists who play a variety of percussion instruments, including small soda bottles, water gongs, water drums, water tube drums, water shakers, Tibetan double cymbals, Tubular chimes, bass drums, and timpani.

[1] http://tandun.com/about/
[2] Also called Tibetan tingsha (or Ting-Sha) (Tibetan: དྲིལ་ཤགས, Wylie: ting-shags) are small cymbals used in prayer and rituals by Tibetan Buddhist practitioners.
[3] The xun (simplified Chinese: 埙; traditional Chinese: 塤; pinyin: x n; Cantonese= hyun1) is a globular, vessel flute from China.

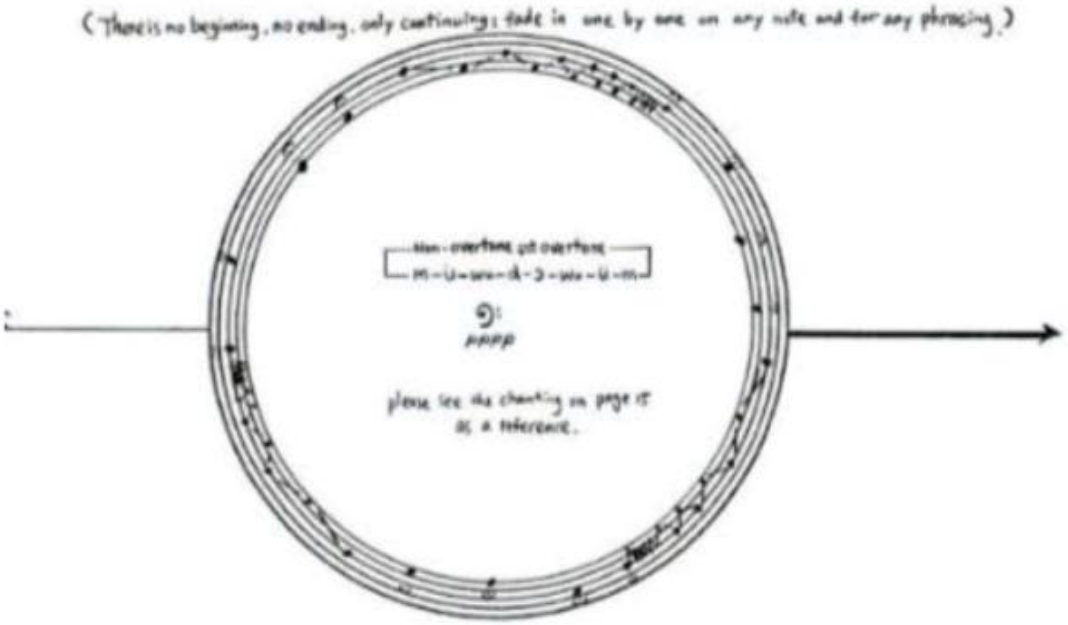
Tan Dun follows the western tradition to use the texts from the Gospel of Matthew, but Tan also wrote some texts by himself in this piece, for example, the opening words, "A sound is heard in water, in darkness, the tears are crying for rebirth."

Tan Dun constructs this piece into two parts, eight movements. Part I: 1. Baptism, 2. Temptations, 3. Last Supper, 4. In the Garden of Gethsemane; Part II: 5. Stone Song (Peter and Judas), 6. Give us Barabbas, 7. Death and Earthquake, 8. Water and Resurrection.

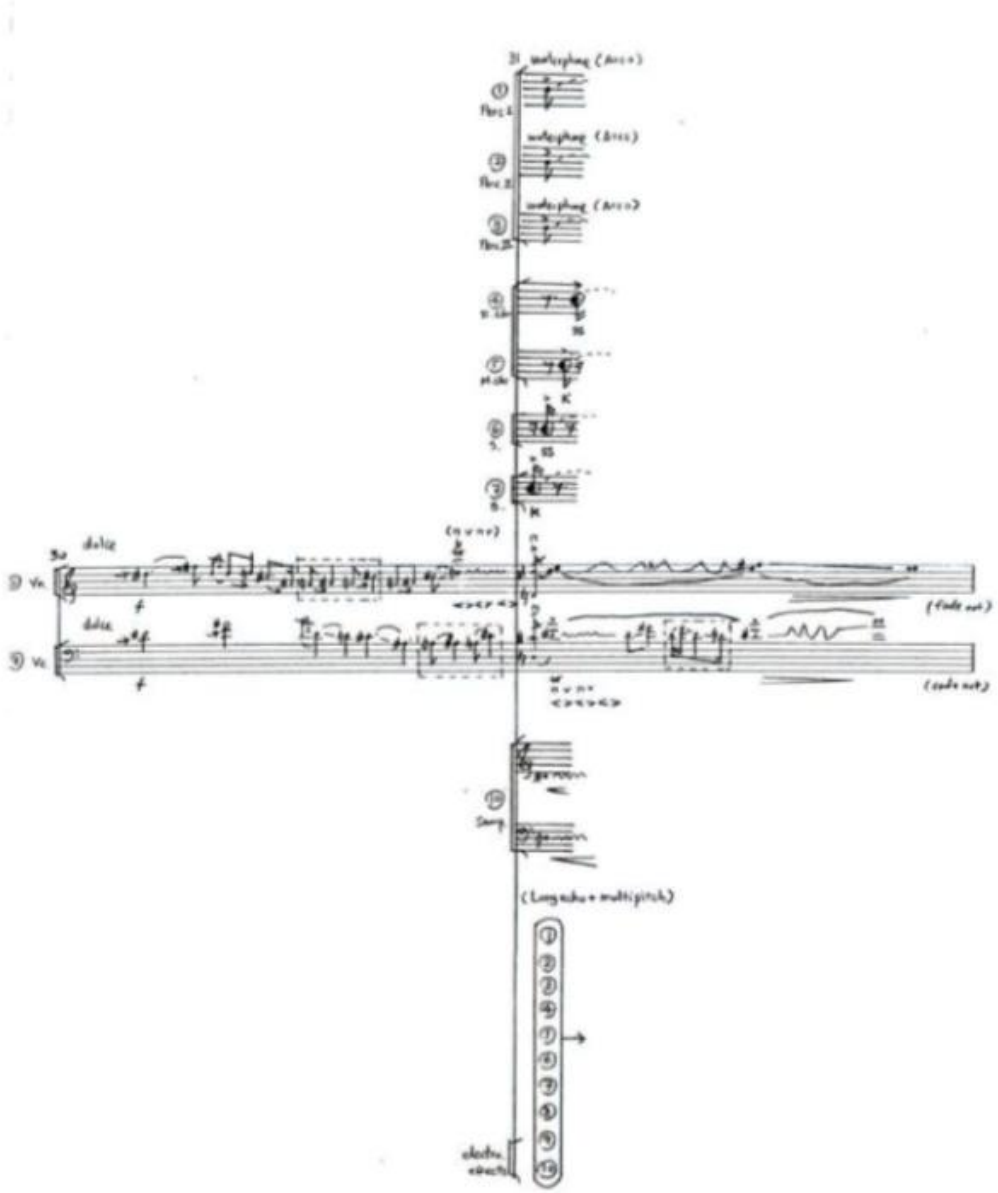
Although it structurally seems like in a western Passion form, there are some unique musical presentations in this piece. Firstly, organic music is one of the most salient features. Tan was the pioneering composer to experiment with organic music ideas, in this piece, Tan employed several organic elements, such as the stone, water.

Second, visualization is another feature of this piece, not only the score presents some symbolized notations, like the circle notation, crucifix notation, but also the arrangement of the stage, Tan arranged seventeen bowls filled with water into a crucifix on the stage.

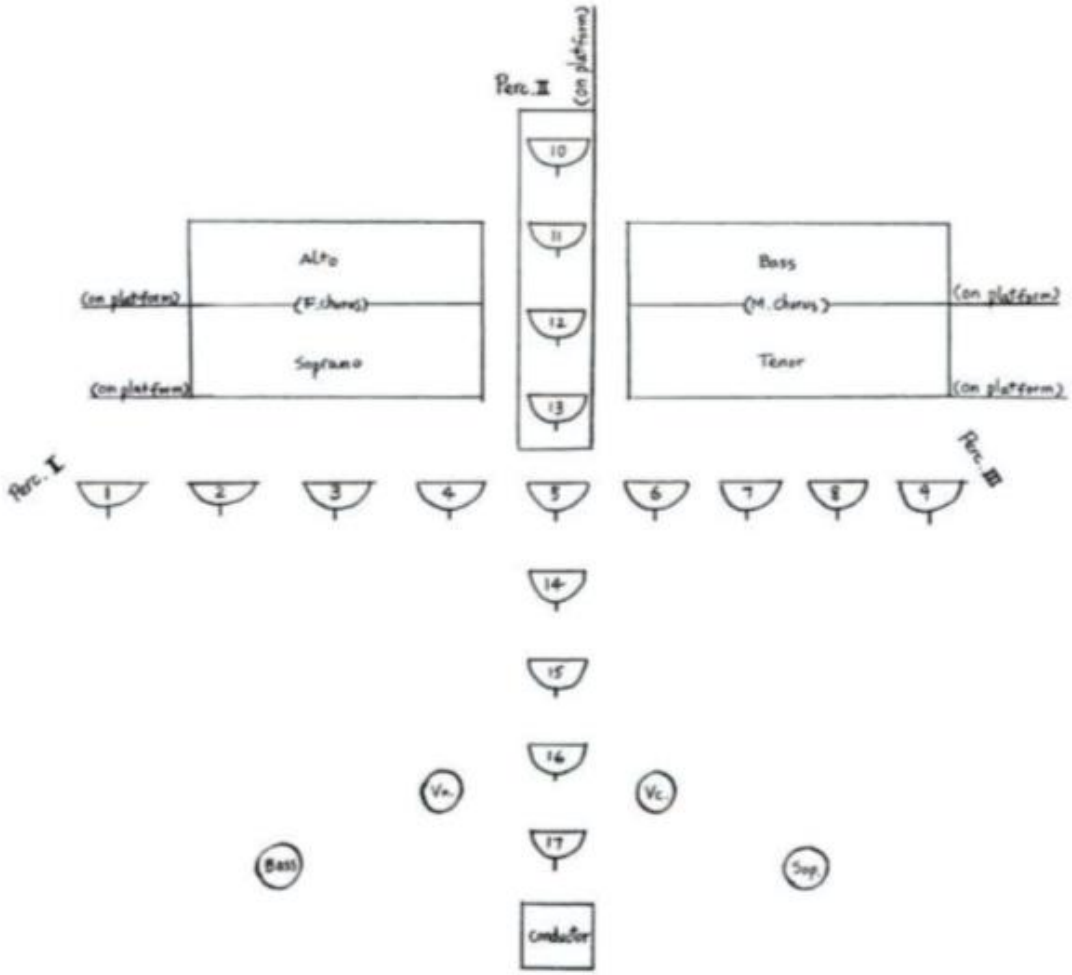
Ex. 1 The circle notation, movement 1, measure 1, M. chorus



Ex. 2 The crucifix notation, movement 1, measure 30-31

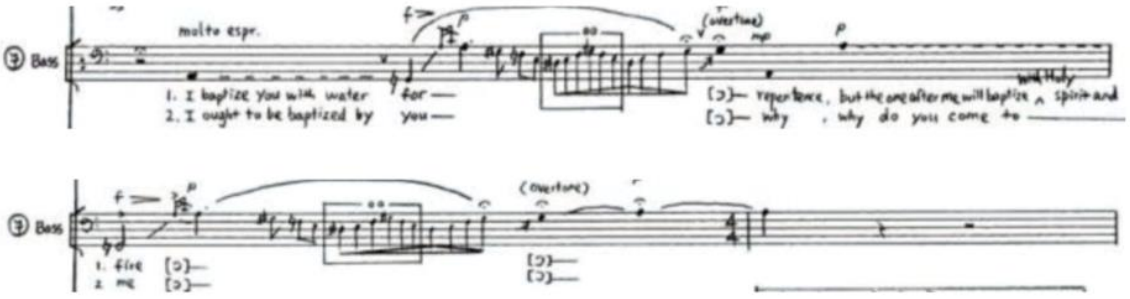


Ex. 3 The Chart of Stage Arrangement of Water Passion after St. Matthew

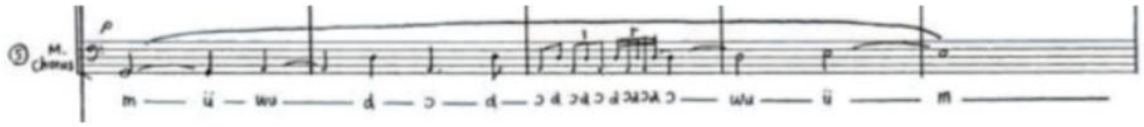


Lastly, Tan used a lot of unconventional instrumental and vocal techniques. For the vocal parts, it has 3 sections, Soprano soloists, Bass soloists, and a mixed choir (sometimes divided into the female choir and male choir), Tan employed a wide range of vocal styles, including overtone, Peking opera, etc. Besides singing, the vocal parts also asked to play some organic instruments (stones and water). And for the instrumental parts, Tan experimented with an extraordinary range of sound effects, for example, the violin and cello asked to combine Asian string instrumental techniques (Chinese Erhu, Chinese Pipa, Mongolian horse head fiddle), they also asked to play microtones, long melismatic melodies and use different tuning systems. The percussion section is the most unconventional part in this piece, instead of some traditional percussion instruments, Tan uses a lot of containers filled with water, and the water phone.

Ex. 4, Overtone Singing, Bass Solo, measure 32-33



Ex. 5, Monk's Chant(Pentatonic melody), measure 62-66



In conclusion, Tan Dun merged the western and eastern ritualization music within the Passion form. Especially with the concept of organic music. Tan Dun said in an interview: "*Organic Music" concerns both matters of everyday life and matters of the heart. These ideas find their origin in the animistic notion that material objects have spirits residing in them, an idea ever-present in the old village where I grew up in China. Paper can talk to the violin, the violin to water. Water can communicate with trees, and trees with the moon, and so on. In other words, every little thing in the totality of things, the entire universe, has a life and a soul."*

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ASD and Inclusion: Teacher Training and the Use of Alternative and Extended Communication in Inclusive Educational Contexts

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Abstract

In recent decades, there has been a search for a model of education that allows the participation of all students in the same school space, that is, an inclusive school. Inclusion of students with autism spectrum disorder (ASD) has been a recurring topic and has posed challenges for teachers, families and school management aiming at the participation of these students in the school environment and its pedagogical practices. ASD is currently classified as a neurodevelopmental disorder marked, mainly, by the difficulty of interaction and social communication (APA, 2014). As a result, it is common for students with ASD to present verbal and/or nonverbal communicative deficits. Given the pivotal role communication has in ensuring the socialization and educational inclusion of students with autism, this research seeks to answer the following questions: How does teacher training prepare teachers to help students with ASD? What resources of alternative and/or extended communication (AEC) can enable students with ASD to better communicate with their teachers? In order to answer these questions, the present paper investigates the theoretical and political foundations that regulate the inclusion of students with ASD in regular school, and analyzes teacher training in its relation to promoting their inclusion. Thus, the present paper discusses teacher training for the use of AEC tools in the regular classroom. It is believed that the great challenge teachers face is continuing education of the pedagogical strategies and practices for assisiting students with ASD in their learning processes in the regular classroom. This paper also addresses relevant public policies and the responsibility of the public power to effectively promote education for all, an education that respects the Other as a true Other.

Keywords: ASD; inclusion; alternative and extended communication; teacher training.

1. Introduction

In the last few decades – especially after Brazil's endorsement of the international and domestic treatises stating the importance of students sharing the same school environment, as well as the approval of the Brazilian National Policy for Special Education in the Perspective of Inclusive Education (PNEEPEI, 2008) –, the social inclusion of students with autism spectrum disorder (ASD) has been debated among

educators who seek to develop activities that will encourage the participation and learning of these students in the regular school system (NUNES; AZEVEDO; SCHMIDT, 2014, WALTER; NUNES, 2013).

ASD is currently classified as a neurodevelopmental disorder marked, mainly, by the difficulty of interaction and social communication (APA, 2014). As a result, it is common for students with ASD to present verbal and/or nonverbal communicative deficits. The scientific literature points that, approximately, 20% to 30% of people with ASD do not develop spoken language, and those who do may show lack of colloquial exchanges or speech that is contextually ill-adjusted, echolalic or repetitive (AVILA, 2011; KLIN, 2006).

According to Passerino and Bez (2015), communication is pivotal to ensure socialization and school inclusion of students with ASD. They argue that, in order to enable students with ASD to access school knowledge and participate in the activities proposed in regular educational institutions, it is necessary for teachers to use complementary, supplementary or amplifying means of communication. In these cases, alternative and extended communication (AEC) may be seen as a promising resource to support the development of communication skills and social interaction in the regular classroom and, consequently, favor the inclusion of people with ASD who present communicative deficits (PASSERINO; BEZ, 2015).

Therefore, the present research seeks to answer the following questions: How does teacher training prepare teachers to help students with ASD? What AEC resources can enable students with ASD to better communicate with their teachers? It focuses on the theoretical and political foundations of the inclusion of students with ASD in regular schools, analyzes teacher training in its relation to the inclusion of these students, and identifies the AEC resources which facilitate their communication with teachers in the regular classroom.

We draw upon authors who show the relevance of AEC as a pedagogical resource to promote the communication skills of children with ASD (GONÇALVES, 2011; OLIVEIRA, 2015; MANZINI, 2015). Furthermore, reviews of literature were consulted that point towards the relevance of the use of the Picture Exchange Communication System (PECS) in the development of communicative skills of people with ASD, thus facilitating student-teacher communication, as well as the development of other interpersonal skills (OLIVEIRA *et al*., 2015).

Thus the present paper presents a discussion of teacher training for the use of AEC in the regular classroom, and is organized as follows: section 2 details the Methodology; the research results – encompassing the concept and principles of ASD, teacher training in assisting students with ASD in the regular classroom, and the professionals and AEC resources that help teachers in this task – are presented in sections 3 to 5; our concluding remarks compose section 6.

2. Methodology

Scientific research is continuous, complex and plural, and this is particularly true when its themes are multidimensional and their aspects, concepts, representations and knwoledge, as is the case of inclusive education, with emphasis on teacher training and ASD. Ferrari (2015), and Bornmann and Mutz (2015) state there is a periodic need to synthesize the knowledge produced in a given field, as the volume and speed of output is very high in the technological society. In addition, revisional work allows for a panoramic view of divergences and consensus, the technical updates within a field, and even the gaps regarding themes and subjects of research (BOLDERSTON, 2008; MENDES-DA-SILVA, 2019).

The present research follows a qualitative approach, and belongs to the narrative review type – which, according to Rother (2007), is suitable to describe and discuss the "state of the art", that is, the current level of theoretical or conceptual development of a field. The scientific community shows high interest in narrative reviews, as they not only allow to detail relevant aspects of the advances in a field, but also present research opportunities (MENDES-DA-SILVA, 2019).

Rohter (2007) further suggests that the structure of a narrative review paper is fourfold, comprising an introduction, development (with sections that deal with the topics of the subject), comments and references. However, it is possible to add a fifth session, detailing the methodology adopted, and this is common practice in articles of this genre.

Narrative reviews are generally organized around broad central issues, not specific questions; they use unspecified sources and data selection; however, it uses scientific and reliable sources, and their selection is guided by the authors' judgment – which has attracted criticism, as a source of bias (COOK *et al*., 1997). The risk of bias in the selection of sources was eschewed by the high relevance of the works selected, their technical quality and concatenation within the theme in focus.

Narrative reviews are ideal to build general debates, resume previous discussions in current context, and highlight gaps in the knowledge construction of a field of research. The knowledge here summarized is predominantly qualitative, and its assessment is highly variable (ROTHER, 2007; FERRARI, 2015; COLLINS; FAUSER, 2005).

Narrative review was thus found to be most suitable to the features and research interests here pursued; it seemed the best way to approach them in a broad, consistent and up-to-date fashion.

3. ASD: Concept and foundations

The history of autism, in Brazil and worldwide, is strongly marked by stigma, ignorance and intolerance. Although ASD is currently one of the most researched disorders in several fields, this was not always the case. Science had long neglected the condition of people with ASD; consequently, they were commonly

misdiagnosed with other disorders, and institutionalized in environments unsuitable to meet their real needs, and to help them develop their socio-educational potential.

The first studies on ASD were conducted only in the beginning of the twentieth century by health professionals, mostly psychiatrists. The term "autism" began to be used around 1910 by psychiatrist Eugen Bleuler (DONVAN; ZUCKER, 2017; BRAGA, 2018). Bleuler used it to refer to one of the symptoms shown by adolescent and adult patients with schizophrenia who tended to disconnect from social interactions, and focus on their own fantasies and thoughts.

In the 1940s, psychiatrists Leo Kanner (1943) and Hans Asperger (1944) published parallel studies in which they described cases of children whom they assisted, and who presented significant difficulties and impairments in communication and social interaction (DONVAN; ZUCKER, 2017). These studies, especially that of Kanner (1943), resulted in the recognition of a new diagnostic condition, currently called ASD.

After the medical community acknowledgedd ASD as a new diagnostic condition, studies on autism focused on identifying the genesis of this disorder; as it was considered too rare, scientists sought to understand why some people "present" autism while others do not.

Given the uncertainties regarding the etiology of ASD, one of most historically acknowledged theories among specialists was popularized by psychoanalyst Bruno Bettelheim, who defended the theory of maternal accountability and the term "refrigerator moms". In 1967, Bettelheim published *Empty Fortress: Infantile Autism and the Birth of the Self*, in which he argued that autism would be a disorder of emotional and relational origins in which the child, not feeling welcomed in the family environment, would choose to inhabit an "empty fortress", and surrender to a state of complete loneliness (LOPES, 2017).

The understanding that family rejection, especially maternal rejection, encouraged children to enter an "empty fortress" led Bettelheim to counsel the medical community to remove children diagnosed with ASD from family life (LOPES, 2017). Bettelheim's theory on the etiology of autism enjoyed international acceptance for more than two decades and, as a result, many children, upon being diagnosed with ASD, were referred to institutions that isolated them from social life, and often remained institutionalized for the rest of their lives.

Currently, contrary to the theory that autism is a disorder of relational origin acquired through family upbringing, the neurodiversity[1] paradigm argues that the genesis of ASD is neurobiological and that, therefore, it is impossible to develop ASD in life, nor should a cure be sought (FADDA; CURY, 2016). Souza defines neurodiversity as the notion that "non-standard" neurological conditions are natural

[1] Australian sociologist Judy Singer is considered the creator of the term "neurodiversity" due to her pioneering thesis on the subject, later transformed into the book *Neurodiversity: the Birth of an Idea*.

variations, that is, they are part of human diversity. Souza states they are not due to a tragedy, "brain imbalance" or a "limitation"; they are simply different neural connections (2018, p. 1).

According to this understanding, from the perspective of neurodiversity, ASD is, above all, a different human condition that must be respected and valued like any other. It should be noted that neurodiversity does not deny the occasional need of health interventions for ASD patients; however, it posits that these actions should not be aimed at "curing" individuals or trying to make them "indistinguishable from their peers".

Interventions should be planned and conducted as to stimulate the autonomy, independence and communication of ASD patients, inserting them progressively and comfortably into their community, without the need to eliminate their autistic identity or suppress their autistic behaviors (SOUZA, 2018, p. 1).

The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5[2]), consistent with the understanding of neurodiversity that it is not possible to "develop" autism throughout life, classifies ASD as a neurodevelopmental disorder present since birth (even though it is usually noticeable only in the early years of child development), and distinguishes three support levels: I (mild, requiring support), II (moderate, requiring substantial support), and III (severe, requiring very substantial support) (APA, 2014).

It is the exclusive task of doctors, usually pediatricians, child psychiatrists or neurologists to diagnose ASD, through observation and interviews with family members, caregivers and with the patients themselves, depending on their age.

4. Teacher training in helping students with ASD in the regular classroom: collaborative work among Specialized Educational Service teacher, main teacher and "specialized caregiver"

Thinking teacher training related to assisting students with ASD to learn requires reflection on how teacher training is established in the current Brazilian legislation.

In the Brazilian legal system, Law No. 12,764/2012 establishes the National Policy for the Protection of the Rights of People with Autism Spectrum Disorder, which has as its guideline encouraging the training of professionals specialized in the care of people with ASD (BRAZIL, 2012). One of the services regulated for teacher training in working with students with autism is Specialized Educational Service (SES). The provider of this service should be articulated with the teacher of the regular classroom, in order to promote

[2] Diagnostic and Statistical Manual developed by the American Psychiatric Association (APA) to define the criteria for the diagnosis of mental disorders.

the teaching-learning process, that is, school inclusion. The above-mentioned law also establishes that, in cases of proven necessity, the person with ASD included in the regular classroom, in accordance with Paragraph IV, art. 2 of the above-mentioned law, will be entitled to a specialized caregiver (BRAZIL, 2012).

According to current legislation, teacher training to work with autistic students involves a collaborative work of three types of professionals: the SES teacher, the specialized caregiver and the teacher of the regular classroom. Public authorities must provide initial and continuing training for these types of professional so that this service may be provided in regular schools.

It is noteworthy that the process of ASD student inclusion in the regular classroom will depend significantly on the level of understanding shown by the professionals assisting these students, that is, the fuller the understanding educators show, the more effective their intervention directed to students with ASD will be (BARBOSA & FREDERICO, 2016, p. 6394).

In this sense, it is essential to invest on initial teacher training, so it may contemplate theoretical and practical knowledge of the teaching-learning process of students with autism. Such knowledge may be acquired by participation in projects, pedagogical workshops, congresses, seminars, meetings, study groups, among other actions that provide opportunities to think, reflect and practice inclusive pedagogical actions in the regular classroom with autistic students. This set of actions may open for teachers in training the possibility of learning to rethink, create and recreate their practice, based on the reflection on the new knowledge acquired (BARROS, 2010, p. 40).

Such pedagogical actions for initial training should be the responsibility of Higher Education Institutions in articulation with the education systems, under the competence of the Ministry of Education. As Saviani states, the training institution must ensure, deliberately and systematically, by curricular organization, the pedagogical-didactic preparation; this is what Saviani calls the “pedagogical-didactic model of teacher training” (2011, p. 09). It is essential that initial teacher training provide experience of the functioning of basic education that may relate to the theories studied, especially regarding students with autism; such experience should allow for reflection on their own practice. Teacher-training institutions and education secretariats must, therefore, establish partnerships.

As Barbosa and Frederico state, massive investment is needed in initial teacher training, so continuing training need not be retroactive and compensatory. Thy believe it is essential to articulate initial and continued training, so the latter may elaborate on the former, and update teachers regarding changes in education, among other goals (2016, p. 6401).

With an initial training contemplating both theory and practice, and the continuing training of professionals working with autistic students (SES teacher, regular teacher and “specialized caregiver”), it should be possible to promote the educational inclusion of these students.

It is in continuing education that professionals have the opportunity to obtain knowledge related to educational changes, and thus be made aware of current discussions (BARBOSA; FIGUEREDO, 2016, p. 6.400). Such a training should respond to the anxieties that exist in your classroom to promote the teaching-learning process, answer questions and modify teaching practice through action-reflection-action. When acting with autistic students, the teacher must assume the role of essential mediator, seeking to build a teaching focused on students' potentials, in order to overocome their limitations, promoting, as Nascimento states, an educational intervention by means of age-appropriate techniques, bearing in mind students' potential and shortcomings (2018, p. 145).

Competent, properly trained professionals, who master challenging pedagogical strategies that favor the learning of students with ASD are pivotal for these students' educational progress. It also requires collaborative work with school management, as well as resources, family engagement, sound educational policies and a special education staff on school systems, offering regular classroom teachers support. This pedagogical support is legally provided for as SES teachers.

Students with ASD are part of special education's target audience, and, consequently, are entitled to SES. Camargo, Gomes and Silveira state that this special education service is currently a reference in meeting students' specific needs, in addition to establishing itself as support framework for students, teachers and families, being integrated to the other individuals and spaces within the school (2016, p. 21).

SES teachers assume an important role in their pedagogical relationship with regular classroom teachers – providing support for teachers and the students' families, developing intervention strategies that grant these students access to school social practices. According to Basic Education Chamber Resolution No. 4, one of the functions of SES teachers is to ascertain, in connection with regular classroom teachers, the availability of services, pedagogical and accessibility resources, and the development of pedagogical strategies that promote student participation (BRAZIL, 2009). This articulation becomes essential for regular classroom teachers to develop their teaching strategies targeting students with ASD, as talk with their peers – especially those more experienced – helps them model their pedagogical practice so it may favorably impact students.

However, without public authorities' commitment to provide continuing education for SES and regular teachers – by providing pedagogical and financial resources, and elaborating and implementing public policies –, policies are very unlikely to become a reality.

The third professional involved in this collaborative work and introduced by means of legislation is the "specialized caregiver" – a support professional that accompanies autistic students, when necessary, in the regular classroom.

Technical Note 24/2013, which guides school systems for the implementation of Law No. 12,764/2012, explains this professional must be available whenever the individual need of a given student is identified,

and must assist this student in communicating, as well as tending to their personal needs of food, hygiene and locomotion (BRAZIL, 2013, p. 4).

The above-mentioned Technical Note states that this service is directed to students who are not capable of eating, communicating, moving or cleaning themselves; it is also justified when the student's specific needs are not contemplated by the regular classroom; this service is not a substitute for those provided by the regular teacher, the SES teacher or any other school activity; furthermore, it must be evaluated jointly and continuoulsy by family and school, in order to assess its efficiency and the need for its continuity.

This type of legally prescribed assistance to ASD students is not different from that which must be offered to any student, that is, it must aim at students' personal and social development, allowing for their participation in various different environments, without restraining their potential to their shortcomings. If this subject is still being discussed today, and if regulation was needed, it is because schools have not as yet succeeded in becoming fully inclusive.

5. SES resources instrumental in assisting students with ASD

As autistic people present communication and language impairments, they can use resources to aid in the communicative process, the so-called "assistive technologies" (AT), which can be understood as any artifact that allows better accessibility to the individual who has some specific need. According to Manzini, "we can call assistive technology a cane, used by our grandparents to provide comfort and safety when walking, as well as an amplification apparatus used by a person with moderate hearing loss" (2005, p. 82).

Thus, people with ASD can make use of AT tools to promote communication in an alternative and extended perspective. In education, AEC has been pointed as favoring the development of verbal and nonverbal communicative skills of students with ASD (PASSERINO; BEZ, 2015).

According to Santarosa et al. (2010), AEC is defined as a set of resources (boards, albums, software), strategies (storytelling, games, mimicking), techniques (pointing, tracking, holding) and symbols (gestures, signs, images) that aims to promote processes that facilitate communication and sociocognitive development.

Thus, the use of AEC tools in the teaching-learning process allows teachers to develop and implement pedagogical strategies that help in the exploration and development of numerous communicative functions of students with ASD, especially for those who have changes in verbal and/or non-verbal communication and interaction. The educator must plan his pedagogical strategies taking several aspects of qualitatively differentiated assistance into account, especially in the case of autistic children.

Educators must also observe and assess these children's particularities, interests and learning styles, as well as their specific communicative limitations. Taking the potential and limitations of an autistic child into

account, as well as using visual resources that meet their interests are points to be considered for interventions that will consequently promote the development of more effective communication (GAIATO, 2018).

In the search to improve the communicative process, as well as interpersonal interactions, autistic people can make use of AEC, as it has shown positive results, with a history of success in its use, to the extent that research has shown positive results with significant improvement in the development of communication and language (TOGASHI; WALTER, 2016, p. 356).

Thus, there are many AT tools incorporated into AEC for the public with ASD that may or may not have significant financial value. The Picture Exchange Communication System (PECS) is among the resources that enable the communication of people with deficits in communication skills; it uses low-tech resources such as pictures, images, posters, etc., which enable interaction and communication between student and teacher, positively impacting learning. PECS was developed by Andy Bondy and Lori Fost in the US in 1985; Togash and Walter define PECS as an AEC system that uses communication cards: in order to communicate, users trade a card they possess by an item they desire – an object, the performance of an action –, or even to express feelings and sensations (2016, p. 353).

Such a system can also be adapted, as Walter (2000) proposes, by dividing it into five application stages, and is indicated for autistic people or people who have other communication impairments (WALTER, 2017). Moreover, the adapted PECS generates the same positive results as the one developed by Bondy and Fost (MIZAEL; AIELLO, 2013).

Walters describes PECS as a system that requires neither complex materials nor specialized techniques for training; it does not use expensive equipment or comprehension tests, nor is it finantially burdensome on family and technical staff (2000, p. 25). Oliveira et al. state that PECS enables the use of learning strategies through visual stimuli, with the exchange of a card for objects of interest of the child or the performance o a given action (2015).

PECS requires no previous skills of the child, although, as Gonçalves (2011) points out, they should be able to hand the cards to their instructor. Thus, Gonçalves views PECS as seeking to develop in the child the ability to initiate communication, and to be spontaneous in the communicative process (2011, p. 39), which is highly relevant for autistic children with various levels of language and communication impairment.

In addition to enabling AEC and the development of verbal repertoire, the use of PECS has other advantages. Among these, Jesus mentions its low cost, the fact that it is portable, which allows it to be used in different places, and the fact that it requires few complex movements of the child (2012, p. 25). Thus, PECS is easily available to families and schools, as it is has low cost; the portability of the resource is also

relevant, mainly because it allows interventions to occur in different environments, which enables the skills developed to be more highly generalized.

When assessing the implementation of PECS, instructors must evaluate the level of understanding of the pictures, photos, words or other resources that may be part of the AEC. There are, therefore, different AEC systems, which, as Gonçalves states, must be used according to the specific potential and needs of their users, enhancing their communication capacity, so that they may be as effective and independent as possible in the communication process (2011 p. 35).

For adapted PECS, Walter (2017) suggests drawings, clip-arts, inserts, as well as pictures found on Internet pages. However, it will always be necessary to diagnose the potential and limitations of an autistic child for more effective interventions and communications.

Oliveira, et al. (2015), in a revisional bibliographic study on the considerations of the application of PECS with autistic people, systematized different contributions from different studies. They showed an increase in communicative intentions after the use of PECS, as well as the presence of vocalizations (FIDALGO, 2008; AZAROFF et. al., 2009). The studies reviewed also found an increase in the number of figure exchanges autonomously, which enabled the development of interpersonal interactions (BEZ, 2010; FIDALGO, 2008; ORRÚ, 2006; CHAABANE et. al., 2009).

In summary, all the artifacts used in PECS, as well as in all the systems that enable AEC, should be easily understood by autistic students, as well as meet their interests and preferences, so that the communicative process, especially between teacher and student, can occur effectively, thus facilitating the promotion of communication, both in an alternative and/or extended perspective.

6. Final Remarks

ASD is classified as a neurodevelopmental disorder marked, mainly, by the difficulty of interaction and interpersonal communication, and by various levels of repetitive, stereotypical behavior.

The use of AT tools intends to promote direct and intensive learning, prompting higher communicative autonomy, so individuals may manifest their personal and social needs and demands in an understandable way.

This paper investigated the theoretical and political foundations that regulate the inclusion of students with ASD in regular school, analyzed teacher training in its relation to promoting their inclusion of these students, and identified AEC resources used by regular classroom teachers and directed to ASD students.

The narrative research was chosen as methodological strategy, as it was understood as the best approach to treat the theme under discussion in a broad, updated and consistent way. In addition, revisional work

allowed for a panoramic view of divergences and consensus, the technical updates within a field, and even the gaps regarding themes and subjects of research (BOLDERSTON, 2008; MENDES-DA-SILVA, 2019).

The importance of SES as a fundamental part in the process of school inclusion is emphasized, assisting the student in the resource room and in the classroom. It is necessary for the SES teacher to work in parallel with the regular teacher, despite the difficulties and barriers encountered. In the case of students with no verbal communication, it is essential that resource room teacher guides the regular teacher in using AEC, as a means of promoting this student's inclusion and autonomy. Only from the moment students are able to express their desires, fears and anxieties, will they be able to organize their feelings and abate their challenging behaviors.

It is worth noting that there are many possibilities to work on the needs of students with ASD, in terms of communication and learning, improving their social interaction within the school environment. AT tools show themeslves as an excellent option, taking into account the technological apparatus, technical conditions and improvement of methods.

From the theoretical framework presented, it is believed that the great challenge of the teacher is to understand the pedagogical strategies and practices that help in the teaching and learning process of students with ASD in the regular classroom, focusing on the elaboration of public policies and the responsibility of the public power to effectively offer an education for all – an education that respects the other as a true other.

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THE EFFECTIVENESS OF CUSTODY HEARING: AN ANALYSIS OF THE BRAZILIAN CASE

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Abstract

In Brazilian law, the hearing can be an instrument of protection and promotion of human rights, makes it possible to eliminate the idea of impunity, with which it is seen mainly by lay people, and demonstrating that this institute is not synonymous with freedom or injustice, but a way of ensuring the fundamental laws guaranteed in the Federal Constitution of Brazil of 1988. It seeks to establish here a relationship between the researched theme and Human Rights, seeking to promote analyses on facts that occurred before the legalization of the Custody Hearing in Brazil and the changes that came with the establishment of this institute. It is a study based on forensic literature, international norms and treaties such as the American Convention on Human Rights and Specific Laws dealing with the theme. In this sense, the research also develops by analyzing the different positions and identifies which are the constitutional principles that were commonly violated in view of the non-existence of the Custody Hearing. This research also develops the possibility of the Applicability of Article 37 §6 of the Federal Constitution of Brazil of 1988, as well as developed an investigation of the concept of general repercussion and its consequences, in view of the Supreme Court having presented such an understanding for the question. It is a bibliographic reference based on doctrines, treaties, articles, arranged in physical and digital libraries.

***Keywords**: Hearing of Custoday. Human Rights. International Treaties. Constitution.*

1. Introduction

Currently much has been discussed or commented on, in society in general, about custody hearing. However most comments are made without the necessary deepening. By presenting this study, we seek to develop a possible analysis about the Custody Hearing in the Brazilian context. What is this legal instrument really? how is it being carried out? what is your legal rationale? What is the deadline for its realization? It also seeks to analyze the consequences of these hearings for the Brazilian prison system.

The custody hearing is a legal instrument that has aroused much controversy, not only in society in general but also in the legal environment. Since it began to be implemented, the custody hearing, had to go a long way with many obstacles until it was consolidated. However, it has been held in all Brazilian states.

The overcrowding of Brazilian prisons has been a recurrent problem. A large portion of this amount is provisional prisoners. It is well-off that our legal system is slow, which aggravates this situation. These

hearings do not solve the problem definitively, nor is that the intention. They help to ease the situation, as they prevent people from being imprisoned without conviction. It is verified with this study that, in a way, the hearings promote an adaptation to what is contained in the International Treaties of which Brazil is a signatory.

The main objective of this work is to show that the custody hearing represents an evolution in the Brazilian legal system and undo the belief that it was created only in order to empty the Brazilian prison system.

2. CUSTODY HEARING

Custody Hearing is the procedural act that requires the realization of the first hearing of the prisoner in flagrante, before the judge, within 24 (twenty-four) hours, as a rule. The deadline issue will be reviewed separately in another topic. It is at that hearing that the judicial authority will be able to verify the legality of the arrest and the need to maintain it. Therefore, it is the presentation of the prisoner before a judge. This allows personal contact between the judge and the prisoner. In this way, respect for the fundamental rights of the person custody of the State can be ensured. This mechanism enables the most appropriate and appropriate assessment of the prison. The physical presence of the person caught red-handed is the guarantee of the contradictory still in a timely manner. Timely because it allows the judge, the member of the public prosecutor and the technical defense to know the possible cases of torture and take legal action. In this way, the Custody Hearing Institute prevents the cycle of violence and crime from continuing. Enabling the judge to analyze whether he is facing the arrest of an occasional criminal or someone who is in the criminal field, that is, dangerous to society. At this time the judge may determine the continuity of the prison or the granting of liberty with or without precautionary measures.

According to Luciana Pimenta, 2016, p.39:

> Custody Hearing is the procedural instrument that determines that every prisoner in flagrante must be brought to the presence of the judicial authority, within 24 hours, so that it evaluates the legality and need to maintain the prison.

According to Aury Lopes and Caio Paiva, 2014, p. 75: The custody hearing:

> It basically consists of the right of (all) imprisoned citizens to be led, without delay, to the presence of a judge so that, on this occasion, any acts of ill-treatment or torture are ceased and also to promote a democratic space of discussion about the legality of the need for imprisonment.

The code of criminal procedure has undergone repeated changes in recent times to adapt criminal prosecution to the standards established by the Federal Constitution of 1988. It has not been easy to make this adjustment, since the Code of Criminal Procedure was born in a time when an authoritarian climate prevailed in Brazil. It was a complicated time in our recent history, in which individual rights and guarantees were in some way not respected in their entire dimension.

Although the most usual nomenclature is a "custody hearing", some find the name "presentation hearing" more appropriate. O Min. Luiz Fux of the Supreme Court, for example, prefers it that way. There are also

those who prefer "warranty hearing". Here I will use the term "custody hearing" because it is the expression for which it became better known. It is the most popular term, although the term "presentation hearing" seems to avoid the idea that the purpose of the audience is to cost someone. The Custody Hearing is far from consensual between the indoctrinators and enforcers of law. There are many who stand against its realization. Society in general also does not see with good eyes the subject dealt with here. This is because a more technical analysis of the facts involving the realization of the Hearing is not made.

Of course, in some situations there may be a sense of impunity, especially for the laity in the field of law. It is noteworthy that there are scholars of law who also do not approve of this realization. However, you must remember, here. of a popular phrase: "One mistake does not justify the other" Thus could not the State curb crime by committing other crimes, such as torture, with the aim, often, of plucking confessions. There is a danger that instead of achieving the main goal, which is justice, if you commit the exact opposite. Not that this occurs in all cases, but we will analyze, at another time, examples of facts that occurred before the implementation of the Custody Hearing in Brazil. The purpose is not to defend impunity; on the contrary, it is to analyze the application of justice and, if justice is done when it is fulfilled by law. If the law endeashes, including prisoners, the need for a right to be exercised in its fullness by anyone who is subject of law.

It is worth noting that the holding of the Custody Hearing is a relatively new fact in Brazil. All European countries have been carrying out this procedure for a long time, in South America, it has also been practiced for a long time, such as in Peru, Colombia, Argentina and several other Latin countries. In these countries, the structure for holding these hearings is called "Guarantees Court". It is a procedure with the objective of civilizing and humanizing the legal process. It distinguishes between individual offenders and high-risk criminals. This prevents prison from becoming a school of crime, since prison should have the opposite goal, that is, the resocialization of the prisoner. It was very common, in the very recent past, to delay between the arrest in flagrante and the hearing of inquiry. So it was called earlier. This often came years before the judge looked at the defendant's face for the first time. This was the case in cases where the law provided for the possibility of provisional freedom or precautionary measures. Prisoners who could not be economically able to become a lawyer were at the mercy of the very course of the process that was walking slowly.

Article 319 of the Code of Criminal Procedure deals with various precautionary measures of imprisonment, especially in the case of minor crimes. Such measures may be applied by the judge by the presence of certain requirements. The applicability of these regulatory precautionary measures in the CPP was compromised without holding custody hearings. In this sense, it is worth remembering that the prisoner submitted to this hearing will not be convicted or acquitted; but only stuck or loose. Therefore, you will have to respond to criminal proceedings before the courts in any case. He will, however, answer for his crime. At the end of the case you can be acquitted or convicted and in the last possibility you will receive the penalty imposed by law.

The egregious that lead prisoners to the hearings have the most varied reasons. From a neighbor's fight to first-degree murders. Among these, of course, there are those less serious to whom penalties can be replaced by fines or restriction of rights, according to the law. If the law imposes less severe penalties, without restriction of freedom, for crimes of lesser offensive potential, then the Custody Hearing prevents

injustices from being committed. Nothing fairer than complying with the law. It would not be fair for a person to be imprisoned for months, and sometimes even years, when the crime committed by him does not imply imprisonment.

It is important to leave recorded here that although the custody hearing is held to present prisoners in flagrante before a judge, Caio Paiva is in favor of carrying out the same in case of preventive and temporary detention. According to him the holding of the hearing in these circumstances would have the purpose of verifying or reassessing the need for imprisonment. It serves to reassess the grounds that led to his arrest. Bardaró also shares this view; as this passage quoted in the book of Caio Paiva,2015, p. 67, confirms, when it refers to it:

> In the case of temporary arrest or pretrial detention, due to prior and reasoned judicial decision, it is not necessary a subsequent analysis of its legality. Nevertheless, the arrested person is entitled, on the basis of Article 7(5) of the American Convention on Human Rights, to be brought before a judge without delay, to hear it, and to reassess the necessity and adequacy of the prison, which may be relaxed, revoked or replaced by an alternative precautionary measure to prison, if the circumstances of the case so indicate appropriate.

Not infrequently the news of a crime scares us and plays with our imagination. If we are human, when we read a prison report in flagrante or a complaint describing, for example, the conduct of Paul K., consistent with having entered a house at dawn, for the purpose of subtracting property and, in its course, have been caught by the resident, elderly lady, who fired two shots, without having died, fleeing, following the crime scene and , then arrested by the police, we would have to fill in the gaps. We would not remember a sweet, respectful, polite face, but rather a subject who brings together the attributes of evil. This human conduct (filling the spaces devoid of information) creates what is called the priming effect, that is, the effect that the network of association of signifiers operates individually without us realizing, based on what we have just realized, even in the absence of information from the case. Hence, the simple reading of the accusatory play or the arrest warrant in flagrante generates, to those involved in criminal proceedings, the anticipation of meaning. Therein lies the first fundamental step towards hosting the custody hearing. It will no longer be the "criminal" we imagine, but the subject of flesh and blood, with a first name, surname, age and face. The human impact provided by the agent, in his first manifestations, may modify the imaginary understanding of those involved in the Criminal Procedure. Decisions, therefore, can be made with more information about the agent, conduct and motivation. Remember that injunctive detention is always procedural, that is, they do not serve to anticipate the penalty, and it should be based on the exceptionality of precautionary restraint, criticism that we have already done before. Hence the state's device for analyzing the reasons for face-to-face injunctive detention is gaining importance. Respect for the rules of the procedural game. This invective has been launched by us for years in texts, as well as many jurists concerned with establishing a minimum standard of procedural standards apt to guarantee substantial due process. (LOPES, MORAIS, 2018, p. 226)

We have seen in this passage above that these renowned jurists justify holding the custody hearing as a way to humanize due process.

The custody hearing is also justified, according to some scholars in the field, in cases of pretrial or temporary detention.

2.1 Minor Crimes

Penalties should vary according to the severity of the crime committed. The Custody Hearing, in a way, makes a selective analysis of cases avoiding unnecessary arrests. It selects cases in which the person could respond to the process in freedom by obeying some precautionary measures. The release in these cases makes people have a misconception about the hearings.

The general idea is of mass incarceration, which is not true. It does not reach the population with the information that the number of prisoners did not vary significantly with the implementation of custody hearings. If it wasn't for the hearing, many innocent inmates would probably spend months in prison until their cases were evaluated. Some say the custody hearing is gradually humanizing criminal proceedings.

Law No. 12,403/2011 amended 32 articles of the Code of Criminal Procedure of 1941. According to the aforementioned law, persons who commit minor crimes, punished with less than four years in prison and who have never been convicted of another offense will only be arrested in the last case. It is worth clarifying that Brazilian legislation considers minor crimes: simple theft, manslaughter in traffic, misappropriation, damage to the public good, smuggling, private imprisonment, coerceration of witness during the course of the process, false testimony, among others.

Currently, people who commit minor crimes are only arrested if the judge understands that they can pose risks to society. Not offering risks during the course of the process, there is no reason to wait for a trial in prison. However, when the person has already been convicted in cases of domestic violence, when there is doubt about the identity of the accused, when he has no fixed address making it difficult to locate by the Court his arrest is justified. If you don't agree with the law, that's another situation. It would be a problem of the legislator we have electd for this. At the custody hearing, only the law is up to the court.

According to the law, there are several alternative measures that can replace prison before the accused is tried definitively. It is not a mere incarceration in order to avoid overcrowding. There are legal criteria that the judge will take into account when deciding to release or maintain the prison. It is worth reinforcing that the release does not mean absolution. That's because only at the end of the process will a sentence be given. It should be noted here that if you fail to comply with some of the precautionary measures imposed on him, the individual who is released at the Custody Hearing may be arrested before the end of the proceedings.. This freedom, therefore, is provisional. But if he were imprisoned, incarceration would also be temporary; since there is still no conviction. If he were to be convicted and the sentence is a restriction of rights and not of restriction of freedom, incarceration would also be provisional.

The cold letter of the law does not reach the differences between people. It may also not detail circumstances in which each fact occurs. These peculiarities can be observed by the judge during the hearings.

3 FUNDAMENTALS

The Custody Hearing is based mainly on international treaties, but also on national legislation originating from them. We will first analyze the legal basis of the Custody Hearing at the international level, as it was the starting point for the internalization of this institute in the Brazilian legal system.

The Custody Hearing seeks to meet the longings of the American Convention on Human Rights (ACHR) which states that:*"Every person arrested detained or held shall be conducted without delay in the presence of a judge or other authority authorized by law to perform judicial functions (...)"* and the International Covenant on Civil and Political Rights (ICCPR) which also dictates that: *"Any person arrested or imprisoned for criminal offense shall be conducted, without delay, in the presence of a judge or other authority empowered by law to perform judicial functions (...)"* (art.9.3).

Despite some minor differences in the texts of the above-mentioned International Treaties, it can easily be seen that the essence remains the same or, at the very least, similar; this is because they have the same goal as the use of a form of judicial control of prisons in flagrante.

In such a way that it can be affirmed that the custody hearing in Brazil came to establish a synchrony between the Brazilian criminal process and the International Human Rights Treaties.

It is worth remembering that these Treaties have status, according to the Understanding of the Supreme Court, of supralegal norms.

3.1 Pact of St. Joseph of Costa Rica

The American Convention on Human Rights, also called the Pact of San José of Costa Rica, for having been signed in that country in 1969, has as one of its main objectives, to recognize the essential rights of the human person, regardless of his nationality; for the fact that it is based on the attributes of the human person justifies being possessed of the essential rights that must be extended to all human beings as written in Article 1, item 2 of that convention:*"For the purposes of this Convention, a person is every human being"*. It is also important to mention Article 5, item 1 which mentions: *"Everyone has the right to respect his physical, psychic and moral integrity"*

These above-mentioned articles are related to the Custody Hearing Institute, but Article 7, items 5 and 6 of this Convention makes direct reference to the Custody Hearing. See:

> Article 7. Right to personal freedom.
>
> [...]
>
> 5. Every person detained or detained shall be conducted without delay in the presence of a judge or tried within a reasonable period or to be released, without prejudice to the proceedings. Your freedom may be conditioned to guarantees that ensure your attendance in court.
>
> 6. Every person deprived of liberty shall have the right to appeal to a competent judge or court in order for him to decide without delay on the legality of his arrest or detention and to order his release if the arrest or detention is unlawful. In States parties whose laws provide that any person arrested who is threatened with being deprived of his liberty has the right to appeal to a competent judge or court in order for him to decide on the legality of such a threat, such an appeal cannot be restricted or abolished. The appeal may be brought by the person himself or by any other person.

As we have seen, the custody hearing is supported by two important international human rights documents to which Brazil is a signatory. By voluntarily ratifying the aforementioned treaties, Brazil undertakes to comply with the terms contained in these documents. However, it took more than 20 (twenty years) to effect the presentation hearing. That is, in a way Brazil has omitted it all this time; because only a documentary analysis of the situation of the person arrested in flagrante delicto was made, differently from what the international treaties mention.

3.2 International Covenant on Civil and Political Rights

The International Covenant on Civil and Political Rights is one of the three instruments that make up the International Charter of Human Rights. Also part of this are the International Declaration of Human Rights and the International Covenant on Social and Cultural Economic Rights.

However what interests us at the moment is the relationship between this pact and the custody hearing, since it also retains the rights it aims to protect.

The International Covenant on Civil and Political Rights in Article 7 reads:

> Article 7 - No one shall be subjected to torture, cruel, inhuman or degrading treatment or punishment. In particular, no one will be submitted without your free consent to medical or scientific experiments.

And in Articles 9 and 10:

> 1-Every individual has the right to personal freedom and security. No one may be subjected to arbitrary arrest or arrest. No one may be deprived of his liberty, except for the reasons laid down by law and in accordance with the procedures laid down therein.
>
> 3- Every person arrested or arrested for a criminal offence shall be present, as soon as possible, to a judge or other official authorized by law to perform judicial functions, and shall be entitled to be tried within a reasonable period or to be released. Pre-trial detention should not constitute a general rule, however, freedom must be conditional on guarantees ensuring the act of justice or at any other time of the procedural proceedings, or for the execution of the sentence.
>
> Article 10:
>
> 1- Every person deprived of liberty will be treated humanely and with respect due to the dignity inherent to the human being.

As can be seen, the International Covenant on Civil and Political Rights is another international document that supports, substantiates and protects the rights that the custody hearing seeks to implement. It seems a little repetitive, but the goal is to make it clear that the custody hearing is the realization of international anides in dialogue with national objectives, as we will analyze some articles of the Federal Constitution.

3.3 Federal Constitution of 1988

The Federal Constitution of 1988 does not make direct references to custody hearings, because it is a new legal instrument in a certain way in Brazil; however, article 5, which deals with fundamental rights and guarantees, it is possible to identify in item III the protection of rights that meet the objectives of holding

the custody hearing. See:*"Article 5: III - no one shall be subjected to torture or inotheror or degrading treatment."*

It is clearly verified in the above mentioned article the protection that the Constitution guarantees to Brazilians and foreigners in the national territory. However, what was missing was the instrument to put into practice such rights.

It is also possible to cite the following item of the same article:*"XXXV- the law will not exclude from the assessment of the judiciary injury or threat to the right."*

In this case, it turns out that the custody hearing came precisely to exercise what was already guaranteed in the Federal Constitution of 1988.

In the xlix item it emitters*read: "XLIX- prisoners are assured of respect for physical and moral integrity."*

As we see the custody hearing brought no news, only came to curb injustices; because these rights were already protected by the 1988 Constitution.

In the same article cited in the item LXV states:*"LXV- illegal imprisonment shall be immediately relaxed by the judicial authority."*

It turns out that he already mentioned the immediate release in cases of illegal imprisonment. And to finalize the citations of the Federal Constitution, we will see that it cites the international treaties in the lxxviii item:

> *§2- The rights and guarantees expressed in this Constitution do not exclude others arising from the regime and principles adopted by it, or from the international treaties to which the Federative Republic of Brazil is a party.*

It is also possible to mention another excerpt from the Brazilian constitution of 1988 that deals with international treaties.

See also in Article 5, item LXXVIII:

> *§3- The international human rights treaties and conventions that are approved, in each house of the National Congress, in two shifts, by three-fifths of the votes of the respective members, shall be equivalent to the constitutional amendments.*

So it is clear that the rights guaranteed in the International Treaties were preserved by the Federal Constitution of 1988 and that they were put into practice from the achievements of custody hearings in Brazil.

3.4 CNJ Resolution on Custody Hearing

The custody hearing was much requested by various sectors of Brazilian society; mainly by human rights protection entities, undoubtedly contributing to the implementation of this institute in the Brazilian legal system. However, the National Council of Justice (CNJ), *launching the Custody Hearing Project,* was indispensable for the judiciary to put the matter in evidence in Brazil. First, the said project was launched only in the State of São Paulo on February 6, 2011, however, in his presentation speech Minister Lewandowski has already announced the intention to expand the project to other states. On April 9 of that

year the CNJ, the Ministry of Justice and the Defense Institute of the Right of Defense (IDDD) signed three agreements aimed at encouraging the implementation of the project throughout the national territory.

It is worth remembering that Maranhão was the first state to regulate the holding of custody hearings in the country in 2014. This was due to serious problems faced in its prison system, which was even broadcast in the national media. The next state to regulate the custody hearing was the State of São Paulo on 01/22/2015. On 04/09/2015 the Court of Justice of the State of Espírito Santo also regulated the holding of the hearings. Then the State of Minas Gerais also joined the CNJ project. And so the states gradually were commencing themselves to the CNJ project and at the same time to international treaties and conventions.

However, it was with Resolution No. 213 of 15/12/2015 that the CNJ, through its president, regulated the holding of custody hearings throughout the country, in which it provides for the presentation of all person arrested to the police authority within 24 hours. This Resolution consists of eleven considerations justifying the hearings, of which two will be cited:

> CONSIDERING that imprisonment, according to constitutional provision (CF, art.5°, LXV, LXVI), is an extreme measure that applies only in cases expressed by law and when the hypothesis does not include any of the alternative precautionary measures;
>
> CONSIDERING the diagnosis of prisoners presented by the CNJ and the INFOPEN of the National Penitentiary Department of the Ministry of Justice (DEPEN/MJ), published, respectively, in the years 2014 and 2015, revealing the disproportionate contingent of people provisionally arrested.

In several articles of Resolution No. 213 of 15/12/2015, a special concern is highlighted in curbing acts of torture and ill-treatment, as provided in the international treaties mentioned above.

4. DEADLINE FOR HOLDING CUSTODY HEARING

The issue of the deadline for holding the custody hearing has been the subject of disagreements since its partial implementation, that is, in some states, until the implementation throughout the national territory.

The first question was about the meaning of the expression "without delay" that appears in the translation American Convention on Human Rights. What does that actually mean? How should this expression be interpreted?

The ACHR uses the expression "without delay" to refer to the temporal aspect between the arrest of the prisoner and his conduct to the judicial authority (Caio Paiva, 43). Although there is, as Bardaró records, some controversy regarding the

translation of the original text of the Convention, as in the English version, which uses the expression promptly ("promptly"), the senses are very close and we will leave, here, from the expression found both in the Spanish version and in the text promulgated in Brazil: "without delay" (Caio Paiva, 43)

Well, that's it. There is a consensus in the jurisprudence of the International Human Rights Courts that the definition of what is meant by without delay should be interpreted according to the special characteristics of each specific case, thus having several precedents both the Inter-American Court and the European Court of Human Rights. However, you can find

some "parameter" in international jurisprudence, which has greatly enhanced the expression "without delay" to attribute to it a meaning consistent with the purposes of the guarantee (Caio Paiva, 45).

At the U.S. regional level, the Inter-American Court has already ruled, for example, that it violates the ACHR (American Convention on Human Rights), the conduct of the prisoner in the presence of judicial authority in the following time lapses after the arrest: almost a week, almost five days, approximately thirty-six days,... On the other hand, the court ruled that in López *Álvarez v. Honduras*,it ruled thatthe state in demand did not violate the ACHR, and that the case would have been brought before the judicial authority the day after his arrest. Thus, it can be concluded, *for the time being*, that is, until other precedents arise, that the IACHR considers that the expression "without delay" provided for in Art. 7.5 of the Convention is not violated when the prisoner is presented to the judicial authority within one day of the arrest (Caio de Paiva, 45)

As can be seen in the above-mentioned section, there was no fixed or determined deadline to be made the presentation of the prisoner.

In Brazil there were also several divergences regarding this deadline. Other questions that were usually asked in our country: from what time should be begun to count the deadline for holding the hearing? From the moment of the arrest? Right after the conclusion of the investigation? Finally, many doubts existed as to the deadline for the submission of the prisoner before resolution No. 213 of the CNJ.

Let it be clear that, in Brazil, Resolution No. 213 of the CNJ establishes the time of 24 (twenty-four) hours for the presentation of the prisoner to the judicial authority, according to its art.13:

> The presentation to the judicial authority within 24 hours also ensured to persons arrested as a result of compliance with injunctions of injunctive or definitive imprisonment, applying, in whatever case, the procedures provided for in this Resolution.

However, several factors have been claimed that may influence the time required for this presentation, such as the structure of the Brazilian judicial police. There are places in Brazil where the operating conditions of police stations are precarious, municipalities where there are no doctors available to perform the necessary tests; there were even suggestions from CONAMP that the deadline in question should be 72 (seventy-two hours). However, I repeat, the deadline stipulated in Resolution No. 213 of the CNJ, which is 24 hours from the time of arrest, is what prevails in Brazil.

5 CUSTODY HEARING FROM THE POINT OF VIEW OF DOCTRINE

Although the custody hearing is a fact that caused disagreements among the indoctrinators, the vast majority consider it as a fundamental guarantee.

As Marcelo Semer warns, 2014, p.116, law (and criminal proceedings, I add) deviates from agency to the extent that it serves as a limit to the exercise of punitive power. Similarly, Caio Paiva pointsout:

> It must not be forgotten that, at least in the Democratic State of Law, the function of criminal sciences, and criminal proceedings in particular, is that of containing power. Criminal proceedings are justified only as an obstacle to oppression. The challenge is to make the criminal sciences

> always, and always act as an instrument of democratization of the criminal justice system" (Caio Paiva, 28).

In this regard, the thought of Pope Francis, who, in one of his speeches, after describing what he called "Criminal Systems Out of Control", is revealed, points out that:

> In this context, the task of lawyers may be solely to limit and contain such trends. It is a difficult task, in times when many judges and agents of the criminal justice system must carry out their task under pressure from the mass media, some unscrupulous politicians and the drive of revenge that is insinuated into society. Those who have such responsibility are called to do their duty, since not doing so endangers human lives, which need to be cared for with greater intrepidity of what is sometimes sometimes done in the fulfilment of one's own functions" (Caio Paiva, 28).

According to Caio Paiva himself:

> Containing or limiting punitive power does not mean commending with impunity, but rather streming for respect for procedural, constitutional and conventional rules that regulate the activity of the criminal justice system. Such a stance represents a clearly counter-majority activity today."

On this purpose, this is the very valuable warning made by Rui Cunha Martins, 2018, p. 87:

> Finally, the process will only be a true operator of change as long as it can assume a facet as unpopular as it is indispensable: being a defraudor of expectations. It is quite true that classically, the process owes the legal certainty that can be expected of its ability to stabilize expectations, whether social, normative, more prosaically, of justice. It doesn't matter. This connection needs to be rethought according to what is now the production mode of expectations. We follow this production too closely, throughout this work, to limit ourselves to fencing the phrase made of the correspondence between process, certainty of the right and social expectations regarding the memo. The truth is that the process today, to be due and legal, has every interest in shutting down its function of the current tables of expectation. This will be one of the greatest glories: to ask him for blood and for him to offer contradictory.

It is important to cite the opinions of the opinion of the function of the process, because it is precisely in this context that the custody hearing fits. It appears with the function of humanizing, limiting punitive power. It is the instrument that makes it possible to prevent excesses and injustices from happening in the process as a whole. So that can actually be a due process.

Still about this, says Alencar and Távora (2013, p. 54):

> The recognition of the authorship of a criminal offence presupposes a final judgment (art.5°, inc. LVII of the CF). Before this milestone, we are presumably innocent, and the prosecution has the evidential burden of this demonstration, in addition to which the precautionary restriction of freedom can only occur in exceptional situations of strict necessity. In this context, the rule is freedom and incarceration, before the sentencing order is finalised, it must appear as a measure of strict exception.

> The Federal Constitution of 1988 determines that the segregation of freedom, prior to the final judgment of the criminal sentence, will only take place with a decision and written judgment given by the competent court.
>
> Prison is the restrain of freedom, that is, it is the incarceration that comes from a criminal sentence that is finalized, which is regulated by the Penal Code.

In this context, the genuine function of the custody hearing is observed. It is worth remembering that for crimes of lesser offensive potential there are precautionary measures as punishment and that custodial sentences would be disproportionate. And even provisional arrest would make no sense, if even if the accused were to be convicted, the sentence would not be custodial.

Regarding proportionality, Oliveira (2011, p.504) comments that:

> Prohibition of excess, but also, in the maximum effectiveness of fundamental rights, effective control of the validity and scope of the rules, authorizing the interpreter to refuse the application of that (standard) containing excessive and out-of-the-line sanctions or prohibitions of the need for regulation [...] it is necessary to allow a weighting judgment in the choice of the most appropriate standard in case of possible tension between them , that is, when more than one rule, legal or constitutional, presents itself as applicable to the same fact.

According to the doctrine of Mauro Fonseca and Rodrigo Alflen, the custody hearing is conceptualized as:

> [...] mechanism of control over the criminal prosecution activity carried out by the state, in particular, on the institutions in charge of acts prior to the prosecution of the criminal prosecution ... it would avoid, therefore, the risk of incidence of one of the main problems that occurred in this initial phase of the criminal prosecution, which is the occurrence of ill-treatment and torture to individuals who had been arrested in flagrante [...] by order of state forces diverse from the judiciary. (ANDRADE, 2016, p.16).

Still on the subject, teaches Rogério Schietti Machado Cruz:

> The possibility that the accused himself intervenes, directly and personally, in the performance of the procedural acts, thus constitutes self-defense (...). It should be noted that self-defense is not limited to the participation of the accused in judicial questioning, but must extend to all acts in which the accused participates, (...). In fact, self-defense unfolds in the right of hearing and in the right of presence, that is to say, the accused has the right to be heard and speak during the procedural acts (...).

It is worth noting the concept of custody hearing of Caio Paiva:

> The custody hearing consists, therefore, in the conduct of the prisoner, without delay, the presence of a judicial authority that must, from a previous contradictory established between the Public Prosecutor's Office and the Defense, exercise immediate control of the legality and necessity of the arrest, as well as assess issues relating to the person of the citizen led, noddedly the presence of ill-treatment or torture (PAIVA , 2015, p. 31)

6 PRACTICE: HOW THE BRAZILIAN JUDICIARY HAS BEEN APPLYING CUSTODY HEARING

As we have seen in the international treaties mentioned above, it has been a concern of the international community, since 1966 with the International Covenant on Civil and Political Rights, the effective protection of human rights worldwide. Brazil, despite being a signatory to such Treaties, took decades to actually implement the custody hearing, which is an important instrument for the protection of human rights.

It is necessary to mention that, in Brazil, a portion of the police agencies, the Public Prosecutor's Office and the public prosecutor's office and the justice system in general are against the draft custody hearings.

The National Association of State Magistrates (ANAMAGES) stands against and claims that the measure will remove police officers from their functions in the streets and police stations, aggravating public safety problems and further increase the administrative duties of judges.

On February 12, 2015, the Association of Police Delegates of Brazil (ADEPOL/Brazil) filed a Direct Action of Unconstitutionality (ADI 5,240) in the Federal Supreme Court that provided for custody hearings. It is of course that the association was unsuccessful in its work.

In fact, custody hearings were effectively incorporated into the Brazilian judicial system in 2015, thanks to Resolution No. 213/2015 of the National Council of Justice that established guidelines and forecasts about the custody hearing and also to the Senate that approved PSL No. 554/2011 in the first round, which you propose the following menu: " Amends the §1 of Art. 306 of Decree Law No. 3689 of 3 October 1941 (Code of Criminal Procedure), to determine the period of twenty-four hours for the presentation of the prisoner to the judicial authority, it began to be applied throughout the national territory. It is worth remembering that it did not happen throughout Brazil at the same time and also that internal regulation would not be necessary, because Brazil is a signatory to the International Treaties that created and dictated its implementation. The states were gradually adhering to the project, well before Resolution No. 213 mentioned above. Today, custody hearings are in varying degrees of application in each state of the federation.

In a survey conducted by g1, currently, custody hearings arrest more than they release in 2/3 of the Brazilian states. According to the website, in 18 states, hearings result mostly in arrests.

It is worth taking stock of the implementation of the hearings after approximately three years of operation. Even with the strong resistance of the operators of the law, the instrument on the agenda has contributed to the non-recording of the situation of the prison system, which is already precarious. In this way, Brazil dialogues with the international procedures with which it has committed itself.

As expected, not everything came out perfectly from the start. An adaptation period is always required. Therefore, failures occurred. The most serious at the beginning of the implementation occurred in the judicial sphere. For a long time, many magistrates examined the arrest notice in flagrante understanding that it was legal and indispensable to injunctive custody, but did not base it as provided for in the Constitution of the Republic, for all judicial decisions. But over time these problems have been sanated mainly by the criticisms of jurists in various respects.

According to the data, from the year 2017, the National Council of Justice would have held 258,485 custody hearings, of which 115,497 resulted in provisional or non-provisional release, this represents 48.68% of the cases. Thus, most hearings resulted in imprisonment; contrary to the idea of mass incarceration. If in Brazil we had more than 700,000 prisoners this year, we will certainly agree that custody hearings have avoided worsening.

I thought it was important to bring, in this context, some information from the State of Rondônia. Here in our state, the custody hearing was regulated by Joint Provision No. 011/2015/PR-CG. Here in Rondônia, the Custody Hearing Center was created. This is open Monday to Friday from 08:00 to 13:00 and from 15:00 to 18:00 hours, and is presided by a guarantee judge.

The custody hearing has been held in the state since 2015. To be more precise, the first hearing was held in Porto Velho on September 14, 2015, the head of the Court of Justice of Rondônia, including the presence of the CNJ and the Supreme Federal Court at the time, Minister Ricardo Lewandowski.

At the time, it is worth mentioning that the State of Rondônia is the state with the lowest rate of provisional prisoners in the country, with only 16% of the total prisoners.

The National Council of Justice (CNJ) has as one of its objectives the reduction of the prison population of Brazil. This is possible by reducing the contingent of provisional prisoners, i.e. without conviction. Which would reinforce the presumption of innocence.

The average, in the State of Rondônia, conversion of prisons into preventive is 51.01%, in provisional release with injunctive measure is 43.45%, in full provisional freedom is 4.10% and 1.43% in prison relaxation. It is also important to note that in approximately six months of hearings, 172 prisoners claimed that there was violence at the time of the arrest, which makes clear the importance of its realization.

7 JURISPRUDENCE

As a way of complementing the study, some jurisprudence on the fact in question is attached. First ly at the national and later international level.

> STF- COMPLAINT Rcl 28834 RS RIO GRANDE DO SUL
>
> Jurisprudence
>
> **Decision:** Regarding the holding of custody **hearings** within the jail, I refer to the Resolution... Felipe Keunecke de Oliveira, inclusive, has designated **custody hearing** for subsequent realization... Second, because from the information provided it is possible to infer that (a) custody hearings **are** daily...
>
> TJ-CE-Conflict of Jurisdiction CJ 00005717020168060000 CE 0000571-70.2016.8.06.0000 (TJ-CE)
>
> Menu
>
> JUDGMENT OF THE 17th CRIMINAL COURT-SINGLE COURT OF **CUSTODY** HEARINGS IN THE FACE OF THE JUDGMENT OF THE 3rd COURT OF DRUG TRAFFICKING OFFENSES. JURISDICTION TO MAKE JUDGMENT OF RETRACTION IN A STRICT SENSE. GRANTING OF PROVISIONAL FREEDOM. DECISION MADE BY THE

JUDGMENT OF THE SINGLE COURT OF **CUSTODY HEARINGS.** ECJ RESOLUTION No. 14/2015. JURISDICTION OF THE COURT RAISED. CONFLICT.

Jurisprudence

1-The present conflict of jurisdiction is consoned, in which body has the jurisdiction to carry out the judgment of retraction of the appeal in strict sense brought against a decision that granted provisional freedom in custody hearing, if the judgment of the 17th Criminal Court – Single Private Court of **Custody**hearing, which delivered the said decision, or the judgment of the 3rd Court of Drug Trafficking Crimes, for which the expedient was distributed after the hearing mentioned. 2. Pursuant to art.96, inc.

STF - COMPLAINT Rcl 34600 RJ RIO DE JANEIRO (STF)

Jurisprudence

Decision: CUSTODY **HEARINGS** Act CLAIMED ART. 2nd OF RESOLUTION No. 29/2015 OF THE TJRJ. POSSIBLE ADMINISTRATIVE DISOBEDIENCE TO THE DECISION OF THE SUPREME COURT THAT DETERMINED THE HOLDING OF **CUSTODY** HEARINGS ... In casu, CNJ disciplined the holding of custody **hearing** through Resolution 213/2015, which...

STF - PRECAUTIONARY MEASURE IN COMPLAINT MC Rcl 27206 RJ RIO DE JANEIRO 0005439-10.2017.1.00.0000 (STF)

Jurisprudence

Decision: custody within the first instance of local custody, enabling the prisoner to appear before the judicial authority within a maximumperiod... Alluding to Notice No. 80/2015, it points out the absence of custody hearings relatively...

As can be seen in the above-mentioned court examples, there are several favorable or determinable decisions that hold custody hearings, when they were not yet fully regularized within the internal scope of the Brazilian legal system. Numerous examples could be cited here in which illegality in not holding custody hearings is recognised. But we will see cases of international human rights jurisprudence cited by Caio Paiva and Thimotie Aragon Heemann/2015.

White Bear Penitentiary Case

Judging Body:

Inter-American Court of Human Rights

Trial:

Provisional Measures determined in 2002 and infiscaluntil August 25, 2011.

On 06/06/2002, the Inter-American Commission on Human Rights submitted to the Inter-American Court of Human Rights a request for interim measures in favor of inmates of the José Mário Alves Detention Center, known as "Urso Branco Penitentiary", located in the city of Porto Velho, State of Rondônia, Brazil. The goal was to prevent interns from continuing to die in that prison unit.

> After several other Resolutions (in 2002, 2004, 2005, 2008 and 2009) underscoring the duty of the State to better implement compliance with provisional measures to prevent more deaths in the Urso Branco Penitentiary, the Inter-American Court adopted its last resolution on the case on 08/25/2011, at which point, considering (I) that since December 2007 there were no violent deaths or riots in the Urso Branco Penitentiary (II) that the State was properly investigating the allegations of violence or ill-treatment presented by the representatives of the victims and, mainly, (III) that the State of Rondônia signed with the representatives of the victims a "Pact for the Improvement of the Prison System of the State of Rondônia and the lifting of Provisional Measures Granted by the Inter-American Court of Human Rights , repealed the provisional measures because it no longer remains the scenario of gravity, urgency and need to prevent irreparable damage to the integrity and life of inmates of the Urso Branco Penitentiary, which does not release the Brazilian State, however, from its conventional obligations of surveillance and protection.

One can imagine what the environment was like within the prison mentioned above by having a capacity of 360 inmates and hold up to 1300. It counts from 2002 to 2011, exactly 100 deaths from the penitentiary. It is worth informing that, on June 24, 2019, the Urso Branco Penitentiary was completely vacated and that a complete renovation will be made in the building, seeking to meet the minimum dignity for prisoners. Not that this unemployment is the court's determination, but it undoubtedly influenced for this to happen.
It is important to note that the Inter-American Court of Human Rights is active in cases of human rights violations, not only in Brazil, but in all countries in which it can intervene. As we will see in the next example:

> **Case Mendonza and others vs. Argentina**
>
> Judging body: Inter-American Court of Human Rights
>
> Judgment: 14 May 2013
>
> Between 09/04/2002 to 30/12/2003 the presumed victims, one by lawyer and the other five by the Public Defender General of Argentina, Stella Maris Martinez, filed several petitions with the Inter-American Commission regarding the imposition of the life sentence for minors under 18 years of age who have committed certain crimes. In the face of the similarity between the allegations of fact and law, the committee decided to accumulate these petitions in one expedient, separating only the case of the victim Guilhermo Antonio Alvarez, who would be processed in another file.
>
> In 2010, the Commission issued a Background Report, concluded that the State was responsible for the violation of rights recognized in the American Convention on American Human Rights (ACHR) and made several recommendations, including to adopt legislative measures to make the criminal justice system applicable to adolescents compatible with international obligations on the special protection of young people. Argentina, however, even after three extensions of the deadline to inform it of compliance with the recommendations, remained inert, and therefore led the Commission to take the case to the Inter-American Court.
>
> The Court begins by noting that the controversies of this case are not related to the investigation of the criminal liability of victims for the crimes allegedly committed, but rather in the imposition of life imprisonment on those, an aspect on which the Argentine State recognized its international

> responsibility for violating the principle of criminal culpability, because life imprisonment would only be provided for imputed adults... Finally, in short, among several other conclusions, of a reparatory nature, of adjustment of the internal legal system etc..., the Court determined that the State refrain from applying the penalty of life imprisonment to victims, as well as to other people for crimes committed when they were minors.

It would be simple to cite numerous cases in which the Inter-American Court of Human Rights intervened to ensure that human rights are respected around the world, but I chose to demonstrate these two cases to illustrate how the Court's intervention was of fundamental importance to prevent such cases from continuing to happen in these countries.

Conclusion

Given everything that has been exposed, it can be concluded that the holding of custody hearings in Brazil is a major step towards the humanization or civilization of the Brazilian prison system. It is a step towards justice in its fullness, for it selects and takes from prison people who did not have the need to be or remain there. However, we must remember that this is a new process and that we are still crawling when we compared ourselves to other countries that have been doing it for decades. It is clear that this is not a mass incarceration with the sole objective of emptying prisons, but rather a mechanism that makes the whole process more fair. It can be seen that the
punishment for some delitive conduct is not always prison. The Brazilian legal system cannot distance itself from its main objective, which should be the reintegration of the individual into society.
The custody hearing allows the correction of possible illegalities and despite and despite the doctrinal and jurisprudential divergences, has proved to be an efficient legal instrument to avoid unnecessary overcrowding in Brazilian prisons and to preserve freedom, even if provisional for those who are entitled to it.

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STRANDING OF MARINE MAMMALS IN THE PERIOD FROM 2003 TO 2016, IN THE SOUTH ERN COAST OF SANTA CATARINA, BRAZIL

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Summary

Stranding is the event in which a marine animal comes ashore after death or comes and is unable to return to the sea, which may occur due to natural, spatial tendencies and anthropic actions. It occurs in many countries, several of which have created formal programs to monitor. Mammals are at the top of the food chain, suffering more from changes in the environment, which is why they indicate the quality of the ecosystem. In the southern region of Brazil, inventories of marine mammal biodiversity emerged in the 1980s. Registering stranded data makes it possible to discover important information about marine animals and the oceans. This work aimed to collect information to identify the composition and abundance of strandings of marine mammals. The studied area is located on the southern coast of Santa Catarina, between the municipality of Jaguaruna and Passo de Torres. Data refer to collections made by the Zoology Museum Morgana Cirimbelli Gaidzinski , from the University of the Extreme South of Santa Catarina (UNESC), during the period from 2003 to 2016, through third-party activations and systematic monthly monitoring. The stranding frequency in this period was 344 mammals, belonging to 15 species, 10 genera, six families and two different orders. The occurrence of rare and unpublished animals was observed, such as Balaenoptera physalus, Kogia breviceps and Arctocephalus gazela.

Keyword: Marine Animals; Strandings; Mammals.

1. INTRODUCTION

Marine animals are recognized as those organisms that obtain most or all of their nutrition from the sea, oceans or estuarine environments (PYLE, 2001; BALLANCE, 2013). According to this definition, the organism does not necessarily need to take all of its ecological niche in the marine environment.

Among them are marine tetrapods, which are vertebrates adapted secondarily to live in marine environments, given that at some point in their evolutionary history primarily inhabited the terrestrial environment, today, still use it for playback and / or rest (POUGH; JANIS; HEISER, 2003; JEFFERSON; WEBBER; PITMAN, 2008).

Some marine animals are totally independent from the terrestrial environment (BALLANCE, 2013), but, globally, all are directly or indirectly affected by human activities, which result in serious compromises in the quality of marine environments, reaching, in many cases, extinction (JEFFERSON; WEBBER; PITMAN, 2008). Human actions are so striking about these environments since the years of 1970 marine mammals and sea turtles are recognized as *fee*, protected in the United States of America (USA) (Swingle et al., 2013).

In this study, as our records also depend on third-party drives and mammals, when stranded, remain on the beaches for a longer time and draw people's attention more quickly, but we limit the study to the Mammalia class.

This species is found on the top of marine food chains (SICI L IANO; ALVES, HACON, 2005) and is more demanding regarding the quality of the environment, therefore, is the one that suffers with the environmental stress, thereby exercising the role of sentinel species for the health of seas, oceans, and coastal ecosystems (PETRY et al, 2010; KRÜGER; PETRY, 2011).

The stranding is considered an event described in marine animals, whose the individual or group of individuals comes to earth after death or is found alive on a sandy beach or on the coast (in mangroves, on rocks or in coral reefs) in a situation helpless, unable to return to water through her own ability (GERACI; LOUNSBURY, 2005; UNEP, 2008). It can be categorized as dead or alive, depending on the state of the animal when it is initially observed as single or in mass (GERACI; LOUNSBURY, 1993; HETZEL; LODI, 1993). A pair (mother and baby - in the case of mammals) is considered a single stranding, while the simultaneous stranding of two or more animals is defined as mass stranding (UNEP, 2008; WIBOWO; DHARMADI, 2014).

Animal data collected stranded provide the best and, often, the only information available on the natural history of many animal species (Bossart, 2009; BOGOMOLNI et al., 2010). Stranding records can indicate seasonal trends in the occurrence of certain species, the occurrence of stranding concentrations in certain areas (READ; MURRAY, 2000) and / or stranding associated with cyclical natural phenomena. The spatial and temporal trends in mortality of marine animals such as those caused by unusual mortality events and / or interactions with the s more varied human activities can also be monitored from stranding records (BOGOMOLNI et al, 2010; Swingle et al., 2013).

Due in part, the observation of difficulty in the environment where they live, data on marine mammals are still unknown with respect to their habits and the behavior, which makes the studies on these animals stranded an important source of information (BOGOMOLNI et al., 2010). Significant historical and current data on seasonal and spatial patterns of occurrence and mortality, diet, age structure, sexual proportion, population genetic variability, diet, interannual variations associated with climatic and / or anthropogenic events, causes of mortality, displacement and other aspects of natural history about marine mammals was acquired through the investigation of stranded animals, because strandings provide exclusive access to species that are evasive (COLEGROVE ; GREIG; GULLAND , 2005; BOGOMOLNI et al., 2010).

A well-organized and maintained database of strandings of marine animals can be an invaluable tool in understanding not only bottlenecks, but also changes in the marine environment (ARAGONES et al., 2010). A database that details the records of strandings of marine animals is a valuable resource for collecting information on occurrence, distribution, potential abundance, and human and oceanic health (BOSSART, 2009).

Strandings of marine animals occur all over the world. Although not exist global statistics on such events (ARAGONES et al., 2010), several countries (like the United States, Canada, Brazil, Peru, United Kingdom, Italy, Ireland, Australia, the Philippines, among others) have established formal monitoring programs (SWINGLE et al., 2013; VIANNA et al., 2016). In 1972 was established in the United States a National Register Network of stranding of marine animals, composed of six regional centers, whose data is stored in a central database (ARAGONES et al., 2010; Swingle et al., 2013).

In 1991, the Rio Grande do Sul Aquatic Mammals Study Group (GEMARS) was founded, a non-governmental, non-profit organization that aims to develop scientific research and environmental

education programs related to conservation of aquatic mammal species, as well as their natural environments. (GERMARS, s.d.).

In 1999, governmental and non-governmental research institutions that work with aquatic mammals in the Northeast proposed the creation of the Stranding and Information Network for Aquatic Mammals in Brazil - REMAB (MEDEIROS, 2006). The network would be composed of four regional networks (North, Northeast, South and Southeast). However, until 2006, the only officially established regional networks were the Northeast (REMANE) and South (REMASUL) (LIMA; CÉSAR, 2005). In 2011, the ICMBIO through Ordinance n the 43/2011 (ICMBIO, 2011), officially established the REMAB and its four regional networks: REMANOR (covering North and Central - West); REMANE (Northeast region); REMASE (Southeast region); and REMASUL (South region). With operations throughout the national territory. The Network aims at optimizing and monitoring the service to strandings and the Catch them in fishing gear, as well as developing researchs and store information in the bank 's national data on aquatic mammals. It aims to enable the exchange of information between institutions working with marine mammals in Brazil (ICMBIO, 2011).

The Center for Earth Technological Sciences and the Sea (CTTMar) the University of Vale do Itajaí (UNIVALI) , in Santa C atarina since 2002 , has been developing the Support System Monitoring of Marine Mammals (SIMMAM) , a geographic information system that collects and stores georeferenced data on sightings, incidental captures and strandings of aquatic mammals (KARAM and BRITTO, 2009).

Medeiros (2006) reviews the literature on the studies with strandings of marine mammals in Brazil, inventorying cetacean strandings records occurred in 1984 to 2005 in the coast of Rio Grande do Norte. He Points out that the scientific surveys have also been used to assess the distribution, the abundance and the diversity of cetaceans in Brazilian coast.

Vianna et al. (2016) reviewed, in the last 32 years, the records of strandings of marine mammals that occurred in the south of the state of Santa Catarina. Report that were obtained 460 records of 17 species of toothed and of baleen whales. Mark, still, in the south of Brazil, in the state of Santa Catarina, inventories of biodiversity marine mammals began to appear on the 1980's with the recovery of animals stranded along 670 km of coastline, citing as the main studies by Simões-Lopes and Ximenez (1993), Simões-Lopes (1995) and Cherem et al. (2004).

The objective of this study, therefore, is to collect information on strandings of marine animals in the south of Santa Catarina in a span of 13 years, verifying the composition of stranded marine Mammal species and their abundance.

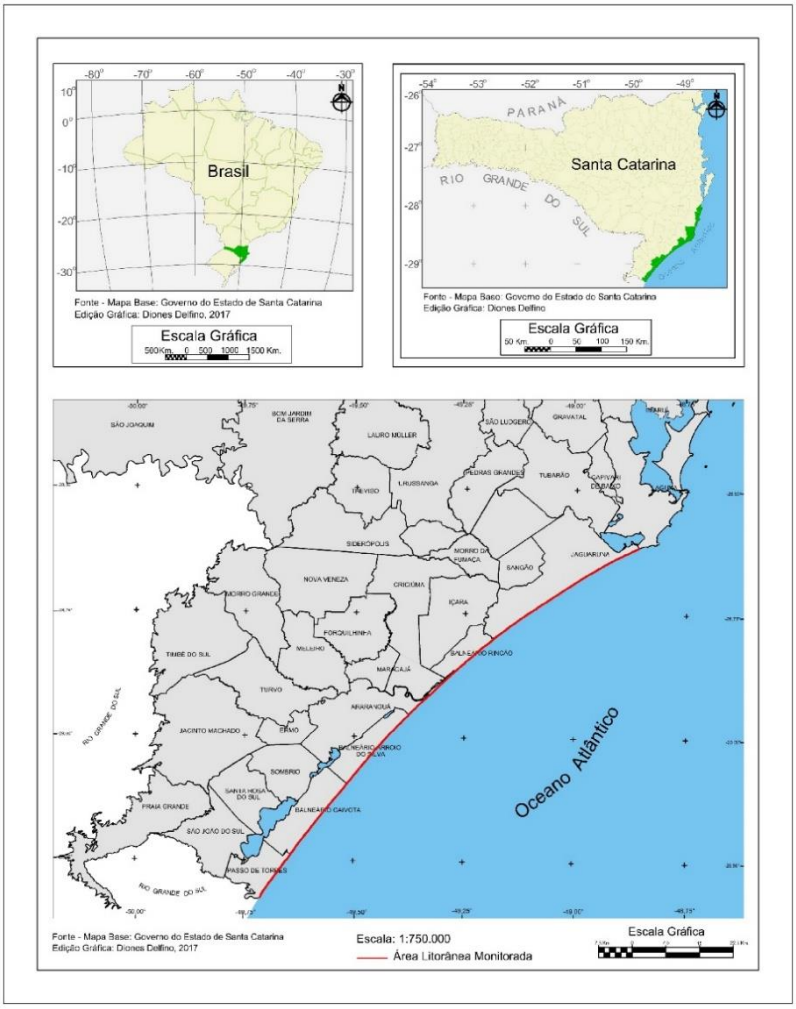
2 MATERIAL AND METHODS

The study was carried out on the southern coast of Santa Catarina, comprising approximately 120 km of open sea beaches, distributed between Barra do Camacho, the municipality of Jaguaruna (28º36'56 "S and 48º51'30" O) and the mouth of the river Mampituba , in the municipality of Passo de Torres (29º20'26 "S and 49º43'22" O) (Figure 1).

The studied area covers the extension of the southern coast of Santa Catarina, in which the Museum of Zoology Professor Morgana Cirimbelli Gaidzinski, from the University of the Extreme South of Santa

Catarina (UNESC), has been working in the registration and rescue of stranded marine animal carcasses since 2003, through two different methodologies: activation by third parties and systematic monitoring. The data collected were stored in an *Excel* spreadsheet and are part of the collection of this museum, using the data collected until the year 2016 in this study.

Figure 1 - Location of the study area between the municipalities of Jaguaruna (28º36'56 ”S and 48º51'30” O) and Passo de Torres (29º20'26 ”S and 49º43'22” O), in Santa Catarina, Brazil



Source: SANTA CATARINA. Government of the State of Santa Catarina. Base Map. Edition: Gráfica Diones Delfino, 2017.

Triggers by third parties have taken place since 2003 and have been serviced continuously. They consist of contacts with the Museum made by third parties such as: fishermen, residents of the riverside and beach communities, Military Police and Environmental Military Police, municipal secretariats for the Environment and municipal foundations for the Environment.

The systematic monitoring, on a monthly basis, originated from the demand for the drives by third parties and started in July 2009. It was performed by a variable group of three to four researchers, always with the presence of the author of the research. The section was covered by a 4 x 2 car, with a speed of approximately 20 km / h. When a strand was found, the research team stopped and the following data were recorded: date and time of registration, municipality, geographic coordinate of the event (obtained from GPS),

identification of the animal in the field (when possible), condition assessment animal's life span (whether alive or dead, debilitated or just resting) and photographic record. In the case of live animals with apparent lesions or very weak, it was informed to the Military Environmental Police and or to the APA administration of Baleia Franca when the event had occurred in its area of coverage.

It was held biometrics (relevant to each monitored group), in order to provide data for the age of the animal identification (young or adult) and to identify the health condition evaluated visually (good, lean animal, very lean animal and cachectic animal).

Taxonomic identification took place with the help of specialized guides (PINEDO; ROSAS; MARMONTEL, 1992; HETZEL; LOD I, 1993). The nomenclature of the registered specimens followed the taxonomic proposition adopted by Paglia et al. (2012).

Wealth was analyzed based on the records obtained by means of both drives and systematic sampling, while the parameters of abundance (absolute and relative), frequency (absolute and relative) and constancy of occurrence were analyzed only with based on systematic sampling campaigns, considering each campaign as a sampling unit, regardless of the number of hours dedicated or kilometers traveled in each one.

The frequency of the *taxa* was calculated as follows:

$$FA_t = 100 \cdot U_t/U$$

$$FR_t = 100 \times FA_t/\sum_{j=1}^{s} FA_j$$

Where:

FA_t = absolute frequency of taxon t

U_t = number of sample units in which the taxon t occurred

U_T = total number of sample units

FR_t = relative frequency of taxon t

$\sum_{j=1}^{s} FA_j$ = sum of the absolute frequency of all species

The abundance of *taxa* was calculated as follows:

Where:

AA_t = Absolute abundance of taxon t

N_t = number the total number of specimens of taxon t

N_T = total number of specimens from all taxa

AR_t = relative abundance of taxon t

$\sum_{j=1}^{s} AA_j$ = sum of the absolute abundance of all species

The constancy of occurrence was assessed by the Constancy of Occurrence Index, adapted from Dajoz (2006), according to which species were classified as abundant (FA ≥ 50%), common (25 ≤ FA ≤ 49.9%) and rare (FA ≤ 24.9%).

The conservation *status* of the registered species followed the lists of species threatened with extinction worldwide at *The International Union for Conservation of Nature - The IUCN Red List of Threatened Species* (IUCN, 2018), at the national level by the Ministry of Environment of Brazil (MMA, sd) and at the state level of the State Environmental Council (CONSEMA, 2011).

Table 1 - Rate, form of registration (triggered or systematic), condition (M = dead, V = alive), number of live specimens, dead and total number of registered marine Mammals stranded on the southern coast of Santa Catarina from 2003 to 2016

Source: From the Author.

Rate	Register Form				Total		Grand Total
	Acionamento		Systematic				
	M		V	M	V	M	
MAMMALIA							
Cetacea							
Cetacea N.I	1					1	1
Balaenidae							
Eubalaena australis (Desmoulins, 1822)	2		3	2	3	4	7
Balaenopteridae							
Balaenoptera acutorostrata Lacépède, 1804	1					1	1
Balaenoptera edeni Anderson, 1879	1					1	1
Balaenoptera physalus Linnaeus, 1758	1					1	1
Delphinidae							
Delphinidae N.I.				4		4	4
Globicephala melas (Traill, 1809)	1					1	1
Orcinus orca (Linnaeus, 1758)	1					1	1
Stenella coeruleoalba (Meyen, 1833)	2		1	1	1	3	4
Stenella frontalis (G. Cuvier, 1829)	1					1	1
Tursiops truncatus (Montagu, 1821)	7			3		10	10
Kogiidae							
Kogia breviceps (Blainville, 1838)	1					1	1
Pontoporiidae							
Pontoporia blainvillei (Gervais & d'Orbigny, 1844)	5			25		30	30
Carnivora							
Otariidae							
Arctocephalus australis (Zimmermann, 1783)	17		22	125	22	142	164
Arctocephalus gazella (Peters, 1875)				1		1	1
Arctocephalus tropicalis (J.E. Gray, 1872)			7	32	7	32	39
Arctocephalus sp.	1		29	25	29	26	55
Otaria flavescens (Shaw, 1800)	9			13		22	22
Total Geral	**51**		**62**	**231**	**62**	**282**	**344**

3 RESULTS

Were recorded 344 stranding mammals, among which 18.02% (n = 62) were alive and 81.98% (n = 282) were dead (Table 1). The records made through the drives represented 14.83 % (n = 51), and those made through systematic samplings 85.17 % (n = 293) of the total registered stranding universe. One hundred percent of the animals recorded by means of drives were dead while those recorded by means of sampling systematic 21.16% (n = 62) were alive and 78.84% (n = 231) were dead (Table 1).

Table 2 - Summary of the taxonomic composition of records by actuation (A), systematic s (S) and total (T) of stranded marine Mammals on the southern coast of Santa Catina from 2003 to 2016.

Register Composition		Mammalia			Grand Total
		A	S	T	
N.I	Classe				**9**
	Order	1		1	**15**
	Family		4	4	**4**
	Genre	1	54	55	**55**
Orders		2	2	2	**7**
Famílies		6	4	6	**16**
Genres		10	6	10	**28**
Especies		13	8	15	**37**
Live Specimens			62	62	**93**
Dead Specimens		51	231	282	**3781**
Total of Registers		**51**	**293**	**344**	**3874**

Source: From the Author.

Note: Where applicable NI = not identified. The blank cells indicate values equal to zero.

F pray registered 344 strandings (62 living and 282 dead) belonging to 15 species, 10 genera, six families and two orders. Fifty-five specimens (29 alive and 26 dead) were identified only at the gender level (*Arctocephalus* sp.); four, at the family level (Delphinidae); and one, at the order level (Cetacea) (Tables 1 and 2).

Table 3 - Frequency of occurrence (FO), absolute frequency (FA), relative frequency (FR), absolute abundance (AA), relative abundance (AR) and constancy index of occurrence (ICO) of marine mammals recorded on the south coast of Santa Cat arina in the period from 2003 to 2016.

Rate	Parameters					
	FO	FA	FR	AA	AR	ICO
MAMMALIA						
Cetacea						
Balaenidae						
Eubalaena australis (Desmoulins, 1822)	4	8,89	1,63	5	0,13	R
Delphinidae						
Delphinidae N.I	4	8,89	1,63	4	0,11	R
Stenella coeruleoalba (Meyen, 1833)	2	4,44	0,81	2	0,05	R
Tursiops truncatus (Montagu, 1821)	3	6,67	1,22	3	0,08	R
Pontoporiidae						
Pontoporia blainvillei (Gervais & d'Orbigny, 1844)	17	37,78	6,91	25	0,67	C

Source: From the Author.

Note: Where there is A = abundant, C = common and R = rare.

With reference to the conservation *status* of the Mammalia Class (Table 4), most (eight species) are, in the world, in the category that requires less concern (LC). Five are found in the category of deficient data (DD), one (*P. blainvillei*) in the vulnerable category and one (*B. physalus*) in the category threatened with extinction. *Ebalaena australis* appears, respectively, as threatened with extinction at the national level (MMA, sd) and as vulnerable at the state level (CONSEMA, 2011). *B. physalus* is threatened with extinction at the national level and *P. blainvillei* figure as critically endangered, at the national level, and vulnerable, at the state level.

Table 4 - Conservation status, according to IUCN (2018), MMA (sd) and C ONSEMA (2011), of marine mammal species recorded on the southern coast of Santa Catina from 2003 to 2016.

Rate	**Conservation *Status***		
	IUCN	**MMA**	**CONSEMA**
MAMMALIA			
Cetacea			
Balaenidae			
Eubalaena australis (Desmoulins, 1822)	LC	EN	VU
Balaenopteridae			
Balaenoptera acutorostrata Lacépède, 1804	LC		
Balaenoptera edeni Anderson, 1879	DD		
Balaenoptera physalus Linnaeus, 1758	EN	EN	
Delphinidae			
Globicephala melas (Traill, 1809)	DD		
Orcinus orca (Linnaeus, 1758)	DD		
Stenella coeruleoalba (Meyen, 1833)	LC		
Stenella frontalis (G. Cuvier, 1829)	DD		
Tursiops truncatus (Montagu, 1821)	LC		
Kogiidae			
Kogia breviceps (Blainville, 1838)	DD		
Pontoporiidae			
Pontoporia blainvillei (Gervais & d'Orbigny, 1844)	VU	CR	VU
Carnivora			
Otariidae			
Arctocephalus australis (Zimmermann, 1783)	LC		
Arctocephalus gazella (Peters, 1875)	LC		
Arctocephalus tropicalis (J.E. Gray, 1872)	LC		
Otaria flavescens (Shaw, 1800)	LC		

Source: From the Author.

Where there is CR = critically endangered; EN = threatened with extinction; VU = vulnerable; NT = almost threatened; LC = less concern; DD = data deficient. Blanks indicate that the conservation *status* of the species has not been assessed at the national or state level.

5 DISCUSSION

Strandings of marine animals have origin in various causes, but fundamentally the reasons for the occurrence are more related to the opinion of those who report them than the established facts (CORDES, 1982). The relationship of the observer with this phenomenon, in our study, directly influenced the sampling effort, as well as the results.

Marine mammals and turtles, in general, tend to draw more public attention than the birds, especially the fact of being exposed for longer on beaches prior to decomposition, because of their rarity or requires human action for the proper final disposal of the carcasses. These facts influence directly the drives and therefore the data obtained in this study.

The species *A. australis,* which is widely distributed in South America, has reproductive colonies from Uruguay to Tierra del Fogo, still in the Atlantic, and from southern Chile to Peru, in the Pacific Ocean (BONNER, 1994). Simões-Lopes (1995) reports the regular occurrence of the species for Santa Catarina in the winter and spring months, a fact also corroborated in the present study, although the seasonal data on the occurrence of species have not been presented and discussed.

Pinedo (1994) found 1.085 dead specimens along the coast of the Rio Grande do Sul, in southern Brazil, between 1976 and 1987. This shows that the anthropic pressure generated by overfishing and degradation the coastal environment through pollution of human molestation and the accidental capture in fishing nets, ends up creating one set of factors that increase the rates of mortality of marine mammals, impacting the population.

In a study on the coast south-central Rio Grande south by Ferreira, Muelbert and Secchi (2010), which were analyzed 690 fishing sets, Deployed the s 23 vessels, resulting at 136 incidental catches and 348 strandings *P. Blai n villei* between January 2002 and December 2003. The authors point out that one of the motors bringing the stranding of the species is related to the incidental fishing. Although Brazilian law prohibits the use of fixed gillmets along the coast of Santa Catarina (Portaria IBAMA 54/1999), this practice is still widely used, representing one of the greatest threats to the conservation of *P. blainvillei* in its distribution (CREMER et al., 2013).

According to the studies of Ferreira, Muelbert and Secchi (2010), most carcasses *P. blainvillei* caught accidentally in fishing nets on the beach no beaches because predation by scavengers, such as sharks, can cause the s individuals even come to coast to run aground. The other factor reported for the PMP-Base Laguna is the animal's body by cutting off fishermen know that the porpoise is an animal which has major threat to fishing. The reasons for not occurrence the stranding on the beach are many, from human consumption, bait for shark fishing, production of oil and amulets (DESVAUX, 2013). Mourão, Pinheiro and Lucena (2007) reported the use as bait in longline fishing. Emin- Lima et al. (2010), Loch, Marmontel and Simões-Lopes (2009) reported the use as bait d the tucuxi species *(Sotalia fluviatilis)* and *S. guianensis* . Other factors contribute to the stranding and the death of

the species, as heavy infections caused by the parasite *Hadwenius pontoporiae*, observed in the intestines of 53 individuals of *P. blainvillei*, captured incidentally in massive networks in southern Brazil (ANDRADE; PINEDO; PEREIRA JUNIOR, 1998).

Joint studies carried out since 2011 by the Center for Coastal, Limnological and Marine Studies (CECLIMAR) of the Federal University of Rio Grande do Sul (UFRGS) and the Veterinary Pathology Sector (SPV) of UFRGS on the *cause of death* of pinnipeds found dead on the north coast and central of R io Grande do Sul (AMORIM; SONNE, 2017) reveal that in 96 necropsied specimens three cases of tuberculosis caused by *Mycobacterium pinnipedii* (two cases in *O. flavescens* and one in *A. australis*) were diagnosed, two cases of interaction of *The . flavescens* with a firearm and 25 cases of multiple trauma caused by dog attacks (22 cases in *A. australis* and three in *A. tropicali*).

Please note that this study did not aim to check the occurrence of parasites, neither the animal interaction recorded human activities.

Severe anthropic interactions with firearms are not restricted to the state of Ri o Grande do Sul. In 2016, Oliveira et al. (2017) evaluated the occurrence of anthropogenic interaction by firearms in two individuals adult males of *O. flavescens* found dead in April and in May 2016 in the south coast of Santa Catarina. The individuals were necropsied. The maceration of the skull of the first individual revealed the occurrence of lead adhered to the left side of the maxillary bone and a 22-caliber projectile housed in the distal region of the horizontal branch of the mandible. The second animal, on the other hand, had mild multifocal ulcerative dermatitis in the skull region. At the end of the post-maceration, five loose lead spheres were removed from the contents and the skeleton analysis revealed impregnation with lead in the skull, in addition to a complete transverse fracture of the left tibia (OLIVEIRA et al., 2017).

The sea lions have the habit of moving in search of food in the winter. For the state of Rio Grande do Sul, there are areas that present a large number of occurrences of these animals (PINEDO; ROSAS; MARMONTEL, 1992). For Santa Catarina, it is cited for Florianópolis by Cmardi and Brettas (1996), Palhoça by X imenez, Simões-Lopes and Praderi (1987) and Paulo Lopes by Simões-Lopes (1995). In Brazil, there is no presence of reproductive areas for *A. australis*, however REVIS Ilhas dos Lobos includes these animals either for rest or for food. It is also important to report that some specimens of these animals arrive to the beaches from Uruguay (PINEDO; ROSAS; MARMONTEL, 1992). Pont etal. (2015), in an interview with local fishermen (REVIEW), reports ram that the fishermen could identifie properly to *A. australis* " muffin " and who believe that seals do not attack fishing nets. In fact, the interactions of *A. australis* with fishing are rare the along the coasts of South America with respect to publications to date. The species is cited for Florianópolis, Garopaba, Içara, Imbituba, Itajaí, Jaguaruna, Laguna, Palhoça, Porto Belo and Sombrio by Simões-Lopes (1995). For the species *A. tropicalis* there is no evidence to suggest resting places for it in Brazil. The evidenced records can occur due to strong currents, which are subjected to s during migration in search of food. They were cited for Araranguá, Florianópolis, Itapoá, Laguna, Navegantes and Palhoça by several authors such as Cimardi and Brettas (1996), Simões-Lopes (1995) and Ximenez , Simões-Lopes and Praderi (1987).

A global review of the incipient capture of pinnipeds in 1991 concluded that the incidental mortality in passive equipment contributed to the fall of the populations of several species (REEVES; MCCLELLAN;

WERNER, 2013). Some studies have reported the occurrence of pinnipeds in southern Brazil, in association with the Falkland / Malvinas current during the winter. This current, originating from a branch of Antarctica, a circumpolar current, penetrates the Brazilian continental shelf more intensely (MOURA; SICILIANO, 2007). It facilitates the movement of pinnipeds from their breeding areas to the south of Brazil, where entanglement in fishing gear seems to be occurring with Antarctic seals of the species *A. gazella* (CROXALL; RODWELL; BOYD, 1990). Similar facts are reported for Australian seals *A. pusillus* (PEMBERTON; BROTHERS; KIRKWOOD, 1992; JONES, 1995).

In a study conducted in the United States, a young of the species *K. breviceps* encalh ed living in Texas was rescued and after 11 days come to death (Tarpley; Marwitz, 1993). After the autopsy, the first two compartments of the stomach were completely occluded by plastic debris. Another five cases of cetaceans that had ingested plastic, including *O. orca,* were reported by Coleman and Wehle (1984) and Baird and Hooker (2000). The genre *Kogia* comprises only two existing species, *Kogia sima* and *Kogia breviceps,* and represents one of the least known groups of cetaceans in the global ocean; its stranding can help in the recognition of epidemiological aspects associated with the mortality of organisms found on the beach (MOURA et al., 2016) . *K. sima* prefers warm waters, while *K. breviceps* seems to prefer temperate and productive waters like those in southern Brazil (MOURA et al., 2016). Wind speed results are also an important factor in predicting *Kogia* strandings on the Brazilian coast.

Tusiops truncatus, which also has worldwide distribution occurs from the North East to the Rio Grande do Sul and is usually observed near the coast, river mouths and estuaries (PINEDO; ROSES; Marmontel , 1992; HETZEL ; LODI, 1993). The species has been referred to by Araranguá and Laguna Simoes-Lopes (1991), Florianópolis Içara , Paul Port Belo by Lopes and Simoes-L options and X imenez (1993) and Jimenez , Simoes-Lopes and Praderi (1987). Still in Laguna, the species suffers an intense negative interaction with fishing (BORGES et al., 2007; SCHIAVON, 2007).

According to Pont et al. (2015), report s of fishermen point out that the dolphins nose bottlenose not have negative interactions with fishing, on the contrary, they help, causing the harassment of fishermen towards these Animas is more attenuated. With the *O. flavescens* species, the fishermen's feeling was not at all friendly. They showed extremely negative compared to sea lions, reporting the losses caused by them, which in turn translates into damage to networks. Faced with this perspective, the interaction with the lions is sharply negative and ends up explaining found animals (stranding) with traces and marks s ammunition. Both *S. coeruleoalba* and *D. delphis* are pelagic species and most likely their occurrences on the coast are associated with marine currents or the search for greater safety due to the state of poor physical conditions (ROSAS et al., 20 10). This fact ends up explaining the low occurrence of these species.

The distribution of the species *E. australis* is often related to calm and shallow waters, mainly in the breeding season (KARAM; BRITTO, 2009). For Brazil, the species has a preference for South-Brazilian waters only from sightings in the Abrolhos bank and Bahia coast (GROCH, 2005). The species has a higher concentration in coastal waters of the Rio Grande do Sul and of Santa Catarina (SICILIANO et al., 2006). The frequency of occurrence exacerbated during the months of August and September in the waters of the coast of Santa Catarina, together with the presence of young, leads to the conclusion that the area is used as a nursery (SIMÕES-LOPES; XIMENEZ, 1993; KARAM; BRITTO, 2009).

With more updated studies, it is understood and affirmed with certainty that the Santa Catarina coast is one of the most important reproductive areas of the Atlantic for *E. australis.* The weighing Imbituba not contemplate the study area, the beach Ribanceira was considered a satisfactory area for the animals, with a greater number observed in that spot, which could be considered the favorite of mothers in the process giving birth and giving the first care to the offspring (DANILEWICZ et al., 2017). The stranding volume can explain better how to a volume of considerable species on the Brazilian south coast Greig et al. (2001) recorded the occurrence of 24 stranding events of *Eubalaena australis* along the southern coast of Brazil between the years 1977 and 1995, based on bibliographic records.

Regarding the species *B. physalus,* this cetacean migrates from the poles to Ecuador (PINEDO; ROSAS; MARMONTEL, 1992), suggesting that despite occurring throughout the Brazilian coast, its records are occasional. There are no studies showing the use of the area for feeding or reproduction by this species. It is noteworthy that the occurrence of the species is described for São Paulo (VIVO et al., 2011). The species *B. acutorostrata* is cosmopolitan, but has few records for the state of Santa Catarina, being mentioned for Balneário Rincão by Baldas and Castello (1986), in Balneário Gaivota by Simões-Lopes and Ximenez (1993) and Zerbini et al. (1996). Es is the kind usually approach the coast between bays and estuaries (LEAHERWOOD; REEVES, 1983).

Menezes (2005) made an important review of the literature on strandings of marine mammals when reporting the events of strandings of cetaceans that occurred between 1993 and 2004 on the coast of Rio Grande do Sul. with a sampling effort of 33,201.4 km, it registered 969 strandings of *Pontoporia blainvillei* , 73 of *Tursiops truncatus* and 143 of other species of cetaceans.

Ferreira, Muelbert and Secchi (2010) stands out m the meaning of ecological data on long-term and the importance of integrating sets of oceanographic and climatic data Similar to identify the ecosystem level standards. Integrated ecological investigations that involve regular surveys of cetaceans in the region provide a means by which changes in the abundance and distribution of cetaceans could be investigated. At another level, the results presented here can help to predict periods of increase in the number of stranding events. They can also provide an important guide to potentially disturbing activities (for example, those involving seismic or sonar operations) to be scheduled for other periods when the patterns of organisms and their responses are known.

As is observed in discussions presented previously the stranding records contribute to the knowledge of the migratory range and, therefore, the distribution of various species, and can also indicate changes in mortality patterns or the age structure of a population (GULLAND; HALL, 200 7; COLEGROVE; GREIG; GULLAND, 2005; BOGOMOLNI et al., 2010). In addition, marine mammals are recognized as sentinel species (BOGOMOLNI et al., 2010; PANGALLO et al., 2008; BOSSART, 2009). Data analysis and the samples collected cetacean and pinniped stranded also provides m information on ocean health (Gulland; HALL, 2007; Colegrove; GREIG; Gulland, 2005; BOGOMOLNI et al., 2010).

6 FINAL CONSIDERATIONS

The study contemplated an area little studied regarding a class, considering the number of mammals found, which showed high diversity and high wealth. The hydrographic basins that cover the study area, as well

as the resurgence currents, provide a wealth of microhabitats, niches and elements that support the migration and occurrence of marine animals. In this context, the area deserves attention, mainly due to the rare occurrences and unpublished records, such as *Balaenoptera physalus, Kogia breviceps and Arctocephalus gazella*.

Getting to know the stranded species and their abundances-based decision making in the project 's conservation, as well as open space for the development of other studies that address in other aspects, such as diet, the distribution and the *cause of death* of the species stranded and so complements the study started here. That way, it is possible to achieve a higher level in the conservation of the class Mammalia and passing the coast of the Extreme South of Santa Catarina.

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THE FEAR OF "OTHERS": A STUDY ON SOCIO-SPATIAL CHANGES AND SOCIABILITY IN A DISTRICT OF CRICIÚMA, BRAZIL

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Abstract

São Domingos, district in the municipality of Criciúma (State of Santa Catarina, Brazil), has undergone several transformations arising from the advance of urbanization. Since the 1980s, the neighborhood is no longer exclusively agricultural, with the installation of a ceramic industry, the beginning of a process of fractionation of properties and, more recently, the installation of a prison complex. This article presents the results of research that understand that the changes in the neighborhood are, among other factors, the fruits of the interaction that occurred between the subjects, producing various forms of social relationship. The research focuses on the perspective of the oldest residents of the neighborhood. The results show these changes are understood as a risk to their sense of community and to the values, which has contributed to the establishment of a culture of fear and insecurity, marked by the demarcation of differences between the subjects and the rupture of everyday life.

Keywords: culture of fear; everyday life; penitentiary; community; difference

1.Introduction

The district of São Domingos, located in the municipality of Criciúma, in the south of the State of Santa Catarina, has been going through several transformations arising from the advance of urbanization over rural areas. The locality's history is marked by the arrival of European immigrants, mainly those of Italian origin, in the second half of the 19th century, when they started to inhabit the region and to develop agriculture (HOBOLD, 2005). The neighborhood stopped being exclusively agricultural only in the 1980s, with the installation of a ceramic industry. More recently, with the economic instability of family farming and the shift of the children of farmers to other professional activities, it has been observed the fractionation and sale of lots of properties, which has resulted in more residents coming to the locality. In 2008, the South Male Penitentiary was installed in the neighborhood, and ten years later, the South Female Penitentiary and

the Socio-Educational Service Center (CASE), aimed at receiving teenagers who committed infractions. The process of installing the prison complex was controversial, and sparked protests from residents.

This article is the result of research that aimed to investigate the socio-spatial changes that have occurred in the São Domingos neighborhood in recent decades and its impacts on sociability among its residents. Sociability, according to the Simmel perspective, is defined as "being with one another, for another, against another who, through the vehicle of impulses or purposes, forms and develops material or individual contents and interests" (SIMMEL, 1983, p. 168). In this approach, "society is not external to individuals, but emerges from the interaction between them" (ASSUNÇÃO; CONCEIÇÃO, 2018, p. 71).

Thus, it is understood that the changes that occurred in the neighborhood are, among other factors, the fruits of the interaction that occurred between the subjects, producing different forms of social relationship (SIMMEL, 1983). Often this contact with "others" brings "opposition, aversion, feelings of mutual strangeness, disgust, hatred, social struggles" (SIMMEL, 1983, p. 127). These interactions are part of modern urban life, which "[...] puts each person in contact with innumerable others every day. The entire internal organization of urban interaction is based on an extremely complex hierarchy of sympathies, indifference and aversions, from the most ephemeral to the most enduring type" (SIMMEL, 1983, p. 128).

The neighborhood is a social place with multiple representations (FRÚGOLI, 2013), which can be understood as an intermediary between small and large neighborhoods, where relations of solidarity and conflict arise between residents, and between these and subjects from other contexts (CORDEIRO, 2001). It is also the locus of the processes of identification and constitution of feelings of belonging. Thus, it is in the neighborhood that "difficulties are perceived and social problems" of multiple orders (ALMEIDA, 2011, p. 2).

This article focuses on the perspective of the older residents of the neighborhood, who have been participating in the socio-spatial changes that have occurred for several decades. It points out that the arrival of new residents and the installation of prison projects have been the most impactful changes for these research subjects. These changes are understood as (1) a risk to their sense of community and to the values considered traditional, which has contributed to (2) the establishment of a culture of fear and insecurity, typical of the modern city, marked by the demarcation of differences between subjects and the disruption of everyday life.

2. The social production of space

The research starts from the understanding that "everywhere is a social product and, therefore, spatiality, appropriated by social practices in meeting the individual and collective needs of reproduction and identification" (SALGUEIRO, 2003, p. 99). According to Carlos (2011, 2015), space is a condition, means and product of human action. "Space as a social product is a concrete production process, born of work, which is nothing more than man's response to a series of needs that he must satisfy in order to survive" (CARLOS, 2011, p. 7). Thus, space and society are understood in a strictly related manner, as "each stage of the development of society will correspond to a stage of development of spatial production" (CARLOS, 2015, p. 31).

Space, for Lefebvre's theory, is a product and producer, a passive agent in social relations, and active in

relations itself, portraying the divergent dimensions that compose it in terms of social reality and its constitution linked to capital (LEFEBVRE, 1991). Thus, the production of space refers not only to its use and appropriation, but also to the development of social practices (LEFEBVRE, 1991).

Historically, some conceptions of the rural have emphasized the cultivation of agriculture as a way of survival for the subjects who inhabit the space, while the urban is related to industrial production. "The rural is a historically situated category, which emerges with the process that sees the combined forces of industrialization and urbanization (mobility rather than the expansion of cities) to progressively integrate the fields within a unified economic and socio-political system" (MORMONT, 1996, p. 161).

In order to understand the socio-spatial transformations that affect the rural environment, it is necessary to understand a new dynamic of this production process, which includes an expansion in the territory of "infrastructures and the general conditions of production related to production and consumption for the market" (RESGALA, 2017, p. 269). In Lefebvre's words, "the expanding city attacks the countryside, corrodes it, dissolves it" (LEFEBVRE, 1991, p. 68-69). This expansion, still according to the author, leads to the disappearance of the so-called "traditional elements" of peasant life, such as handicrafts and the "small centers that define for the benefit of urban centers (commercial and industrial, distribution networks, decision centers etc.)" (LEFEBVRE, 1991, p. 69).

This expansion of the city into the rural environment is called by several authors as rural-urban transition, whose limits are difficult to define, and can encompass both "urban manifestations concretized in space" and "cultural manifestations related to the urban way of life" (QUEVEDO NETO; LOMBARDO, 2005, p. 12158).

These transformations also change the ways of life of those who live in the so-called rural spaces. The development of pluriactivity is observed, in which the income obtained for the support of families living in rural areas does not always come only from agriculture and agriculture, constituting a multiple form of work and income from agricultural units (BALSADI, 2015; SCHNEIDER, 2001; RODRIGUES, 2014). Wanderley explains that this process of "rural modernization" does not imply the "end of agriculture" or the "end of the rural", but the emergence of a new reality.

> The modernization of society in local / rural spaces is based on the growing "social parity", that is, the similarity between the living conditions of the populations living in cities and in the rural environment and the increasing availability, in the rural environment, of that which is still defined as the standard of "urban comfort" (WANDERLEY, 2003, p. 132).

For Wirth (1997), there are three elements that distinguish the city, namely: number of inhabitants, population density and heterogeneity. Therefore, it is stated that the attempt to differentiate the rural from the urban is based on three dimensions: demography, economic development and ways of life (RODRIGUES, 2014). The rural-urban transformation initiates a new contrast in the place, with the "emergence of new dilemmas, inequities and social inequalities" (BACCI; SANTOS, 2017, p. 199).

2.1 The culture of fear and the prison system

This new socio-spatial dynamic also impacts the relations between the inhabitants of the urban environment. As Almeida explains, Simmel understands a tension in the configuration of the modern city, which impacts "the development of new actions and reactions of the subjects, new configurations and social and cultural possibilities". In this context, "the city and the neighborhood become the stage for the emergence of possibilities, actions and reactions of the individuals who are immersed in it, where the other of the relationship is present as a model of social practices" (ALMEIDA, 2011, p. 4).

A striking feature of modern urban life, contact with "others", strangers or foreigners, can lead to conflicts.

> A fixed component of urban life, the ubiquity of foreigners, so visible and so close, adds a remarkable dose of unease to the aspirations and occupations of the city's inhabitants. This presence [...] is an inexhaustible source of anxiety and latent aggression - and it is often manifest (BAUMAN, 2009, p. 36).

One of the consequences of this socio-spatial reconfiguration pointed out in the research was the emergence of a culture of fear and insecurity. Fear can be understood as inherent to the human being, a feeling that can avoid danger, which arise from any nature. In this research, fear is considered as socially constructed, which is constituted from the dynamics of social groups, as explained by Baierl (2004, p. 48):

> a socially constructed fear, with the ultimate aim of subjecting whole people and collectivities to self and group interests, and has its genesis in the very dynamics of society. Produced and built in certain social and individual contexts, by certain groups or people, with a view to achieving certain objectives of subduing, dominating and controlling the other, and groups, through intimidation and coercion. This fear leads collectivities, territorialized in certain spaces, to fear such a threat from these groups.

The culture of fear, according to the same author, "has been profoundly altering the territory and the urban fabric and, consequently, the daily life of the population. Everyone feels affected, threatened and in danger" (BAIERL, 2004, p. 20). This is because the city has been associated with images of crime, leading individuals to fear being victims of violence, such as robberies, assaults and assaults. Freedom has been curtailed, and the victims, whether real or not, are adopting protection strategies and criticizing the lack of security in cities (ECKERT, 2002).

One of the main responses of the public authorities in Brazil to the increase in crime and the feeling of insecurity of the population is the policy of incarceration (PASTANA, 2009), which generates an increasing need for places in prison systems.

The application of penalties for those who break rules has a long history. It goes back to the Hamurabi Code, proposed by the King of Babylon, which had as its premise the determination of "an eye for an eye, a tooth for a tooth", which occurred in the year 1970 before Christ (PAULA, 1963). Subsequent to this Code, other forms of restraining criminal practices remained in place, as described by Foucault (2013), such as those that fell on the physical body, through punishment, and that would occur publicly, so that everyone could follow the punishment.

Over the years, it was observed that these practices of criminal torture did not prevent new criminal conduct

from being committed, culminating in the need for other means to be found, with more effective results (FOUCAULT, 2013). Thus, surveillance techniques emerged, which consisted of measures aimed at social regularization, based on establishing the rules of disciplined behavior, so that they were docile and useful for society (FOUCAULT, 2013). "Disciplinary power builds a disciplinary society, collectively training and producing individualized and docile bodies" (BENELLI, 2014, p. 64). In the transition from the 18th to the 19th century, the penalty of detention is created, in which punishment becomes a general function of society (BENELLI, 2014).

The prison is a "place for observing punished individuals: surveillance to control detainees, but also knowledge of each prisoner, their behavior, their profound dispositions and their progressive improvement" (BENELLI, 2014, p. 64). This new model, in which it has been gaining growth nowadays, has as its premises "the retributive punishment of the evil caused by the delinquent; prevention of the practice of new offenses, through the intimidation of the condemned person and potentially criminal people; regeneration of the prisoner, in the sense of transforming him from criminal to non-criminal" (THOMPSON, 1980, p. 04).

Brazil was no different from the rest of the world, considering that the penalties applied to physical bodies were also practiced, in which the slaves suffered public penalties. Subsequently, the first prisons were created; reports demonstrate that they were places where misery prevailed, with no penal policy, there was disregard for the place of serving sentences and there were already problems with overcrowding (SANTOS; ALCHIERI; FLORES FILHO, 2009).

Wacquant (2009), when analyzing the American prison system, denounces that mass incarceration started to be used as a systematic form of repression after the advance of neoliberalism. With fewer social protection services offered by the state, the prison becomes a central element of discipline and control of the masses, acting in the repression of the poorest. Thus, the biggest targets of the prison system become poor and black, residents of the ghettos of the cities (WACQUANT, 2001). At the discursive level, incarceration acquires a positive moral connotation as a means of punishing offenders, while social policies are now considered immoral (WACQUANT, 2009).

Like the United States, incarceration emerged with great emphasis on Brazil in the late 1980s as a means of implementing public security policy, constituting a form of social control (SOBRINHO, 2014). There are several criticisms of this form, as it is understood that it is high-cost and inefficient in resocialization (BENELLI, 2014). In addition, academic studies indicate that the majority of the incarcerated population is black, poorly educated, with low income and living on the outskirts of Brazilian cities (PASTANA, 2009; FERNANDES, 2015; ZACKSESKI; MACHADO; AZEVEDO, 2016; DANIN, 2017), denouncing the system prison for reaching only socially disadvantaged classes.

The construction of prisons and prisons is currently also being directed to rural areas, due to the concentration of people in urbanized areas. When installed, prisons generate demands for services and products that were previously nonexistent in the locality. The construction with guardhouses, electric fences, cameras, sensors, among other elements also present in closed condominiums to ensure safety (ZOMIGHANI JUNIOR, 2015), contributes to the alteration of the local landscape.

Developments such as the South Male Penitentiary, the South Female Penitentiary and the Socio-Educational Service Center (CASE), installed in the district of São Domingos, are, therefore, due to the

existing public security policy. The beginning of the installations of the penitentiary enterprises, in the location of the research, occurred with the South Male Penitentiary, inaugurated in the year of 2008, and should receive only people in the masculine gender. This project is considered to be of maximum security, and has the capacity to house 790 men, although it started with a capacity for 352 people, and in 2014, it was extended to 552 people.

In 2018, the South Women Penitentiary also started to operate, next to the South Male Penitentiary, which is also intended to receive those women who are convicted in a closed regime, from all over the State, and with a capacity for 286 people.

The operation of the CASE in the district of São Domingos took place in November 2018, and is to receive teenagers from the city of Criciúma and the entire region. Initially the capacity is for 60 male adolescents detained, and, during the research, 43 people were detained.

3. Methodological procedures

The research has a qualitative character (GOLDENBERG, 2004), and was carried out through field research, with semi-structured interviews (GASKELL, 2002). The interview script consisted of 13 questions, which comprised questions about the residents' knowledge about the emergence of the neighborhood, their perceptions about the changes that have occurred in space over the decades and the impact of these changes on their lives.

The selection of the research subjects was made by the oldest residents of the neighborhood, descendants of the families that started the colonization of the place. Thus, 16 (sixteen) family nuclei were selected. All interviews were conducted with the participation of people who were present in the house at the time of the survey, therefore, with more than one family member. The families participating in the research develop agriculture, but not exclusively, with the pursuit of other professional activities, mainly among the children of farmers. It was also observed that a good part of the children does not reside on the parents' property or even in the neighborhood, as can be seen in Table 1.

Table 1. Families participating in the survey and numbers of children residing in the district.

	Number of children	Number of children residing in the district
Family 1	2	2
Family 2	2	0
Family 3	3	0
Family 4	3	0
Family 5	2	2
Family 6	3	3
Family 7	3	0
Family 8	2	1
Family 9	4	2

Family 10	2	0
Family 11	9	5
Family 12	3	3
Family 13	5	1
Family 14	3	3
Family 15	2	1
Family 16	14	2

Even though they were informed that they would not be identified in the research, most of the research subjects did not accept that the interviews were recorded, demonstrating the existing tension around the installation of the prison complex (South Male Penitentiary and South Female Penitentiary) and Service Center Socioeducativo (CASE) in the neighborhood. Some interlocutors even requested that some information not be noted by one of the researchers. One of them explained his fear by stating that, if he affirmed that the installation of the Prison System was positive, other similar undertakings could be installed. On the other hand, if it claimed to be bad, the community could be penalized for not complying with the compensatory measures for the installation of the complex.

The research subjects signed the Free and Informed Consent Form (ICF), presented before the beginning of the interviews, following the recommendations of Resolutions nº 466/2012 and 512/2016 of the National Health Council (BRASIL, 2012, 2016), with Presentation Certificate for Ethical Appreciation (CAAE: 07204818.7.0000.0119).

Data analysis was carried out following the method of interpretation of meanings systematized by Gomes (2010), which associates two distinct theoretical bases: hermeneutics and dialectics. This method has the following steps: 1) comprehensive reading of the selected material, seeking to have a complete view of the data, as well as the particularities of the material; 2) exploration of the material, with the identification of the main ideas and search for meanings, in addition to its articulation with the studied literature; 3) elaboration of the interpretative synthesis, relating the research objectives, the theoretical framework and the study data (GOMES, 2010, p. 100-101).

4. Risks to the sense of community and values

The socio-spatial changes that have occurred in the district of São Domingos, such as the installation of the ceramic industry in the 1980s and the prison complex since 2008, in addition to the fractionation and sale of properties in recent decades, have led to an increase in the population of the neighborhood and to a greater circulation of vehicles and people. The arrival of new residents and the circulation of "strange" individuals in the locality appeared in the speeches of the research subjects as the greatest impacts of these changes. In these statements, markers are repeatedly used to establish differences between old and new residents. The latter, according to the research subjects, put the values and way of life of local families at risk.

To understand this context, we start from a non-essentialist perspective, seeking to distance ourselves from approaches that reduce differences to identities (SILVA, 2002) and opting for a perspective that considers

relational processes. Miskolci (2012, p. 15) clarifies that the term “diversity” is supported by the notions of tolerance and coexistence, while the term “difference” is based on “recognition as social transformation, transformation in power relations, of the place that the Other occupies them”. Thus, the author argues that, while the first term presupposes the idea of maintaining distances, the second emphasizes the relationship and dialogue between the subjects. Thus, the perspective of difference admits that “we are all involved in the creation of this Other”, and, through the relationship with the different, it is possible for the subjects to transform themselves (MISKOLCI, 2012, p. 16).

Added to this perspective is Bauman's observation (2009) that borders serve to define differences, not just separate them. Using the work of Barth, the sociologist points out that it is “precisely because boundaries are drawn that, suddenly, differences emerge, that we perceive them and become aware of them. In other words, we are looking for differences precisely to legitimize the borders” (BAUMAN, 2009, p. 75).

During the interviews, the concern of the research subjects was evident in maintaining the values perpetrated by the families of descendants of European immigrants who started the constitution of the neighborhood, mainly those of Italian origin. These families and their values are characterized by the interviewees themselves as “traditional”.

The concept of family adopted in this research refers to the interconnection of obligations between its members, which provides the basis for coexistence and social life (SARTI, 1994). It is understood that the family is supported by a “moral axis”, whose values transcend the family entity to the social world, shaping the subjects' ways of acting and thinking (SARTI, 1994).

When asked about living in the neighborhood, some interlocutors associated their positive experience in the neighborhood, among other factors, with the presence of the so-called “traditional” families: “Yes, I like [living in the neighborhood], as it is easily accessible to cities Criciúma and Araranguá. [The neighborhood is a] community of well-structured traditional families.” “Yes, [I like it] a lot [to live in the neighborhood]. Because family, educational, behavioral and religious values are still preserved here.”

In the statements of other research subjects, it was noticed that the neighborhood was associated with the idea of integration among its residents, which is also related to the notion of family. One of the interlocutors, for example, stated that she likes to live in São Domingos “because it is a quiet place and people are still united. Whenever there is something, they are participative in the community, since they are children, young people ... opportunities abound.” When asked if her observation is attributed to all the people who live in the neighborhood, the resident emphatically explained that she referred only to the people who make up the family nucleus of those families considered "traditional". For another interlocutor, "before the prison there was more tranquility, families had peace and knew each other, they have means of communication".

It is evident in the speeches of the interlocutors that the relations between the residents of the neighborhood were marked by personality, which is one of the characteristics of the community. The academic literature mentions that community differs from society. Bauman (2003, p. 7) explains that the word community has a positive and idealized connotation, "a good thing: whatever" community "means, it is good" to have a community "." The community refers to the idea of comfort and coziness, and suggests a social group in which everyone maintains relationships of trust and mutual help, without the presence of strangers (BAUMAN, 2003). The notion of society, on the other hand, “seeks to highlight the aspects of competition, conflict, competition and rivalry between social actors. At the same time, it also contemplates moral

dimensions and rules of conduct that permeate social relations". However, the sociologist warns that "" community "is the kind of world that is unfortunately not within reach - but in which we would like to live and hope to have" (BAUMAN, 2003, p. 9).

In the research, the notion of community is associated with families with the strong religiosity that is cultivated in the neighborhood and its surroundings, where the presence of the Catholic Church predominates, especially for those belonging to the so-called "traditional families". This importance is evidenced in the speech of an interlocutor who assured that the coming of other people is a negative point of the neighborhood, because she understands that "it weakened the religious part", being that "some are evangelicals and others have no religion, reducing the demand of people by the Catholic religion."

Similarly, another interlocutor demonstrated that the arrival of new residents was negative for religiosity, referring to a loss of believers from the Catholic Church, as she understood that "before they had a strong religious culture. In Vila Maria there are Evangelicals, and a large majority disconnected from religious belief. With the arrival of families, the religious part weakened." Vila Maria is the locality of the district of São Domingos where the South Male and Female Penitentiaries are located, a place where the city of Criciúma has been seeking recognition as a district, as they demonstrate their intention to dismember themselves from São Domingos.

Likewise, another interlocutor highlighted the arrival of new residents, with regard to their religious beliefs, one of the interlocutors stated that they "do not have their faith in the Catholic Church", and highlighted that the Assembly of God Church was installed in the community. Still, according to the research subject, there are still people who still do not have any religion, "a fact that was not seen".

The arrival of new residents was characterized as positive by only one of the survey participants, who justified: "the arrival of new residents is positive for the community. In addition to growth, we have the opportunity for new friendships and new knowledge, being able to share ours". Another interlocutor considered what she considers to be the positive and negative sides:

> a double-edged sword. Positive about knowing new cultures, new people, different ways of seeing life, in short a bunch of things that can enrich our knowledge. On the other hand, it shakes our structures, our comfort, things are changing without being able to do much. Our children are absorbing what is different from their classmates and changes happen. So, the coming of new residents has its pros and cons.

The speech of this interlocutor refers to an observation by Bauman (2009) about the ambivalence of urban life. The heterogeneity of the city can offer attractions and possibilities, even if it causes fears. According to the author, mixophilia and mixophobia coexist in the city space, and can manifest themselves in the same subject.

However, the most recurrent perception of the research subjects was that the arrival of new residents is concomitant to the increase in violence in the neighborhood, as is highlighted in the statements of two interlocutors:

> I am insecure with the arrival of new residents, as there may be more crimes, drug use and trafficking.
>
> [The arrival of new residents is] negative… and more violence is happening [in the neighborhood]. We no longer know the people who pass on the road, who live in the neighborhood. There have to be closed gates,

> which we didn't feel needed before.

The community brings, in an imaginary and sometimes idealized way, a concept of greater security among its social actors, which, in the neighborhood, occurs through the development of the same religious belief and personal relationships, while society distances itself from this understanding, generating a greater feeling of insecurity. This feeling appears in the speeches of the research interlocutors regarding the insertion of new people.

It is agreed that Almeida's statement (2011, p. 2) that "to be strange in a neighborhood with personal characteristics is to be intrusive and different". The author correlates the figure of the stranger with that of the foreigner analyzed by Simmel, defined from the unification of proximity and distance. According to him, the foreigner's position in the group "is essentially determined by the fact that he did not belong to him from the beginning, by the fact that he introduced qualities that did not originate and could not originate in the group itself" (SIMMEL, 1983, p. 182). Thus, the foreigner, as a sociological form, must be understood through spatial relationships, which are, concomitantly, the condition and symbol of relations between human beings (SIMMEL, 1983).

At least two interlocutors stated that the arrival of new people has culminated in "various cultures", which they understand as being negative, since "they have been distancing themselves from family values". It appears in another speech by the interlocutor that "it is visible that the respect of the traditional family values has been lost, as they are unstructured families". When asked to explain this understanding, the resident highlighted:

> in the sense of children, parents who do not take the children, and children of several different parents, marriages are not lasting. [Catholic] religion was cultivated and today it is being lost. The appreciation by the elderly person, the care that should be given to them. There are no visits to the sick, not least because the new families don't even know each other. Gossip started, which doesn't exist with those traditional families. There was peace between families, everyone knew each other, which is not seen today.

The research subjects attribute to the new residents the rupture of the nuclear family model, given that they have other family arrangements. In this sense, it is clear that there is different treatment for those arriving in the neighborhood, classified as having "lesser virtue and respectability", as found in the research carried out by Elias and Scotson in a small town in the south of England:

> (...) in this small community, they faced what seems to be a universal constant in any figuration of established-outsiders: the established group attributed to its members superior human characteristics; excluded all members of the other group from non-professional social contact with their own members (ELIAS; SCOTSON, 2000).

According to the authors, the discrimination of certain subjects resulted from a social process that acts to stigmatize certain individuals and, at the same time, reinforce the norms and values established by the dominant groups. Thus, the normal and the stigmatized do not refer specifically to the characteristics of

individuals, but to an expectation in the fulfillment of certain social rules. This process is permeated by power disputes between groups in an antagonistic way (ELIAS; SCOTSON, 2000).

4. 1 The feeling of insecurity and the disruption of everyday life

In addition to the mistrust towards new residents, there is also a fear of strangers who circulate in the neighborhood, caused by the installation of the prison complex. One of the interviewees explained that these subjects "are strange people, we don't know who they are and where they come from." Another interlocutor said that this circulation is changing the way of life of the former inhabitants of the neighborhood: “With the installation of the penitentiaries, a certain discomfort was born in the community ... of mistrust of strangers. You never know if they are people of good faith or not. We are no longer welcoming as we used to be. When someone unknown arrives, we receive them with closed doors and without much attention, wanting to get rid of it soon”.

In addition to this fear of the “other”, the “fear of escape and fear of being persecuted” also appeared in the speeches of the research subjects, or “my fear is that there will be some rebellion, and that prisoners will come in. in our homes, taking us hostage.” Furthermore, the fear of the detainees' actions also extends to their family members and relatives, as shown in the speech of one of the interlocutors, who states that “he fears for his grandson, since he may come into contact with the offending adolescents on the bus, staying unsure of what might happen”. The subject of the research explains that, with the increase in the number of bus lines that go to the prison enterprises, “the tranquility has been lost”, since the relatives of the prisoners, when making their visits, “pass by the houses, and keep watching. " It is observed that the discrimination suffered by detainees includes their family members, who are now identified as “the drug lord's son” and “criminal's mother”, among others (GONZAGA, 2013, p. 50).

Referring to social groups in situations of poverty, Sarti (1994) considers that, in addition to the political and economic dimensions, differentiations and social identifications can be established in the moral sphere, which constitute social hierarchies and maintain the exclusionary system of capitalist society. Taking the author's analyzes on loan, it is valid to state that the category “family members” or “relatives” of “prisoners” also participate in this logic of oppositions, which differentiate and rank subjects on the moral plane, serving as symbolic frontiers in the construction of the “other ”.

Bauman (2009), citing Castells, understands modern insecurity as derived from the exacerbation of individualism, which breaks with the trust in solidarity between human beings. If in the community the protection of its members was maintained by the control and unity of its members, in modern society there is an “individual duty to take care of oneself and to do for oneself”, which makes the inherent insecurity and danger to this form of social life.

Many of these violence prevention solutions are the construction of fortified enclaves - closed spaces for housing, leisure and consumption. By definition, they are privatized and securitized spaces, aimed at the upper-middle and upper classes, which separate different social classes (CALDEIRA, 1997). Its presence intensifies socio-spatial segregation and encourages the abandonment of public space (GOULART; GONÇALVES, 2019).

This consequence is evidenced in the statement of a research interlocutor: “we had to surround our homes, deprive our children of playing in the street”. The undertakings, which are considered as security, for the

interlocutors represent insecurity. In the words of another interviewee, with the installation of CASE and penitentiaries, “the Government is making the neighborhood a prison complex”.

Souza (2008) characterizes the proliferation of these fortified enclaves as an international phenomenon, and considers them a form of self-segregation. This would be an “escapist solution”, a false solution that favors the denial of the idea of the city as a “unity in diversity”. Self-segregation contributes to “deteriorating the quality of life, civility and conditions for exercising citizenship in the city” (SOUZA, 2008, p. 73). This is because, according to Souza, it threatens values such as solidarity, as they prevent spaces for socialization, implying a lack of commitment by the subjects towards the city. In addition, the “voluntary enclosure” reinforces prejudices, leading to an “additional impoverishment of the city experience and the experience of contact with the Other” (SOUZA, 2008, p. 74). It is also a movement, according to Bauman, for the construction of a “community of similars”, which

> [...] it is a sign of withdrawal, not only from the otherness that exists outside, but also from the commitment to internal interaction, which is alive, although turbulent, strengthening, although uncomfortable. The attraction that a “community of equals” exerts is similar to that of an insurance policy against risks that characterize everyday life in a “multivocal” world. It is not able to reduce risks and even less to avoid them. Like any palliative, it promises nothing but protection against some of its most immediate and feared effects. (BAUMAN, 2009, p. 22)

In addition to the encounter with the “other”, the feeling of insecurity is also the result of the rupture of the neighborhood's daily life. One interlocutor reports that, on two occasions, she had to retire to the interior of her residence, together with her family, when the transfer of prisoners was taking place. This transfer was accompanied by helicopter. Both in the aircraft and in the car, the police and agents had their weapons pointed outward, ordering people to withdraw.

In the words of another interlocutor, “in the neighborhood, we saw more police movement, which had not been happening before. This movement does not come to take care of the neighborhood, but to look at the penitentiary and CASE. Many strange people also came”. And she adds: “with the asphalt the speed of the cars is very high, which brings danger to the residents when crossing or traveling on it. It doesn't have a shoulder either, which further increases the danger”.

Daily life, according to Lefebvre (1980), must be understood from its interrelation with time and space. As Levigard and Barbosa explain, the French author shows us that “the domain of space is a fundamental source of social power over everyday life, which is linked to other forms of social power, such as the control of time and money” (LEVIGARD; BARBOSA, 2010, p. 87). Thus, space constitutes, concomitantly, as “a means of production and control, a means of domination and power”, while the daily life empirically reveals reality and acts as a mediator between the universal and the particular (LEVIGARD; BARBOSA, 2010, p. 87). The quotidian appears as the “place of the expropriated man”, reproducing the relations of exploitation and domination, or, as explained by Damiani (2011, p. 111), “the distance between power and the common man”.

Damiani admits that the daily life does not only present inequalities of power and repression, because "it is, on the subjective level, an organization of assured life". Talking to Lefebvre, the author relates everyday

life to the feeling of security: “When the banal of everyday life, how to eat, dress, stay, move around, produce, is part of life in a safe way. With these times, activities and spaces conquered in a way that seems definitive. It is the daily order of material security. Having daily life one sleeps in peace” (DAMIANI, 2011, p. 112).

With this analytical lens, it is understood that the increase in the circulation of strangers, cars and police forces break with a socially established order, and manifests a detachment of the subjects of the research with the spheres of power and with the space of the street. This distance is also evident in the way the interlocutors referred to the process of installing the prison complex and the CASE in the district of São Domingos. According to them, despite the holding of public hearings, there was no community participation in decision making. According to one of the research subjects, "it was not questioned whether we accepted, because they had decided, they were going to put it [...]", referring to the meetings in which they participated. For Lefebvre, effective participation in decision-making processes is essential to overcome the hierarchical and oppressive relationships of everyday life, as it allows “individuals to go beyond the limits of repetitive practices and develop inventive and liberating practices” (LEVIGARD; BARBOSA, 2010, p. 87).

5. Conclusion

The research presented in this article sought to demonstrate how the socio-spatial changes that occurred over the past decades in a neighborhood in the municipality of Criciúma, SC, impact the sociability of its residents. In this sense, qualitative approaches are valid, which use the perspective of the research subjects to access the different ways in which these changes are experienced and also change the ways of life of those who inhabit the space. Thus, it is emphasized that the relationships that individuals establish with each other are also relationships with space, from which the anxieties, fears and insecurities of everyday life emerge.

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Determinates of diarrhea among under-five children in Northwest Ethiopia

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Abstract

This study aimed to assess the determinants of diarrhea among children under-five in Jabitehnan district, Northwest Ethiopia. A community based cross-sectional study was done using a cluster sampling technique. The study was done in Jabitehnan district from April to July 2019. The study was done among women who had children under five during the survey who settled in Jabitehnan district. The main outcome measure was the occurrence of diarrhea. A binary logistic regression was used to identify factors associated with diarrhea. The prevalence of diarrhea was found to be 19.8%. Child lived with whose non-biological mother were 32.44 times more likely to be exposed to diarrhea compared to the child who lived with whose biological mother. The odds of being diarrheal for a child whose mother does not wash her hand after latrine was 7.91 times higher than its counterpart. A child whose mother pregnant was 5.66 times higher risk of developing diarrhea than whose mother do not pregnant. The likelihood of diarrhea for children drinking unprotected water were14.1times higher than its counterpart. Magnitude of reported diarrhea was high. Child age, residence, drinking water, pregnant mother, toilet facility, washing hand after latrine, and child live with whom were the main determinates of diarrhea. Addressing these factors will help to prevent future morbidity and mortality of child and will assist in alleviating hygiene and refining their quality of life. Moreover, trend based sampling design might be considered for a better understanding.

Keyword: Diarrhea, under-five children, Jabitehnan district, Ethiopia

Introduction

Diarrhea is a public health problems of observing the passage of three or more loose or liquid stools within a day or more frequent passage than is normal for the individual[1-4]. Now a day's diarrheal diseases are the second major cause of death among children under-five globally[5, 6] and it responsible for kills about 2.5 million people in a year, of these around 60–70% are children of age under five. Moreover, world health organization (WHO) estimated 1.5m children were died from diarrheal disease each year, almost half of them were in Africa. The most vulnerable children are the youngest ones, particularly before their second birthday[7, 8] as cited in[5] . Even though there is a global decline in the death rates of under-five children, WHO report shows that the risk of a child for dying before the age of 5 years remains the highest in

African(90 per 1000 live births), which is nearly 7 times higher than in European (12 per 1000 live births)[9]. Among the death proportion of children under five years around 82% deaths was observed in Africa and south Asia[10]. From all deaths worldwide, about half of them due to pneumonia and diarrhea occur in just five most poor countries: namely India, Nigeria, the Democratic Republic of Congo, Pakistan, and Ethiopia[4].This implies the event of diarrhea is high in developing countries.

Sub Saharan African countries experiences more suffered in diarrhea, even though there is an improvement of prevention and treatment, it continues to cause for substantial morbidity and mortality in developing countries[6, 11-13] still now.

In Ethiopia particularly, diarrheal diseases alone accounted 23% caused for child mortality, which is greater than the annual deaths due to malaria, HIV/AIDS and measles all together [5, 14]. Hence, to overcoming this problem the government of Ethiopia in collaboration with NGO and private organization, tried to performing several interventions[15-17]. Even if these intervention program was started the event still continues for causes of death for child in Ethiopia particularly severe in the study area Jabitehnan district.

Even though, more research is need to refine the quality of life, almost all previous studies suggests that improving the communities standard of living, advances in sanitation[18], water treatment, improved hygiene and food safety awareness and education helps to reducing the event of diarrhea occurrences[19-23]. On the other hand, all these studies did not consider the climate [24-27] and place specific variations. This may up or down the actual estimation of diarrhea prevalence. As a result in the present study tried to incorporate climate variation in the study period, which insight new look for implementing the right prevention strategies. However, in Jabitehnan District, no study is available on the prevalence of diarrhea among under-five children at community level and there were an observed evidence that diarrhea is a major health problem in the study area. Therefore, this study aims to assess the prevalence of diarrhea and associated factors among age under-five children in Jabitehnan District, Northwest Ethiopia.

Materials and Methods

Study settings

The study was conducted among women who had children under five in Jabitehnan district, Northwest Ethiopia from April to July 2019. Jabitehnan district is one of the northwest district of Ethiopia which is found at 383Km northwest of the capital city of Ethiopia, Addis Ababa. According to the National central statistics agency of Ethiopia 2007 census report the district has 3 town and 128 kebeles with an estimated population of 179,342 of whom 89,523 are men and 89,819 women; 12,609 or 7.03% are urban inhabitants[28].

Study design

A community based cross-sectional study design was used.

Participants

All women who were based in Jabitehnan district with those who had children under five during the survey were included in the study. Mothers or caregivers who were mentally ill, have a problem of hearing, and mothers with a critically ill child were excluded from the study.

The sample size was calculated from a previous study, where the prevalence of diarrhea was reported, p=14.5% in Bahir Dar city[29]. Using 3% marginal error, 95% CI and 1.5deff by the following formula: $n = \frac{z^2_{\frac{\alpha}{2}}\, p(1-p)}{d^2}$,

Where: n= minimum sample size required

Z= standard score corresponding to 95%CI

P= assumed prevalence of diarrhea among children under five

d= margin of error(precision) 3%

deff= design of effect for kebeles 1.5

$n = 3.84 * \frac{0.123975}{0.0009} = 528.96 \approx 529$, since measurements was taken from different kebeles, the minimum sample size was multiplied by 1.5 design effect to remove heterogeneity between kebeles(i.e., 529*1.5=794). By adding 10% contingency for non-response, the optimum sample size was 794+59=873.

Sampling procedures

A sampling frame was constructed by kebeles which obtain from the administrative office of the district and it was used as a cluster. The frame was subdivided into kebeles, then, by lottery method and as a rule of thumb (25%), 32 kebeles were selected. Furthermore, the study subjects were proportionally allotted to each 32 kebeles. Household numbers having under-five children were taken from health extension workers registration books. Then, study subjects were selected using Systematic sampling technique. The first household was selected using the lottery method among fife households, while the rest households, were selected every fifth interval. For households with twins children under 5 year of age, the index child was selected by a lottery method and the youngest child was selected for a household having two or more under 5 years of children**.**

Data collection tools and techniques

Data was collected through pretested and structured interviewer-administered questionnaire. It was first prepared in English and translated to Amharic (the local language), and back-translated to English again. A total of 10 data collectors (BSc. in Midwifery) were involved in the data collection process. The purposes and objectives of the study were clearly explained to participants before data collection.

Patient and public involvement

Women who have children under five in Jabitehnan district were involved in the study.

Data quality control

The questionnaire was pretested on 61 women who had children age under five in Banja district, Northwest Ethiopia. based on the pretest findings, necessary corrections were made to the questionnaire. Interviewers received a total of 3 days of intensive training before data collection. Adequate supervision was undertaken by the supervisors and principal investigator during the data collection. Also, continuous

check up was made about the filled questionnaires for errors or any incompleteness. During data collection, any personal identifiers were not recorded.

Data processing and analysis

After the data collection, data was entered in Epi Data 3.10 and exported to SPSS version 23 for analysis. Values of categorical variables were presented as frequencies and percentages. All statistical tests were performed at the 5% significance level. The dependent variable was the occurrence of diarrhea among children under five within five years from the data collection which was dichotomized into yes (labeled '1') and no (labeled '0'). To prevent recall bias respondents were reinforced to remember the occurrence of diarrhea among children under five in the previous 5years. Each independent variable was cross-tabulated and further evaluated for association in the bivariate logistic regression. In bivariate logistic regression analysis, variables with p-value less than 0.20 were considered into the multivariable analysis to control the possible effect of confounders. Adjusted odds ratio(AOR) with a 95% confidence interval (CI) was calculated to see the strength and significant association. Variables having a p-value less than 0.05 in the multivariable logistic regression analysis were considered as statistically significant. Finally, model fitness was checked using the Hosmer lemnshow test.

Ethical Considerations

Ethical clearance was obtained from institutional review board of Woldia University, Faculty of Natural and computational Sciences. Official letter of permission was written to the respective study; district and administrative office at the selected Keble's were communicated through formal letters. Participants were informed about the purpose, benefit, risk, confidentiality of information, and the voluntary nature of participation in the study. Participants were informed that they had the right to withdraw from the study at any time and also informed verbal consent was obtained from respondents before interviewing.

Results and Discussion

Socio demographic, Medical and Behavioral characteristics

A total of 873 women were interviewed, which makes a response rate of 100%. The majority (70.4%) of the women were in the age range of 21–34 years. About 67.8% and 81% of women lived in rural areas and married, respectively. Moreover, 82.2% of women were housewives and 14.4% were pregnant. Likewise 52.8 and 80.2% of children of age under five were male and had no experience of diarrhea, respectively. The majority of 77.8%,55.7% and 85.3% of the children had access to drink protected water, had not good toilet access and washing their hands after latrine, respectively. Likewise 92.7 and 74.5% of child live with their biological parents and had a complete vaccine of measles, respectively (Table 1).

Table 1 Socio demographic, medical and behavioral characteristics of respondents in Jabitehnan district, northwest Ethiopia, 2019 (n=873)

Variable	Frequency	Percentage
Sex of child		
Male	461	52.8
Female	412	47.2
Age of child in years		
≤1	785	89.9
2-3	71	8.1
4-5	17	1.9
Household family size		
4 and below	757	86.7
More than 4	116	13.3
Residence		
Rural	592	67.8
Urban	281	32.2
Age of mothers		
Less than 20	122	14
21 -34	615	70.4
35 and above	136	15.6
Marital status of mothers		
Married	707	81
Others	166	19
Highest educational attainment of mothers		
No education	444	50.9
Primary(Grade1-8)	257	29.4
Secondary(Grade9-12)	95	10.9
Diploma and above	77	8.8
Occupation of mother		
Employed	100	11.5
Housewives	718	82.2
Others	55	16.3
No_ of under five children in the house		
One child	707	81
Two an above	166	19
Child lived with whom		
Parents/family	809	92.7
Other	64	7.3
currently pregnant of mothers		

Yes	747	85.9
No	126	14.4
source of drinking water		
Protected(unsafe)	679	77.8
Unprotected(safe)	194	22.2
Type of toilet facility		
Present	387	44.3
Not good	486	55.7
Hand washing after latrine		
No	128	14.7
Yes	745	85.3
Measles vaccine		
Yes	650	74.5
No	223	25.5
Prevalence of Diarrhea occurrence		
Yes	173	19.8
No	700	80.2

Prevalence of diarrhea Occurrence

The overall prevalence of diarrhea among children age of under five in west Jabitehnan was 19.8% (95% CI 11.9%, 17.1%).

Factors Contributing to Prevalence of diarrhea disease

Both bivariable and multivariable logistic regression analyses were done to see the effects of the selected variables on diarrhea occurrence among children of age under five. As it is shown in Table 2, sex of child, child age, no_ of children under five in the family, no_ of family in the household, residence, age of mother, source of drinking water, Type of toilet facility; Measles vaccine,; current pregnant of mothers, marital status, mother education, mothers occupation, washing hands after latrine and child lived with whom had significant associations with diarrhea disease in the bivariable analysis. However, in the multivariable logistic regression analysis child age, residence, mother age 21-34, mother education, mother occupation, child lived with whom, current pregnant of mothers, source of drinking water, Type of toilet facility, washing hands after latrine and Measles vaccine were significantly and independently associated with diarrhea occurrence. Accordingly, child who lived with his/her non biological mother were 32.44 times(AOR=32.44; 95% CI 14.07,74.80) more likely to be exposed to diarrhea compared to child lived with biological mother. In this study, the higher odds of developing diarrhea disease were also observed among children of age under five whose source of drinking water unprotected(unsafe)(AOR=14.01; 95% CI 7.50,26.15) than those who have protected(safe) drinking water source. Moreover, the odds of developing diarrhea among children of age under five whose mother currently pregnant were 5.66 times (AOR5.66; 95% CI 2.67,11.99) higher compared to children of age under five whose mother not currently pregnant. Likewise, the odds of exhibited diarrhea disease among children of age under five years with

not washing their hands after latrine were 7.91 times (AOR=7.91, 95% CI, 2.77,22.59**)** higher compared to its counterpart and the youngest one were more prevalent (Table 2). The Hosmer-lemnshow test gives P=0.236,indicating no evidence of poor fit. This is good, since here we know the model is indeed correctly specified (Table 3).

Table 2 bivariable and multivariable analyses of diarrhea among children under five age in Jabitehnan district, northwest Ethiopia, 2019(n=873)

Variables	Prevalence of Diarrhea		COR(95%)	AOR(95%)
	No	Yes		
Sex of child				
Female	314	98	1.0	1.0
Male	386	75	0.19(0.15,0.25)	0.93(0.55,1.58)
Age of child in years				
1 and below	625	160	1.0	1.0
2-3	60	11	0.18(0.10,0.35)	0.10(0.02,0.41)[a]
4-5	15	2	0.13(0.03,0.58)	0.11(0.01,0.91)[a]
Household family size				
4 and below	634	123	1.0	1.0
More than 4	66	50	0.76(0.53,1.09)	2.18(0.97,4.91)
Residence				
Urban	273	8	1.0	1.0
Rural	427	165	0.38(0.32,0.46)	2.99(1.30,6.90)[a]
Age of mothers				
Less than 20	59	63	1.07(0.75,1.52)	1.33(0.55,3.18)
21 -34	534	81	0.15(0.12,0.19)	0.40(0.21,0.78)[a]
35 and above	107	29	1.0	1.0
Marital status of mothers				
Married	580	127	1.0	1.0
Others	120	46	0.38(0.27,0.54)	0.47(0.21,1.10)
Highest educational attainment of mothers				
No education	383	61	1.0	1.0
Primary(Grade1-8)	203	54	0.27(0.20,0.36)	0.09(0.03,0.25)[a]
Secondary(Grade9-12)	64	31	0.16(0.12,0.21)	0.10(0.05,0.2)[a]
Diploma and above	50	27	0.54(0.34,0.86)	0.20(0.10,0.41)[a]
Occupation of mother				
Employed	71	29	1.0	1.0
Housewives	583	135	0.23(0.19,0.28)	0.05(0.02,0.10)[a]

Others	46	9	0.20(0.1,0.40)	0.07(0.02,0.28)[a]
Child lived with whom				
Parents/family	677	132	1.0	1.0
Other	23	41	1.78(1.07,2.97)	32.44(14.07,74.80)[a]
currently pregnant of mothers				
No	628	119	1.0	1.0
Yes	72	54	0.75(0.53,1.07)	5.66(2.67,11.99)[a]
source of drinking water				
Unprotected(unsafe)	83	111	1.34(1.01,1.78)	14.01(7.50,26.15)[a]
protected(safe)	617	62	1.0	1.0
Type of toilet facility				
Not good	338	148	0.44(0.36,0.53)	2.74(1.27,5.89)[a]
Present	362	25	1.0	1.0
Hand washing after latrine				
No	90	38	0.42(0.29,0.62)	7.91(2.77,22.59)[a]
Yes	610	135	1.0	1.0
Measles vaccine				
No	126	97	0.77(0.59,1.00)	3.91(2.26,6.77)[a]
Yes	574	76	1.0	1.0

[a] Significantly associated factors at a p-value < 0.05

Abbreviations

AOR: Adjusted Odds Ratio; CI: Confidence interval; COR: Crude Odds Ratio;

Table 3 Hosmer and lemeshow test for model goodness of fit

step	Chi-square	df	Sig.
1	10.427	8	.236

Discussion

The overall prevalence of diarrhea occurrence was found to be 19.8% (95% CI:11.9%, 17.1%). This finding is higher than those of studies conducted in Bahir Dar 14.5%[29], Kamashi district 14.5%[5], Farta Wereda, South Gondar 16.7%[11], the 2016 EDHS report, 11.2%[15], Yaya Gulele 13.4%[22], Jigjiga, East Ethiopia 14.6%[27],Adama town, Central Ethiopia, 14.7%[14] and Dale District 13.6%[19]. This difference might be arising in variations of the areas of studies. For instance, the studies in Bahir Dar, Adama town and jigjiga were small area and more of urban based unlike this study which was also conducted at large community level including rural based and the study period itself might be also have responsible for the source of variation as per studied[24-26] even though it needs more research.

The likelihood of the occurrence of diarrhea among children age under five were 2.99 times higher than children age under five who reside in urban. Commonly, children age under five located in a rural area

have poor access to protected water, nutrition, toilet facility, hand washing facility after latrine and postnatal care. Furthermore, methodological, socioeconomic and seasonal[24-26] variations may explain the differences in diarrhea in Ethiopia on one hand. Moreover, child feeding care have a great effect on prevalence of diarrheal disease actually unsafe water or contaminated food are commonly practiced in rural areas, such children are more likely to develop diarrhea outcomes than urban dwellers. This study agreed with the previous studies[20]. •

The results of this study, showed that have poor access to protected water, nutrition, not good toilet and no hand washing facility after latrine were highly contributing the likelihood occurrences of diarrheal disease in the study area. This finding consistent with the study[5, 9, 12, 21]. Children whose mothers/caregivers had not washing his or her hand after latrines were 7.91 times more likely to acquire acute diarrhea compared to their counterparts. This finding is supported by those of studies conducted in Rwanda[18],Kamashi district[5], Bahir Dar[29],Dale district[19] and Geze Gofa district [14]. Consequently, they had low chance of removing microorganisms that contaminant hands after latrine utilization than those who had such washing facilities.

Child age less than 1 year were at higher risk of encountering diarrheal disease than its counterpart[5, 7, 8, 16]. In this study, women age ≥34 years were at higher risk of encountering diarrheal disease for their child. This is supported by other findings in[15, 16, 20]. Perhaps because of the advanced maternal age result in diarrhea. This might be due to the unprotected nutritional status and socioeconomic burden which increases the sharing of food among family members. Mothers education and occupation also a responsible factors of the occurrence of diarrhea. this finding is supported by those of studies conducted by[3-6, 16, 19, 22, 23]. Likewise, child living with whom is one of the major factors for determining the prevalence of diarrhea disease under-five years. According to the results of this study, it was found that the odds of prevalence of diarrhea in child lives with others(non biological mothers) were32.44times higher than that of children live with his or her biological mother. This may be due to misconception, and the negative attitude of the caregivers toward the causes of diarrhea. A previous study conducted in Ethiopia and outside Ethiopia found that children living with non biological mother's were more probable to the prevalence of diarrhea as linked to broods living with the respondents[1, 2, 7, 10, 17, 29]. The other results of this study found that, children age of under five whose mother was current pregnant have higher odds of prevalence of diarrhea than children whose mother was not currently pregnant. This study also consistent with the study conducted by[11, 29] and For children who had no Measles vaccination were higher chance of developing diarrheal disease than its counterpart[13].

Conclusions

This study revealed that the prevalence of the diarrhea in Jabitehnan District was 19.8%. Child age, residence, mother age 21-34, mother education, mother occupation, child lived with whom, current pregnant of mothers, source of drinking water, Type of toilet facility, washing hands after latrine and Measles vaccine were mainly associated with diarrhea. Addressing these factors will help to prevent future

morbidity and mortality of child and will assist in alleviating hygiene and refining their quality of life. Moreover, trend based sampling design might be considered for a better understanding.

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Contributor HDM Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation, Visualization, Investigation, Supervision, Software, Validation, Writing- Reviewing and Editing, Manuscript preparation and writing revised manuscript.

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Aluminum Slag Separation Process Analysis Through a Vibratory Machine in the Foundry Process

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Abstract

A The aluminum smelting industry has some challenges, due to the characteristics of the alloy that cause reactions that should be controlled. During the foundry process, the alloy is oxidized by contact of the molten aluminum with the ambient air. Oxide films forming on the surface of the molten metal must be removed during the cleaning of the furnaces in order to avoid contamination of the alloy to be used in the production of parts. Analyzing the melting process of a metallurgy at the industrial complex in Manaus,

we saw that during the cleaning of the furnaces a metal tool is used to remove the slag, which brings with it a high level of aluminum brought about by the mechanical drag of the tool. As the company in question does not have resources to recover the metal aluminum contained in the slag, it is destined for the other institution which carried out the processing through the process of refusion of the slag and extraction of aluminum. The high level of losses in the process due to the discarding of slag generates considerable financial damage to the institution, reflected directly in the cost of manufacturing the products. In this way, the aim of the present work was to develop equipment for the extraction of the metal aluminum contained in the slag and consequently to reduce the losses in the process. The design of the equipment was chosen through a product development methodology, which made it possible to define the design specification, which can count on a container for the receipt and separation of the slag by means of the vibration brought on by motorvibrators installed at its ends, followed by a slingshot drawer responsible for the storage of the metal after the solidification and support/translate cars of the containers.

Keywords: Foundry, Aluminum, Slag, Separator

1. Introduction

Foundry is a fundamental industrial process for the production of metal articles. However, in spite of technological advances, this process still presents some challenges related to the losses arising from the oxidation of the alloy, causing the formation of oxides (slag) films on the surface of the molten metal, and the cleaning of the alloy before the transport for the production of parts is necessary. The formation of slag is inherent in the aluminum smelting process, with the factors that potentiate the generation of slag related to the quality of the alloy used, the parameters of the melting process and the removal and handling of the molten metal.

In general, slag can be classified into three types: white, black and saltcake (TENORY, 2001). Table 1 shows the chemical composition of the main types of slag found in the process of obtaining aluminum:

Table 1: Chemical composition of the main types of slag found in the process of obtaining aluminum.

Rubber Type	Al %	% Oxides	% Salts
White Rubber	25 - 80	20 - 85	0 - 1
Black Rubber	7 - 50	30 - 50	30 - 50
Salt Rubber	3 - 10	20 - 60	20 - 80

Source: Guidelines and Definitions (2002).

The chemical composition of this layer depends on the supply of the material produced and manipulating the raw materials necessary for the process, but also the surplus of the slag is made up of an oxide (25 to 30%), metallic (65 to 75%), aluminum carbide (2 and 3%), aluminum nitride (3 to 5%), iron (0.5 to%) and silicon (0.5 and 1.5%) (ABAL, 2007).

It is estimated that around 500 companies operate directly in the aluminum industry (producers, recyclers and consumers). five companies of primary aluminum, the other stages in the other stages of the production-mining chain, refinery, transformation and recycling/production of alloys. In 2010 the world consumption of aluminum was 40 million tons, it is estimated that for 2020 this consumption will be 70 million tons (ABAL, 2012).

The slag removed from the fuser furnaces brings with it a high level of aluminum, brought about by the mechanical drag of the tool and by the imprisonment of particles of the metal in the inside of the spongy body formed by the segregation of the oxides and other impurities. According to the analyzes carried out in the process, on average 6% of the metal introduced into the furnaces for foundry, come out in the form of slag (OLIVEIRA, 2016). Every time the furnaces are cleaned, on average, 800 kg of aluminum slag is removed, which, considering a medium-sized industry, generates a monthly volume of approximately 35 tons which are destined for sale to another institution. The discarding of the aluminum present in slag represents a considerable financial loss to the institution as a result of the average devaluation of the material's sales value (LME, quoting the site and the date corresponding to the price at the time of the analysis) and (purchase price of COMETAIS slag, with this the monthly loss can reach R$ 402,141.93).

Since it is an industrial waste of Class I, aluminum slag must be treated properly and destined for its own places, since it can cause the human organism from anemia due to iron deficiency to chronic intoxication (BRAZIL ENVIRONMENT, 2020). In order to receive this type of waste, industrial landfills must keep the layers impermeable in order to protect soil and water from contamination. According to Abrelpe (2013), in 2012 Brazil generated 62 million tons of solid waste, a fraction corresponding to approximately 326 kg/inhabitants, or about 0.94 kg/daytime.

Some studies were carried out with the aim of recovering the metal aluminum contained in the residual slag. Wang (2008) presents a study for the recovery of aluminum from the slag made by the refusion in electric furnaces with the addition of founding salts. For slag from reverberation furnaces and from the transfer process, the return on recovery is around 55% and 83%, respectively. The recovery data shows that there is a much higher aluminum content in the slag from the transfer of the metal than in its processing by melting in a venerable furnace.

As for Melo (2007), he is presenting a similar study for the recovery of the black sludge, merging this material into induction furnaces. The results indicated are values in the order of 40.3% of aluminum recovered from the thinnest portion of slag below 0.83 mm for the SAE alloy 329 and 42.9% for the SAE alloy 32. For the portion below 0.83mm recovery was 54% for SAE 329 slag mixed with SAE 326 slag.

1.1 Factors influencing the formation of slag

Slag is formed mainly by oxidation of the liquid metal during the foundry process, Figure 1. The thickness of the layer depends fundamentally on the temperature at which the liquid bath is located. The optimal melting temperature of the aluminum oscillates between 700ºC and 750ºC, higher temperatures tend to increase the thickness of the layer of aluminum oxide during the process (ABAL, 2007).

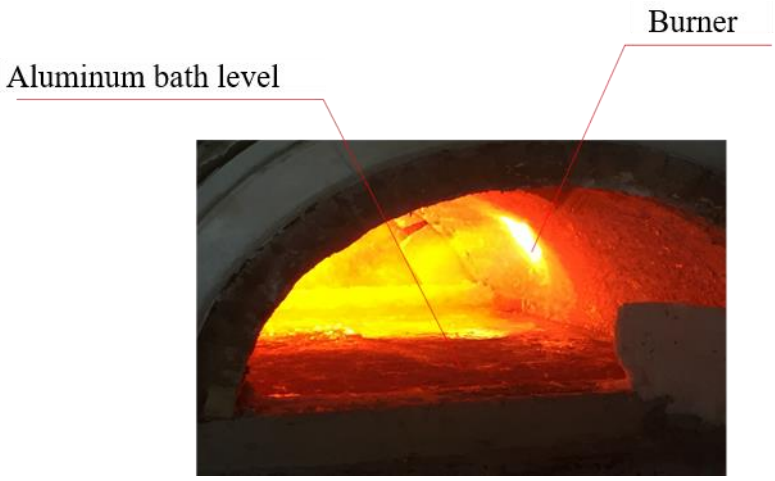

Figure 1: Aluminum bath level flame contact.
Source: Elaborated by the authors (2020).

Another preponderant factor in the generation of slag is the chemical composition of the metal. The presence of magnesium (Mg) in the aluminum alloy facilitates the generation of slag, since magnesium is an element sensitive to oxidation (ABAL, 2007). Thus, aluminum alloys containing high magnesium levels are the ones with the greatest losses in the process.

Productivity losses in the aluminum processing industry range from 0.5% to 1.5% in the primary aluminum fusion processes and from 2.0% to 7.5% in the secondary aluminum processing processes (ABAL, 2007).

A third important factor for productivity losses in this sector is the source area to be merged. Oxidation occurs to a greater degree the greater the ratio of the area/weight of the material, that is, the smaller the thickness of the material to be melted, the greater will be its oxidation in that bath and consequently the greater will be the generation of residues. (ABAL, 2007).

1.2 Processing of Aluminum Slag

Recycling activity is of paramount importance for the foundry industries, as besides establishing an alternative source of the metal, the recovery of aluminum acts under the environmental impacts caused in the production of primary aluminum, since the energy consumption corresponds to one third of the process costs (approximately 15,2 kWh/kg), while in order to carry out the recycling of aluminum, taking into account the whole process from preparation to the fusion of the scrap, they are consumed around 6 % to 8% of the total energy needed to obtain primary aluminum by the electrolyte process (ABAL, 2012).

The slag generated has economic value added by the content of metallic aluminum contained (approximately 10-70% aluminum) (ABAL, 2007). The aluminum sludge generated in the foundry process is generally sent to the other institution carrying out the processing by means of pyrugurgical processes, where it is exposed to very high temperatures in rotary furnaces where the metal is concentrated and can be separated from the accompanying impurities.

The search for a reduction in the cost of production means that companies develop projects that minimize losses and consequently increase the efficiency of the process, in order to make them competitive and to guarantee survival in the market. The development of sustainable projects has provided a very

positive return to the companies that see them implementing them, both financially and in terms of increased operational efficiency, which contributes to reducing environmental impacts and positively favors the company's image in the eyes of investors and society.

In this way, the present work presents a new concept for the recovery of aluminum contained in the residual slag, by implementing equipment developed from studies carried out in the process of foundering a metallurgical company from the industrial complex of Manaus. The equipment designed to work in the extraction of aluminum has a vibration mechanism generated by pneumatic motorcycles attached to the receiving compartment of slag, responsible for the classification and separation of the oxide/aluminum mixture, allowing the metal to recover and minimizing the metal aluminum content discarded from the process.

2. Methodology

With the objective of extracting the aluminum contained in the slag, we began the development of a piece of equipment (oxide/aluminum separator), starting from the mapping of the process of forming slag during the aluminum fusion, the destination of the waste and the methods of processing, in order to establish a design of the equipment that would make it possible to reduce the level of metallic aluminum contained in the residual slag discarded from the foundry process. Mantovani (2011) establishes a product development model that can be divided into three steps as Figure 2.

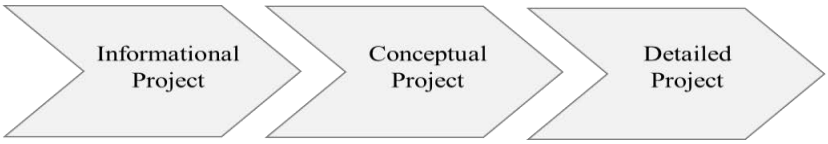

Figure 2: Project development steps.
Source: Adapted from Mantovani (2011).

With the customer/user requirements pre-defined in the information project stage, we started the conceptual project where these requirements are transformed into product designs to determine an initial prototype for making the equipment, the oxide/aluminum separator. At this stage, the overall function of the equipment is to be established, where it has been defined according to the waste processed and the energy input, taking into account the inputs and outputs as outlined in Figure 3.

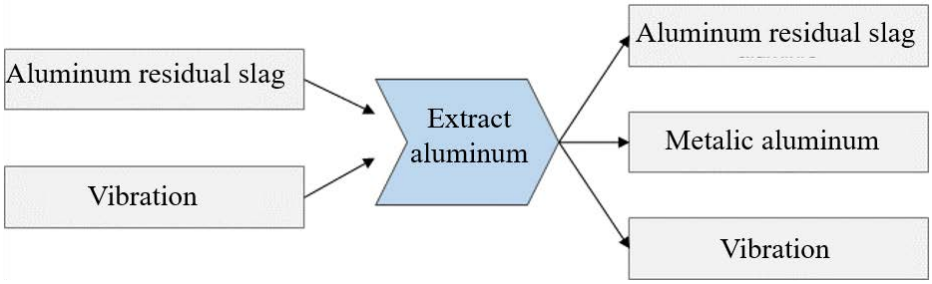

Figure 3: Global function of the aluminum oxide separator.
Source: Elaborated by the authors (2019).

Given the overall and structural function of the equipment, it is possible to work on transforming an abstract design into a concrete design by listing the possibilities for solutions from the defined requirements.

The peripherals that made up the equipment were developed based on the requirements previously raised during the information collection stage. While the project objectives and their customer/user requirements are defined, there are numerous solution principles for your service. By exploring the possibilities for alternative solutions to address the problem, we have put together strengths to select the design specification in order to select the best alternative for each product peripheral, the selection result is shown in Figure 4.

Proposed conception to meet the project requirements						
Residual slag Receiving	Transportation cart structure	Ingot tray	Ingot tray cart	Cart wheels	Springs	Motovibrators
						

Figure 4: Design selected to meet project requirements.
Source: Elaborated by the authors (2019).

After the choice of equipment design, the detailed project development phase was initiated by the technical design as shown in Figure 5.

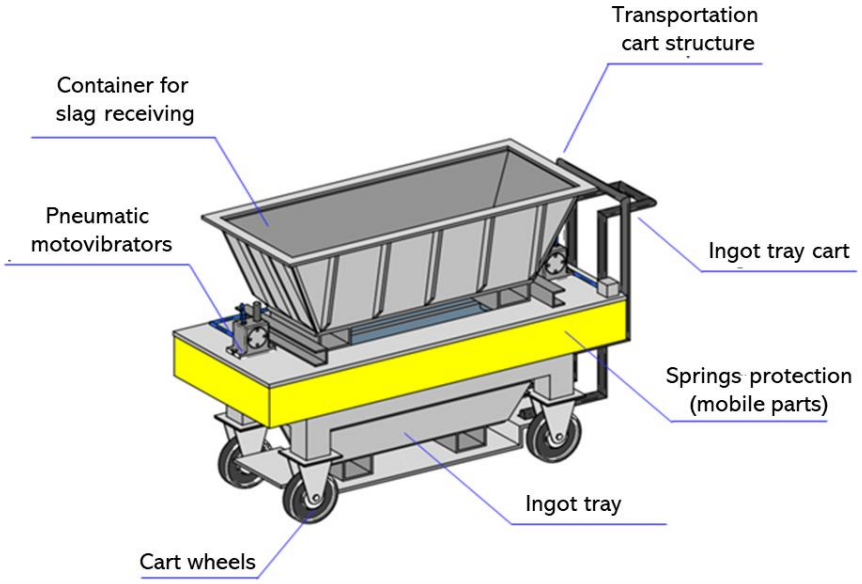

Figure 5: Prototype of the aluminum oxide separator.
Source: Elaborated by the authors (2019).

For the manufacture of the equipment, we use steel for working at high temperatures, essential for the making of the container for receiving slag in which it is responsible for conditioning the residue and for separating the metallic aluminum contained in it. This separation occurs by classifying the mixture by separating the aluminum through the specifically sized pass-through holes. The structure of the trolley is

made up of metal supports of high mechanical and thermal strength, in which it is responsible for the support and translate of the slag-receiving container, and it is also the interface between the container and the ingot tray. The ingot tray is a container constructed of steel with a high thermal resistance, the ingot tray is responsible for receiving the metallic aluminum during separation, its geometric form was developed to facilitate the extraction of the aluminum ingots formed after solidification. Helical springs have been specifically scaled for their strength to boost the vibration inserted into the system by the pneumatic motor vibrators. The equipment was moved by fixed and mobile casters with high thermal and mechanical resistance.

2.1 Operation Test

The equipment's operating test was carried out at a metallurgical company at the Industrial Complex of Manaus, which operates in transforming aluminum into the HD2G and HD4 alloys into parts for meeting the demand for the production of the two and four-wheel pole. These alloys have distinct characteristics, as a function of the concentration of magnesium, an element in which they gain a gain in mechanical resistance, besides improving their machinability and allowing for natural hardening, however, this same element provides for the oxidation of the alloy, the generation of slag and "hard points" in the piece, making the process difficult throughout the production chain. The HD4 League has 4.5 times more magnesium than the HD2 alloy, which makes it a difficult alloy to be worked on, as well as the high loss rate, it still shows low fluidity, which makes it difficult to produce parts.

3. Results

3.1 Analysis of the Alloy Fusion Process and Assessment of Oxide Formation Factors

As stated above, among the parameters analyzed in the aluminum smelting process, the one that has the greatest influence on the generation of slag is the working temperature of the oven, this being directly proportional to the thickness of the oxide films that are formed on the surface of the molten aluminum. After the analysis of the oven working temperature, it was possible to project the rate of formation of oxide films on the surface of the aluminum as a function of the melting time and the magnesium content of the alloys HD2G and HD4 as shown in Figure 6. It is observed that the layer of oxide formed is directly proportional to the melting temperature of the bath, where high temperatures result in layers of thicker oxides with a content of Mg between 4% - 5%, that is, the greater the presence of Mg, the alloy will show an oxide formation higher than the others.

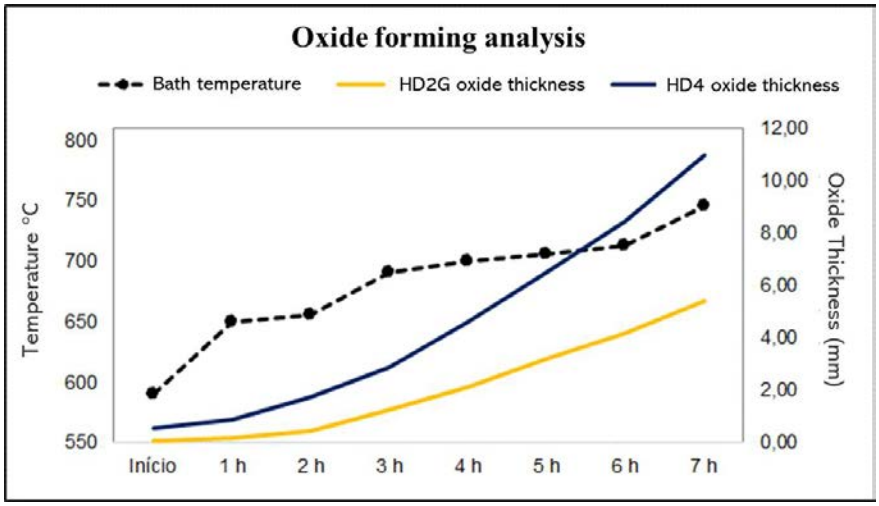

Figure 6: Aluminum oxidation.

Source: Elaborated by the authors (2019).

3.2 Equipment efficiency

In order to assess the efficiency of the equipment, the Schmitz (2006) methodology was used, in which the yield is calculated as a function of the quantity of slag processed and of the metal aluminum extracted with the use of the equipment. The data collected and processed is presented in Table 4. The slag processed in the equipment originated from the process of melting the alloy coming from the furnace composition with Scrap (aluminum that returns from the production in the form of patches) and ingots (the geometry in which the aluminum of the suppliers is purchased). In this way the equipment's work towards the process took place in the most real manner possible, with the objective of identifying negative factors and points of improvement to be implemented, in order to maximize the results with the inclusion of the equipment in the systematic process for the manufacture of the molten aluminum.

As shown in table 4, we can see the percentage of sludge generated due to the aluminum alloy used in the process. It appears that the HD4 alloy has a higher percentage of sludge generation compared to the HD2G alloy, confirming the increase in the oxidation of the alloy provided by the Mg concentration level. Such increase in the generation of sludge makes the HD4 alloy more complex to work with, since this alloy is used for the production of parts with grade A safety (parts for vital use where they will be exposed to greater demands: traction; compression; buckling, etc.), being extremely important the guarantee of the absence of oxide, since this factor negatively affects the mechanical properties of the parts.

Table 4: Analysis of the efficiency of the separating equipment.

Aluminum recovery process analysis – Equipment efficiency											
Alloy	Description	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day
HD2G	Scrap	5.937	13.372	10.106	9.412	12.436	10.010	11.502	7.258	10.198	11.148
	Ingot	5.860	5.467	7.858	4.729	5.569	4.836	5.963	4.636	6.663	10.614
	Sludge	364	345	416	248	156	130	247	351	624	494
	% Sludge	3,1%	1,8%	2,3%	1,8%	0,9%	0,9%	1,4%	3,0%	3,7%	2,3%
	Al Recoveried	118	116	132	100	46	37	76	112	186	156
	% Al Recoveried	32,5%	33,6%	31,7%	40,3%	29,6%	28,5%	30,6%	31,9%	29,8%	31,6%
	Slag disposed from process	246	229	284	148	110	93	171	239	438	338
	% Slag disposed	67,5%	66,4%	68,3%	59,7%	70,4%	71,5%	69,4%	68,1%	70,2%	68,4%
Alloy	Description	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day
HD4	Scrap	5.161	8.015	4.954	4.845	5.920	3.220	7.082	6.730	9.105	9.368
	Ingot	4.119	3.937	6.433	1.054	1.514	900	3.070	2.650	4.797	5.451
	Sludge	581	715	842	650	423	117	585	663	819	650
	% Sludge	6,3%	6,0%	7,4%	11,0%	5,7%	2,8%	5,8%	7,1%	5,9%	4,4%
	Al Recoveried	204	247	305	206	154	41	230	242	284	205
	% Al Recoveried	35,1%	34,6%	36,2%	31,7%	36,5%	34,8%	39,4%	36,5%	34,7%	31,6%
	Slag disposed from process	377	468	537	444	268	76	355	421	535	445
	% Slag disposed	64,9%	65,4%	63,8%	68,4%	63,5%	65,2%	60,6%	63,5%	65,3%	68,4%

Source: Elaborated by the authors (2019).

As a result, the slag-generating characteristics of the HD4 alloy, the efficiency of the equipment is directly influenced, as larger quantities of metallic aluminum are trapped next to it, which will then be submitted to the extraction process carried out by the oxide/aluminum separator. The results of the equipment were followed up for 10 consecutive days, which enabled us to analyze the efficiency in relation to the slag from the alloy used in the process, as shown in Figure 7.

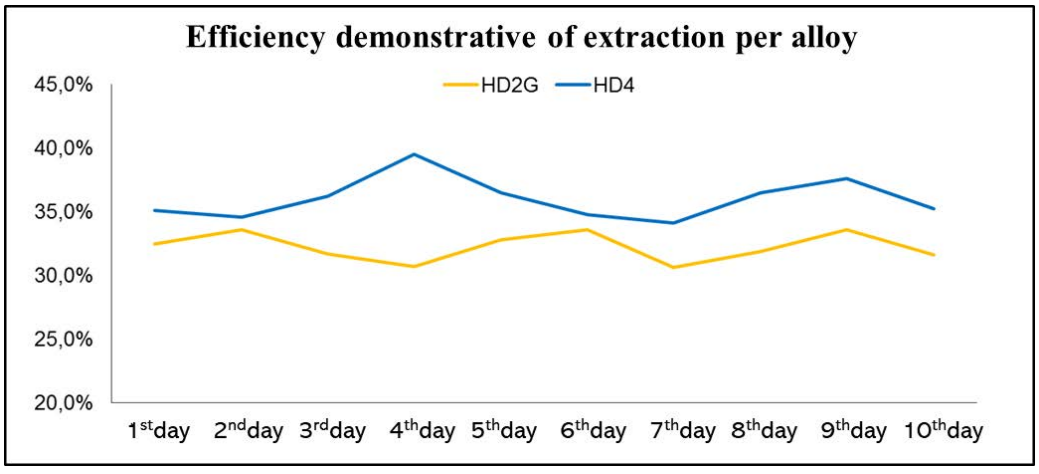

Figure 7: Equipment efficiency per alloy.
Source: Elaborated by the authors (2019).

3.3 Characteristics of Samples

3.3.1 Chemical Characteristics

Generally, the processed slag is basically made up of metallic aluminum 64.8%; Aluminum oxide 25,0 %; Mg oxide 1.5%; Al carbide 3.5%; Al 2,9% nitride; Fe 1.3% oxide and Si 1.0% oxide; as shown in

figure 8. Part of the metal aluminum contained in the slag was free between the oxides, and their removal from the furnaces was due to the mechanical drag caused by the tool used for cleaning. After the removal, the aluminum is trapped amongst the other residues during the solidification process, making it more difficult and expensive to extract when making use of more complex equipment.

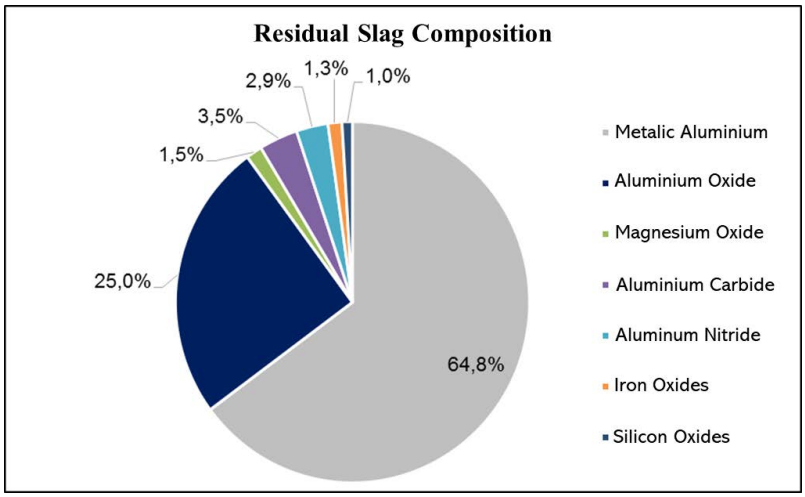

Figure 8: The composition of the residual slag.
Source: Elaborated by the authors (2019).

Therefore, in order to guarantee the reliability of the extracted material, since it will return to production through the reuse of aluminum system, the chemical analysis of the samples collected in the sling tray was carried out. The production of parts using the alloys mentioned above is governed by the internal standard of the company, where the company sets the tolerance limits for each element of the composition of the alloys. In this way, the chemical analysis carried out had as its evaluation parameter the values indicated by the abovementioned standard. The data obtained are previously attributed to the spectrometer reading system and at the time of the analysis the equipment has the resources to identify the alloy corresponding to the analyzed material and to verify the variation in the composition elements of the aluminum extracted using the equipment. The results obtained are presented through a control worksheet, presented in Tables 5 and 6.

We can observe, in a general manner, that the aluminum extracted did not undergo any major alterations in its composition. In Table 5 (assessment of the chemical analysis of extracted aluminum — HD2G), we found that only iron and manganese had a positive variation of 5.7% and 0.4%, respectively, while the other elements remained within the tolerance established in the standard. In Table 6 (chemical analysis assessment of extracted aluminum - HD4), the element variation was even smaller, where only silicon had a different behavior from the standard (+5.5%), with the other elements of the HD4 alloy as well as those of the HD2 alloy that had not changed, remaining within the standard specification.

Table 5: Assessment of chemical analysis of extracted aluminum — HD2G.

Chemical analysis evaluation of extracted aluminum – Alloy HD2G									
	Cu	Si	Mg	Zn	Fe	Mn	Ni	Pb	Sn
Standard	1.0 ~ 2.5	8.5 ~ 11.0	0.20 max.	1.0 max.	1.0 max.	0.30 max.	0.30 max.	0.20 max.	0.10 max.
Result found	1,736	10,204	0,094	0,281	1,057	0,304	0,054	0,052	0,025
Variation	-	-	-	-	0,057	0,004	-	-	-
% Variation	-	-	-	-	5,7%	0,4%	-	-	-

Source: Elaborated by the authors (2019).

Table 6: Assessment of chemical analysis of extracted aluminum — HD4.

Chemical analysis evaluation of extracted aluminum – Alloy HD4									
	Cu	Si	Mg	Zn	Fe	Mn	Ni	Pb	Sn
Standard	0.10 max.	0.50 ~ 1.10	0.40 ~ 5.5	0.10 max.	0.50 ~ 0.8	0.50 ~ 0.8	0.10 max.	0.20 max.	0.10 max.
Result found	0,114	1,161	3,637	0,065	0,720	0,585	0,009	0,022	0,012
Variation	-	0,061	-	-	-	-	-	-	-
% Variation	-	5,5%	-	-	-	-	-	-	-

Source: Elaborated by the authors (2019).

It was previously expected that the HD4 alloy would behave differently from the HD2G alloy in terms of the generation of slag during the alloy fusion, a theory that was confirmed when we analyzed individually the percentage of generation of borer per alloy. At the end of the collection of the data done during the 10 days in which the equipment was in constant operation, we carried out the calculation of the percentage of slag daily, based on the quantity of aluminum loaded from the scrap + lingote furnace, and of the slag removed at each melting cycle. The values resulting from the calculation of the daily generated slag percentage are shown in Figure 9. The HD4 alloy showed in an absolute manner a higher percentage of slag every day analyzed, a phenomenon for which it is justified by the presence of Mg 38.6 times greater than in the HD2G alloy. Magnesium, as seen before, provides oxidation of the aluminum alloy, which brings about the formation of oxide films over the level of bath of the molten metal and consequently increases the index of generation of borer.

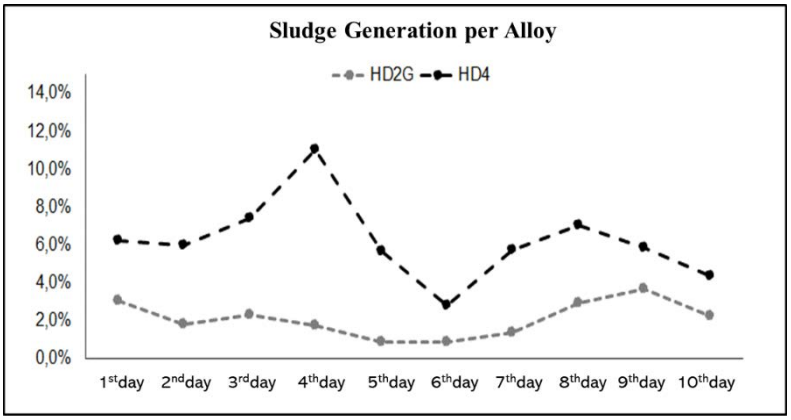

Figure 9: Chemical analysis of the extracted HD4 aluminum.
Source: Elaborated by the authors (2019).

We can observe that even when dealing with the same alloy, there is still a certain variation in the percentage of slag as the day analyzed. To explain this phenomenon, we took into consideration other factors that influence the generation of slag, such as the temperature parameters of the furnace and the degree of purity of the aluminum used, these being fundamental factors for controlling the oxidation of the alloy that results in the control of the generation of slag.

The material to be reused in the process originates from the separation of oxide and other impurities that are found in the form of solid particles mixed with the aluminum that is removed from the furnaces during the cleaning. The oxide micro-particles, when they are removed from the furnaces and deposited in the equipment's container, are added to form a porous body through which the aluminum flows, as a function of the vibration inserted into the system, which potentializes the extraction beyond the process of gravity flow. Aluminum still melted through the Ø20mm holes and is collected in the lingoteric drawer. In carrying out this process, we verified that the aluminum brings with it some microparticles of oxide that are dispersed in the alloy, as presented in the micrographic test carried out through the digital microscope carried out with the samples collected from the aluminum extracted, Figure 10.

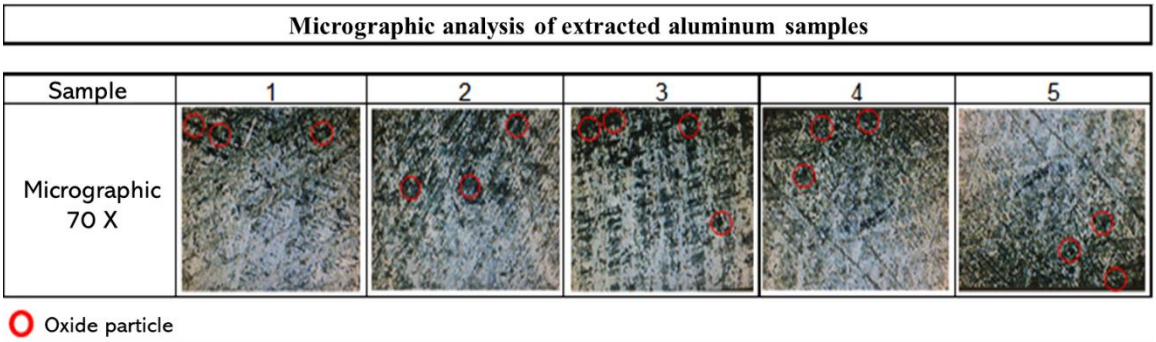

Figure 10: Micrograph of the extracted aluminum samples.
Source: Elaborated by the authors (2019).

We also carried out an analysis of the resistance of the samples of the aluminum extracted and of the ingots conventionally used in the process. Samples of aluminum extracted to the HD4 alloy were collected for resistance testing. The methodology applied to motorcycle brake levers was used to check the resistance of the samples collected. The samples were flex-inflated through the EMIC Dynamometer - DL - 100 KN to their breakpoint. To assess the variation in resistance, we carried out the test on a sample with the same dimensional characteristics taken from the ingot used and then compared to the resistance of the samples of the aluminum extracted, Figure 11.

By superimposing the data for a comparative analysis of resistances, we found that the recovered aluminum samples exhibited a behavior similar to that of the conventional ingot used, with a difference of only 6.2% as a function of the force borne up to its breaking point. Likewise, the deformation of the samples occurs in a very similar manner, except for the fact that the alloy originating from the ingots deforms a

little beyond the samples of recovered aluminum, a phenomenon justified by the presence of microparticles of oxides, which degrade the malleability of the alloy, reducing the deformation at the moment of rupture.

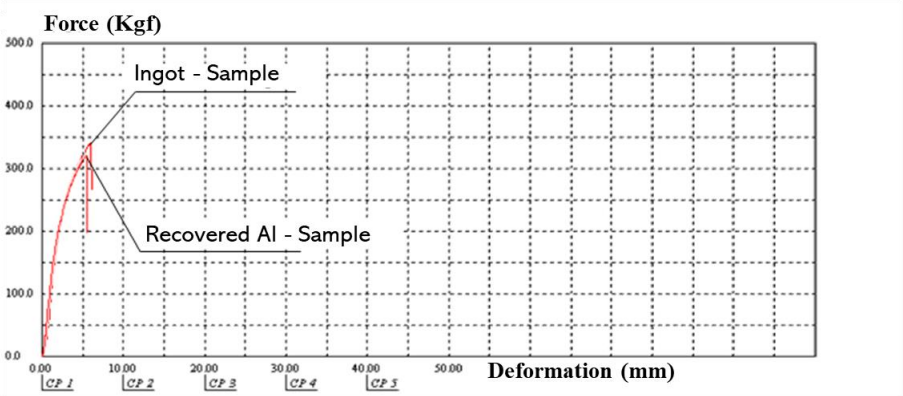

Figure 11: Comparison of resistance of the samples.
Source: Elaborated by the authors (2019).

3.3.2 Economic viability of the project

The development of the aluminum oxide separator took place as a function of the need to reduce the losses of aluminum arising from the foundry process. The main raw material of the metal foundry (in this case aluminum) is the metallurgical industry, so any change in the process is either beneficial or evil, and it has considerable impact on the company. With a view to the economic and financial analysis after the implementation of the separator, the process was monitored using the monthly cast aluminum production indicators and the corresponding borer generation index as Figure 12.

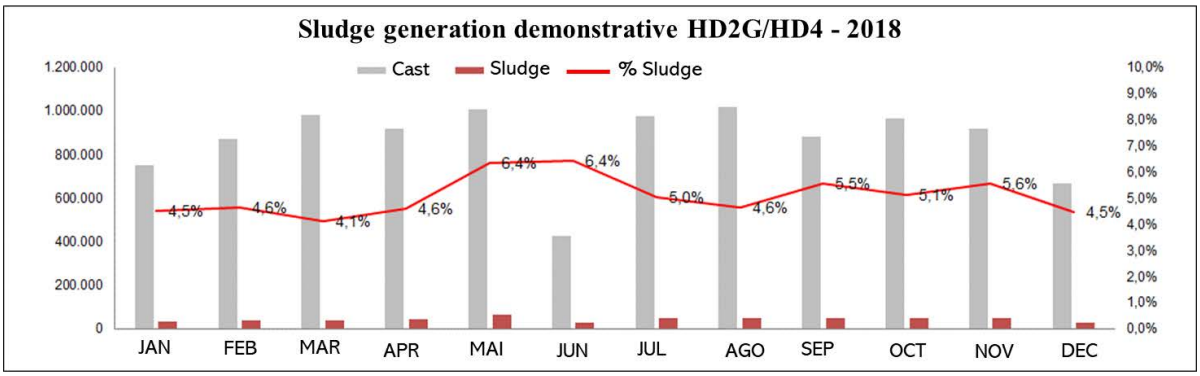

Figure 12: Showcase of sludge generation.
Source: Elaborated by the authors (2018).

Parallel to the production and waste records of the process, the corresponding data was also pointed out for the equipment's work in the aluminum recovery process, which previously had been discarded from the process along with the slag. Figure 13 shows the data on the generation of sludge and the recovery of aluminum, values in which they reveal the efficiency of the equipment, an average yield for the reuse of roughly 35.2% of all slag processed. The extracted material returns to production by means of the reuse system used in the process, in order to guarantee the quality of the parts produced. The aluminum sludge after passing through the extraction process on the separator is destined for another institution that is still working on its processing by way of the process of refusion of slag.

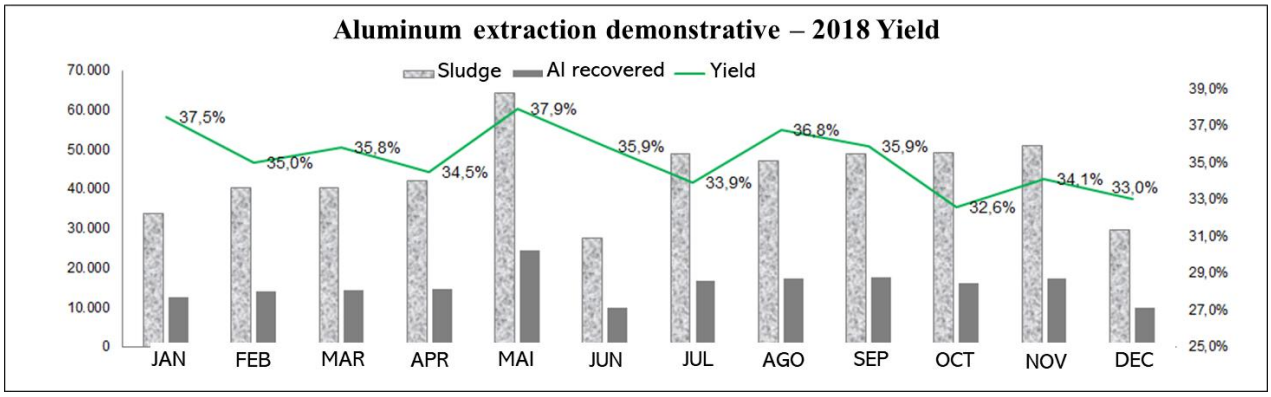

Figure 13: Showcase of blur generation.
Source: Elaborated by the authors (2018).

We have carried out an analysis of the operating cost of the equipment in relation to the energy consumption from the use of compressed air by the motor vibrators and the input used in the process. The operating costs are shown in figure 14.

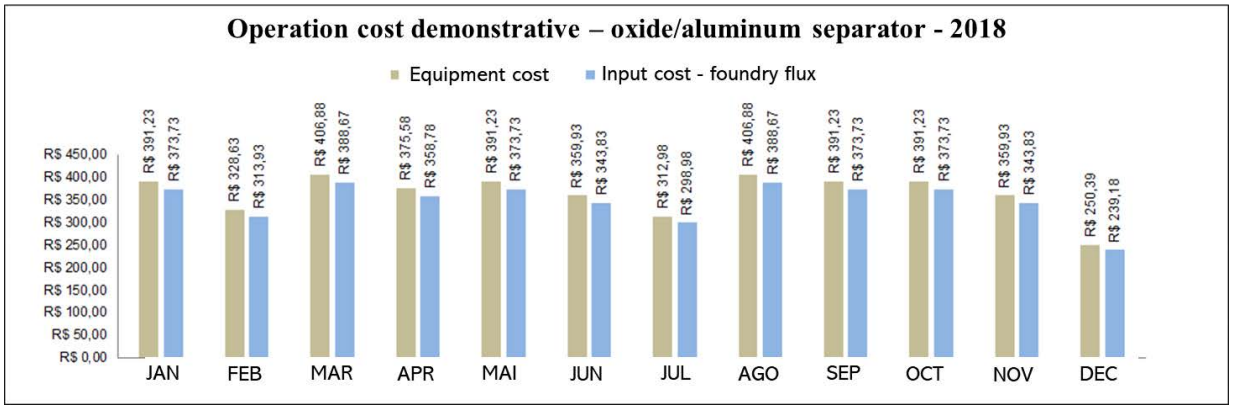

Figure 14: Operation cost - Oxide separator.
Source: Elaborated by the authors (2018).

As previously seen, the discarding of aluminum in the foundry process generated a considerable loss for the company, an average monthly cost of approximately R$ 402,141.93, a factor that reflected directly in the cost of manufacturing the parts. The loss occurs as a result of the devaluation of the metal, a reduction of 81% in comparison with the purchase value of the alloy and the sale of the sludge. After the implantation of the aluminum oxide separator, we can verify, according to the monthly statement of savings, figure 15, an average savings of R$ 109,821.97, as a function of the valuation of the recovered aluminum.

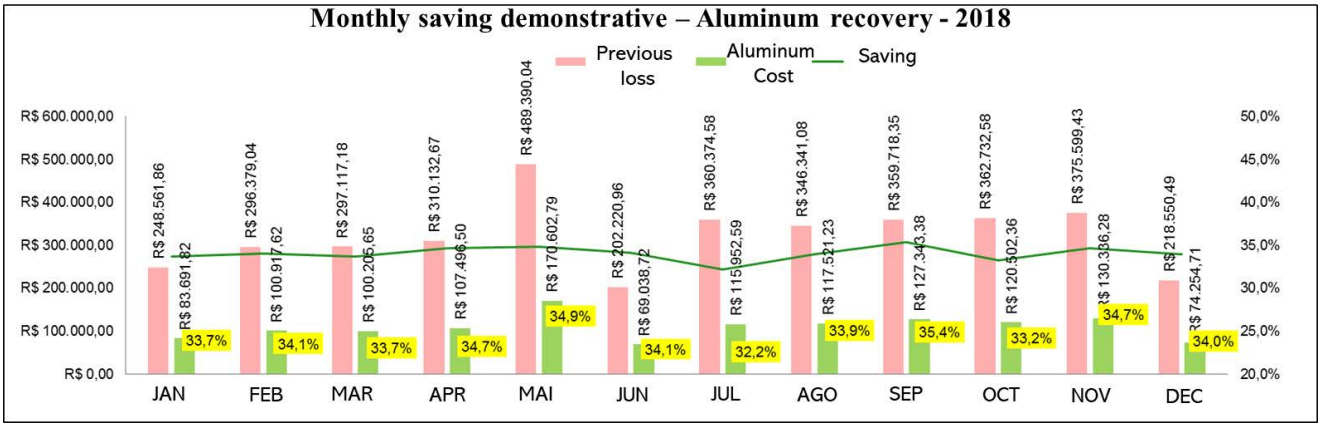

Figure 15: Statement of Work and Monthly Savings.
Source: Elaborated by the authors (2018).

During all the stages of the project development process, equipment was sought that made use of simple mechanisms that are easily accessible to the market, in order to meet the customer/user requirements and at the same time viable from the financial point of view. To construct the equipment, an investment of R$ 13,093.95 was made for each piece of equipment. For the company studied, four pieces of equipment were needed to meet the production demand, totaling the investment of R$ 52,375.80, a value amortized immediately in the first month of the equipment's operation, as shown in figure 16. In view of this, the equipment fulfills the function in which it was conceived, maximizing the institution's results through a high economy with raw material aligned with the low operating cost, factors that collaborate in a positive way for the company's survival in the metallurgical industry, maintaining its competitiveness in the face of market challenges.

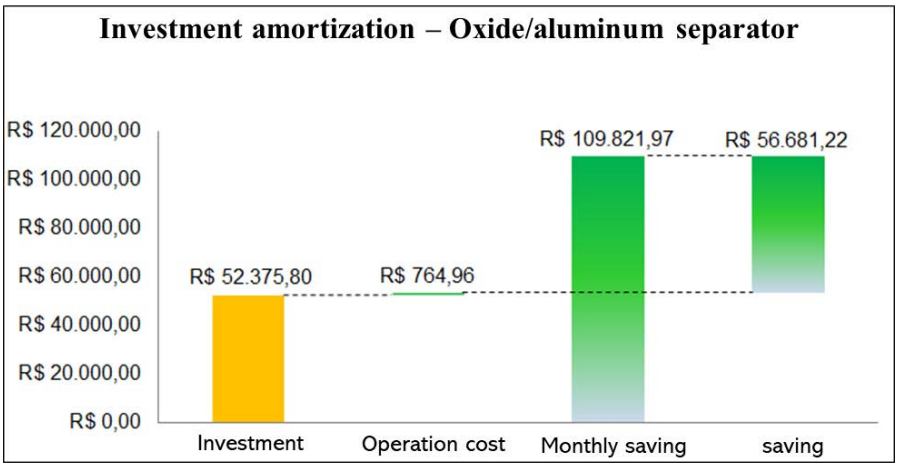

Figure 16: Amortization of investment - Oxide / aluminum separator.
Source: Elaborated by the authors (2018).

4. CONCLUSION

With the carrying out of all the stages of the development of the equipment, governed by a methodology for the research and development of the product, it was possible to select the best design of

the project, which in an efficient manner attended to the needs and requirements brought about during the development of the work, which had the objetive of developing equipment to act in the reduction of the losses of aluminum by separating the metallic content contained in the slag coming from the foundry process and consequently reducing the cost of the raw material in the manufature of the parts.

The equipment showed an average yield of 35.2%, given the content of metallic aluminum extracted from the slag. The alloy yield analysis shows that the recovery rate for the HD4 alloy is higher than that of the HD2G alloy, a phenomenon justified by the higher concentration of metallic aluminum in the slag of the corresponding alloy.

The chemical analyzes carried out on the recovered aluminum samples made it possible to verify the variation in the concentration of the composition elements of the alloys HD2G and HD4. In general, we find that there was a small variation in the chemical elements of the alloy, a factor easily corrected by the re-use system adopted in the process.

The visual characteristics of the recovered aluminum samples were maintained according to the material already used in the process. The micrographic analysis of the samples revealed the presence of aluminum oxide microparticles dispersed between the alloy that are trapped in the extracted material and remain there during the solidification.

The resistance test of the recovered aluminum samples showed a similarity of resistance compared to conventional ingot samples. There was a variation in the resistance of -6.2%, a factor justified by the reduction in the property of the alloy's elasticity as a function of the presence of microparticles of oxides.

By analyzing the cost-effectiveness of deploying the equipment, we have seen the reduction in financial losses. The company had an average monthly cost with the discarding of the slag of R$ 402,141.93, brought about by the depreciation of the alloy as a function of the selling price of the slag. After implanting the separator in the foundry process, an average reduction in losses of 34% corresponding to the material recovered was observed, which brought the company an average monthly savings of R$ 109,821.97, reflecting directly on the reduction in the manufacturing cost and contributing to the company's survival in a competitive market.

By analyzing the monthly economy, we check the viability of the project, taking into account the cost of operating the equipment and the monthly savings it provides. The separator showed a low operating cost, on average R$ 764.96/month, due to the use of a simple mechanism and the low consumption of inputs. We verified the immediate depreciation of the investment, right from the first month of operation, making the equipment viable in the financial point of view.

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Predictors of mortality in the intensive care unit for adult patients admitted on mechanical ventilation: admission profile

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Abstract

Evaluating risk factors for mortality in local populations such as adult patients admitted on mechanical ventilation in intensive care units (ICU) may provide support for the management and improvement of outcomes in these units. The inclusion of the workload of professionals in these models has offered a different view of predictors. The aim of this study was to evaluate whether Nursing workload assessed by the Nursing Activities Score (NAS), predictors of mortality (APACHEII and SAPS3) and some additional admission variables for patients admitted on mechanical ventilation in an ICU are predictors of death. We evaluated 194 patients who remained on mechanical ventilation for 48 hours before or after admission in one ICU, in a university hospital of high complexity. The clinical and socio-demographic profile, the NAS of admission and some admission variables were evaluated. The outcome discharge or death in the ICU was evaluated for all patients, and from simple or multiple logistic regression models, risk or protective factors for death in the ICU were obtained. Individually, only SAPS3 was significant for prediction of death (OR = 1.03; 95%CI: 1.01; 1.05), while the APACHEII and the NAS of admission was not able to predict ICU mortality. In the multiple model, the only risk factors for ICU mortality were the presence of chronic obstructive pulmonary disease (OR = 8.82; 95%CI: 1.82; 42.70), having thyroid diseases (OR = 5.98; 95%CI: 1.15; 31.22) and the increase in the level of urea in the blood (OR = 1.01; 95%CI: 1,002; 1.02). The admission variables of this population were more effective in predicting ICU mortality than the predictors of mortality evaluated here.

Keywords: Nursing workload; risk factor; Nursing Activities Score; blood urea, chronic obstructive pulmonary disease; thyrodopathies.

1. Introduction

The analysis of risk factors and the use of risk indicators for mortality have been widely used in the health literature in different scenarios (HISSA et al., 2013; RISSO & NASCIMENTO, 2010; GULINI et al., 2018; HEYARD et al., 2020). Critical patients or patients at imminent risk of death have been commonly admitted and assisted in intensive care units (ICU), and have high morbidity and mortality (SENTURK et al., 2011). In addition, these patients demand a high workload of health professionals, highlighting among them nurses, with the highest fraction of this time (CASTELLAN et al., 2016).

It is essential to know the risk or protective factors for different clinical outcomes in ICUs. Brazilian ICUs legislation requires units that know and evaluate their risk factors and indicators of patient mortality and health workers workload (ANVISA, 2010). The most widely used predictors of mortality in ICUs are Acute Physiology and Chronic Health Evaluation II (APACHEII) (KNAUS et al., 1985) and Simplified Acute Physiology Score 3 (SAPS3) (GALL et al., 1984; GALL, LEMESHOW, SAULNIER, 1993). Despite the low applicability of APACHEII, its use is still indicated in clinical trials and remains an index used to describe the severity of critically ill patients in clinical studies, but may prove obsolete in some situations (MORENO & NASSAR JR, 2017). Knowing other risk factors not covered by scores, local factors or factors related to specific groups of patients or units becomes essential. The inclusion of new variables in these models is able to improve the predictive capacity of various indicators (WANG et al.,

2012; GUTHC et al., 2018; KATO et al., 2020; MOHAMMED et al., 2020).

A group of patients in ICUs who have called attention are the patients using invasive mechanical ventilation, considered here the use of artificial airway route concomitant to the use of mechanical ventilator. The fact that undergoing mechanical ventilation and time on mechanical ventilation have been routinely reported as risk factors for mortality or worse clinical outcomes (SENTURK et al., 2011; OLIVEIRA et al., 2010; GULINI et al., 2018; GOMES et al., 2019), although models for predicting clinical outcomes to specific populations in the ICU are poorly addressed for admission itself.

Patients on mechanical ventilation in ICUs may represent up to 41.5%, and those on mechanical ventilation for more than 21 days up to 10% of these patients (LOSS et al., 2015). These patients are subject to a high risk of ventilator-associated pneumonia (VAP), which is the most common health care-related infection in ICUs with a prevalence of 9 to 68% and also strongly associated with mortality, which can reach up to 13% (CAMARGO et al., 2004, ROCHA et al., 2008; MOTA et al., 2019). Moreover, the non-provision of the healthcare workload demanded by patients independent of the professional may lead to non-execution of health care, and if associated with other risk factors may increase the incidence of VAP, the use of tracheostomy and reintubation rates (HUGONNET et al., 2007; JANSSON et al., 2019), which may trigger higher morbidity and mortality in this group.

In this scenario, it is essential to measure the Nursing workload. Its measurement is recommended and required by the legislation of Brazilian ICUs for all patients (ANVISA, 2010). The most used Nursing workload measurement instrument currently used in ICUs is the Nursing Activities Score (NAS) (MIRANDA et al., 2003), translated and validated in Brazil by Queijo e Padilha (QUEIJO & PADILHA 2009). NAS has also been listed as a predictor of clinical or health outcomes (eg. GOMES et al. 2019), which reinforces its potential role as a predictor of risk or protection.

The objective of this work is to evaluate the admission variables and mortality scores of patients admitted on mechanical ventilation in an adult ICU as predictors of mortality in the ICU, in addition to evaluating whether SAPS3, APACHEII and Nursing workload of admission measured by NAS singly are predictors for ICU mortality.

2. Material and Methods

2.1 Type and Place of Study

The study is retrospective, documental (patient's health records), descriptive, analytical and cross-sectional cohort. The data analyzed here were collected in the study of ventilator-associated pneumonia performed by GOMES (2018), and had part of the data and results published in GOMES et al. (2019) and GOMES et al. (2020). See full detail from profile and their discussion on previous papers.

Data were collected inside the ICU for adult patients of the Clinic Hospital of Uberlândia (Hospital de Clínicas de Uberlândia in Portuguese) the Federal University of Uberlândia (Universidade Federal de Uberlândia in Portuguese). The hospital is located in the city of Uberlândia, Minas Gerais state, Brazil. It is a public hospital, teaching (university type), tertiary care (high complexity), with 525 beds and linked exclusively to the Unified Health System (SUS- Sistema Único de Saúde in Portuguese). The Adult ICU is classified by the criteria of the Brazilian Ministry of Health as complexity level III (BRASIL 1998), a

higher level of complexity. The ICU was structured at the time of data collection as a general ICU with no defined specialty, with thirty beds for hospitalization of clinical, neurological, traumatic and surgical patients. The unit treats patients from 13 years of age, although patients from 18 years predominate.

2.2 Study and Sample Population

The study population consists of all patients admitted to the Adult ICU from January to June, 2014, admitted to invasive mechanical ventilation as defined by Gomes (GOMES, 2018). The inclusion criteria in Gomes' study were the medical records of patients over 18 years of age, admitted on mechanical ventilation for more than 48 hours before ICU admission. The author also considered patients who remain on mechanical ventilation for more than 48 hours immediately after admission to the ICU, because it represents the criterion of minimum mechanical ventilation time for the diagnosis of VAP (primary outcome of the original study, GOMES, 2018). Exclusion criteria were medical records that did not contain the variables necessary for the study. For our study, we included as an additional exclusion criterion, the patients without NAS measurements during ICU stay.

Data were collected from 198 patients by GOMES (2018). Four patients were excluded due to the absence of data or NAS evaluations. A total of 194 patients were included in the current study, of which 71 died in the ICU and 123 were discharged from the ICU.

2.3. Clinical and Demographic Profile

Data were collected directly from patients' healthcare records. Initially an individual form was filled out for each patient, containing the following data of patient admission: age (in years), gender (male and female), body mass (Kg), height (cm), diagnosis of admission (characterized in clinical, trauma and surgical; observing that the patient may present more than one diagnosis at admission and with this may belong to more than one group), $C0_2$ partial pressure (mmHg), axillar temperature (^oC), time of mechanical ventilation before admission in ICU (day), mean blood pressure (mmHg), blood urea level (mg/dL), PIRO score (points), and the predictors of mortality APACHEII and SAPS3. The presence of comorbidities, chronic obstructive pulmonary disease, congestive heart failure, thyroid alteration (or thyroid diseases) was also evaluated. The Nursing workload was also evaluated at admission by the Nursing Activities Score (NAS), the first 24 hours of ICU stay. The original study includes other variables, which were not described here due to high data loss, see GOMES (2018), GOMES et al. (2019) and GOMES et al. (2020).

2.4. Ethical and Legal Considerations

The study was conducted in accordance with Resolution 466 of 2012 of the National Health Council (BRASIL, 2012) and in accordance with the ethical principles of the Declaration of Helsinki for research involving humans (WORLD MEDICAL ASSOCIATION DECLARATION OF HELSINKI, 1997). The study was submitted to the Ethics and Research Committee of the Federal University of Uberlândia, and approved under the number CAAE: 43409414.8.0000.5152. As the study involved the evaluation of patients' health records and not the direct approach to the patient, their families and the health professional, the Ethics and Research Committee was waived the application of the Free and Informed

Consent Form.

2.5. Statistical Analysis

The patients were divided into two groups for analysis, the patients who died in the ICU and the patients who discharged from the ICU. Qualitative data were described with point estimate of percentage and their exact 95% confidence interval (*95%CI*) based on the *F* distribution (LEEMIS & TRIVEDI, 1996). Quantitative data were described with mean and their *95%CI* based on *Z* distribution (data with Gaussian distribution), or described with median and their *95%CI* based on the interpolation method (HETTMANSPERGER-SHEATHER, 1986), for data that did not follow Gaussian distribution. The data of each group were tested for normality by the Shapiro-Wilk test (SHAPIRO & WILK, 1965). All confidence intervals were proposed as a descriptive approach, the groups were compared by the tests described below.

The independence between the groups and the qualitative variables was tested with the Chi-Square Test of Independence (when the expected frequencies were greater than five) or Fisher's Exact test (when at least one of the expected frequencies were less than five) (PEARSON 1900; FISHER 1922; FISHER 1924). The Chi-Square test had continuity correction (YATES, 1934). For the comparison of data of quantitative variables between the two groups, when the two groups separately presented normality, the differences between the means were tested with Student's *t*-test for homogeneous or heterogeneous variances (STUDENT 1908). The homogeneity of variances was tested between groups with the Levene test (LEVENE, 1960). When at least one of the groups did not present normality, the groups were compared by the Mann-Whitney test (Wilcoxon rank-sum test, unpaired) (MANN & WHITNEY, 1947).

To evaluate the linear relationship between the predictor variables, a simple linear correlation of the Spearman type (SPEARMAN 1904) was performed between all predictor variables of the death event. The significance of the correlation was tested with Student's *t*-test for correlation. The dichotomous qualitative variables were also included assuming the values zero (if not) or one (if yes) for the variable levels, as dummy variables. This analysis was proposed to support the choice of variables included in the complete multiple logistic regression model avoiding collinearity. Some mathematical, theoretical and practical relationships were also used to exclude variables from the complete model.

For the prediction of the occurrence of death in ICU (considered the event of interest) the data of predictor variables were adjusted to simple and multiple logistic regression models (HOSMER & LEMESHOW, 1989) with dependent variable response to death in the ICU (0: success or discharge from the ICU, 1: failure or death in the ICU). In all cases, the Odds-Ratio and their *95%CI* were also calculated. The backward criteria of selection were used from the multiple model, adopting the probability of Wald greater than 0.05 for variable exclusion.

All models constructed were used from a descriptive and non-predictive perspective. The complete models were not presented due to the complexity and difficulty of implementation in the clinical practice of the ICU, always opting for the most parsimonious models. The adequacy and accuracy of the logistic regression models were tested by the Hosmer and Lemeshow Test and the Likelihood Ratio Test (HOSMER & LEMESHOW; 1989) and the Nagelkerke coefficient of determination (NAGELKERKE, 1991). The probabilities of success, failure and total were also reported.

For all analyses, the data were analyzed in the R environment (R CORE TEAM 2020). A significance of 5% was adopted for all analyses, except as described above.

3. Results

3.1. Comparison of the profile of the two groups

The ICU mortality rate for patients admitted on mechanical ventilation at least by 48 hours was 36.60% (71 deaths in 194 patients evaluated). Of the 123 patients discharged from the ICU, 11 died in the ward with a mortality rate after discharge from the ICU of 8.94% (11 deaths in 123 patients evaluated). The hospital mortality rate was 42.27% (82 deaths in 194 patients evaluated). We did not use deaths in the ward (11 deaths) in the prediction models, since the risk factors for this phase (ward) were not evaluated, and the intention was to predict death in the ICU and its related factors.

The two groups of patients, discharge or died in the ICU, showed significant differences in some of the variables evaluated in the profile. There is a predominance of male patients in both groups, with no differences between them (p = 0.586). Patients discharged from the ICU have a lower prevalence of clinical admission (32.52% versus 50.7%, p = 0.019), higher prevalence of admission for trauma (30.08% versus 2.82%, p < 0.001), lower prevalence of chronic obstructive pulmonary disease (1.63% versus 14.08%, p = 0.001), and lower prevalence of congestive heart failure (4.88% versus 16.9%, p = 0.012). The two groups showing the same prevalence of surgical admission and presence of thyroid disease (p > 0.05). (Tables 1)

Table 1. Admission categorical variables of patients admitted on mechanical ventilation in an adult intensive care unit (ICU) at least 48 hours, stratified into death or discharge from the ICU.

Trait	Level	% (n) [LL *95%CI*, UL *95%CI*]		Statistic; *p*
		ICU Discharge	ICU Death	
Gender	Male	65.85 (81) [56.76; 74.16]	61.97 (44) [49.67; 73.24]	X^2 = 0.15; 0.586
	Female	34.15 (42) [25.84; 43.24]	38.03 (27) [26.76; 50.33]	
Clinical admission	No	67.48 (83) [58.45; 75.65]	49.30 (35) [37.22; 61.44]	X^2 = 5.51; 0.019
	Yes	32.52 (40) [24.35; 41.55]	50.70 (36) [38.56; 62.78]	
Trauma admission	No	69.92 (86) [61.00; 77.86]	97.18 (69) [90.19; 99.66]	X^2 = 19.17; < 0.001
	Yes	30.08 (37) [22.14; 39.00]	2.82 (2) [0.34; 9.81]	
Surgical admission	No	43.09 (53) [34.20; 52.32]	54.93 (39) [42.66; 66.77]	X^2 = 2.08; 0.149
	Yes	56.91 (70) [47.68; 65.8]	45.07 (32) [33.23; 57.34]	
Thyroid Change	No	98.37 (121) [94.25; 99.80]	91.55 (65) [82.51; 96.84]	FET; 0.054
	Yes	1.63 (2) [0.20; 5.75]	8.45 (6) [3.16; 17.49]	
COPD presence	No	98.37 (121) [94.25; 99.80]	85.92 (61) [75.62; 93.03]	FET; 0.001
	Yes	1.63 (2) [0.20; 5.75]	14.08 (10) [6.97; 24.38]	
CHF presence	No	95.12 (117) [89.68; 98.19]	83.10 (59) [72.34; 90.95]	X^2 = 6.37; 0.012
	Yes	4.88 (6) [1.81; 10.32]	16.9 (12) [9.05; 27.66]	

Legend: COPD: chronic obstructive pulmonary disease, CHF: congestive heart failure, X^2:Chi-square test

with continuity correction; *p*: probability; FET: Fisher's Exact Test; LL *95%CI*: closed lower limit of the 95% confidence interval; UL *95%CI*: closed upper limit of the 95% confidence interval.

Patients discharged from the ICU had a lower mean for SAPS3 than patients who died in the ICU (60.56 points versus 67.14 points, $p = 0.002$). The means for APACHEII and mean blood pressure were the same between the two groups. When comparing the medians, patients discharged from the ICU had lower medians for age (48 years versus 64 years, $p < 0.001$), lower median for urea concentration in the blood (41 mg/dL versus 54 mg/dL, $p = 0.005$) and higher median for axillary temperature (36.3 ºC versus 36.0 ºC, $p = 0.021$). The other quantitative variables of the profile did not show differences between the two groups, and the two groups did not differ statistically in terms of median for NAS-ad, body mass index, PIRO, weight and height. (Table 2).

Table 2. Admission quantitative variables of patients admitted on mechanical ventilation in an adult intensive care unit (ICU) at least 48 hours, stratified into death or discharge from the ICU.

Trait (unit)	**ICU Discharge**	**ICU Death**	**Statistic; *p***
	Median (*95%CI*)		***Z; p***
Height (cm)	165 (165; 170)	165 (161; 167)	-1.89; 0.058
Age (year)	48 (39; 54)	64 (57; 69)	-4.9; <0.001
Body mass index (Kg/m^2)	24.61 (24.09; 24.84)	24.82 (24.34; 25.39)	-0.86; 0.390
NAS-ad (point)	52.8 (52.7; 55.0)	54.0 (52.7; 56.2)	-0.23; 0.821
PIRO (point)	2 (2; 2)	2 (2; 2)	-0.8; 0.422
$C0_2$ partial pressure (mmHg)	36.7 (34.0; 38.6)	34.5 (33.0; 37.5)	-1.33; 0.183
Axillar temperature (ºC)	36.3 (36.0; 36.6)	36.0 (35.8; 36.4)	-2.30; 0.021
Time of mechanical ventilation before admission in ICU (day)	0 (0; 1)	1 (0; 3)	-0.82; 0.411
Urea in blood (mg/dL)	41 (36; 45)	54 (45; 70)	-2.78; 0.005
Trait (unit)	**Mean [*95%CI*]**		***t; p***
APACHEII (point)	18.41 [16.95; 19.86]	18.89 [16.88; 20.89]	-0.38; 0.701
Body mass (Kg)	69.44 [67.77; 71.11]	67.17 [64.91; 69.43]	-1.62; 0.107
Mean arterial pressure (mmHg)	84.11 [81.48; 86.74]	85.20 [80.72; 89.67]	-0.41; 0.682
SAPS3 (point)	60.56 [58.13; 62.99]	67.14 [64.60; 70.68]	3.09; 0.002

Legend: *95%CI*: confidence interval (lower limit and upper limit being adopted ( ) for open interval and [ ] for closed interval), obtained by *Z* distribution for the mean when the data follow Gaussian distribution; or by the interpolation method for the median; *p*: probability; *t*: Student *t*-test statistic; *Z*: *Z* statistic approximate for the Mann-Whitney test.

3.2. Selection of variables for logistic regression models

As SAPS3 was the unique predictor of mortality that differed between the two groups, it was selected as a predictor of mortality for the multiple model and for the patients admitted on mechanical ventilation, and the variables that are used in its calculation were not included in the multiple regression model for predicting mortality, to avoid redundancy. With this, the variables of age, presence of congestive heart failure, axillary temperature, CO_2 partial pressure ($PaCO_2$), mean blood pressure, types of admission (clinical, surgical and trauma admission) were not included in the multiple regression model. We did not have access to all the variables necessary to compute the SAPS3 or APACHEII calculation, since these scores are often calculated by the ICU team, and they do not record these variables in the patient's health records. With this, it was not possible to evaluate the variables that make up these indexes singly or in the multiple model. Despite this we assume that SAPS3 is a validated and more informative predictor than the isolated use of the variables that compose it.

It is observed that most correlations between predictor variables are weak and with values below 0.750, the criteria adopted her for exclusion (regardless of whether positive or negative, full results are not showed here). This criterion not was allowed the additional exclusion of variables for the full multiple model. So, for the M4 model, the full multiple prediction model that evaluated the admission variables adopted the following variables - gender, presence of chronic obstructive pulmonary disease, presence of thyroid disease, blood urea level, PIRO scale, NAS-ad and SAPS3. The anthropometry variables were not included, since there were indications of not differing between groups and were maintained in the study, only descriptive of the population studied.

3.3. ICU Mortality prediction models

In the simple regression models, the model M1 (Table 1), which assesses the predictive capacity of the NAS-ad (NAS of admission), singly, showed that this is not able to predict ICU mortality (B_1 = 0.003; p = 0.853; Model M1; Table 3). When were tested the predictors of mortality, only the SAPS3 was capable of predicting ICU mortality (B_1 = 0.03; p = 0.003; Model M2; Table 3) and that the increase in one unit of the SAPS3 indicator increases the chances of death in the ICU in 3% (*OR* = 1.03; *95%CI*: 1.01; 1.05). The APACHEII was not able to predict ICU mortality in the group of patients studied here (B_1 = 0.01; p = 0.699; Model M3; Table 3). The SAPS3 was the ICU mortality predictor selected for use in the multiple logistic regression model. (Table 3).

When the ICU admission variables were evaluated together with SAPS3 in the model M4 (Table 3), only three variables were maintained in the reduced model, and neither the NAS-ad nor SAPS3 remained in the final model. Patients with chronic obstructive pulmonary disease were 8.82 more likely to die in the ICU than those without COPD (*OR* = 8.82; *95%CI*: 1.82; 42.70), and patients with thyroid diseases were 5.98 more likely to die in the ICU than those who did not (*OR* = 5.98; *95%CI*: 1.15; 31.22), and patients who had increased urea levels have a higher risk of mortality (B_3= 0.01; p = 0.012), and the increase in one unit in urea blood levels, a continuous variable, increases the chances of death by 1% (*OR* = 1.01; *95%CI*: 1,002; 1.02). (Table 3)

Table 3. Simple or multiple logistic regression models and respective Odds-Ratio for prediction of death in the intensive care unit (ICU) in patients admitted in mechanical ventilation at least 48 hours in one ICU.

Mi	Trait or constant	*Bi*		*SE Bi*	*Wald*	*p*	OR	LL	UL
M1	Constant	B_0	-0.73	0.99	0.54	0.462	0.48		
	NAS-ad	B_1	0.003	0.02	0.03	0.853	1.00	0.97	1.04
M2	Constant	B_0	-2.58	0.71	13.13	<0.001	0.08		
	SAPS3	B_1	0.03	0.01	8.70	0.003	1.03	1.01	1.05
M3	Constant	B_0	-0.68	0.37	3.44	0.064	0.51		
	APACHEII	B_1	0.01	0.02	0.15	0.699	1.01	0.97	1.04
M4	Constant	B_0	-1.34	0.28	22.08	<0.001	0.26		
	COPD presence	B_1	2.18	0.80	7.31	0.007	8.82	1.82	42.70
	Thyroid problem presence	B_2	1.79	0.84	4.50	0.034	5.98	1.15	31.22
	Urea blood level	B_3	0.01	0.00	6.25	0.012	1.01	1.002	1.02

Legend: *Mi*: *i-th* model; M1: Admission Nursing workload; M2: Mortality predictor 1, SAPS3; M3: Mortality predictor 2, APACHEII; M4: SAPS3 plus some additional admission variables; COPD: Chronic obstructive pulmonary disease; NAS-ad: NAS of admission; *Bi*: *i-th* estimate of model parameters, *SE Bi*: standard error of *Bi* estimate, *OR* = Odds-Ratio; Wald: Wald Test Chi-Square Statistic; *p*: probability based on the Wald test, LL and UL: lower and upper limit, respectively, of the Odds-Ratio 95% confidence interval. In all models, n failure = 123 discharges and n success = 71 deaths in ICU.

The predictive capacity of the models was tested by likelihood ratio test. For the APACHEII and NAS-ad in the simple logistic regression models the hypothesis that all logistic regression coefficients are null was not rejected ($p > 0.05$). While for SAPS3 and model M4, the null hypothesis was, and then these models were able to predict mortality in the ICU, that is, they contribute to improve the quality of predictions for the estimated model (Table 4). The Hosmer and Lemeshow Test show that all models no show significant differences between the results predicted by the model and those observed indicated that the predicted values and could be used ($p > 0.05$; Table 5). Despite this, the R^2 were lower than 0.17 for model 1 to 4, showing low fit in most tested models, which indicates that they should be used with caution for future prediction. All proposed models were more efficient in identifying patients who discharged from the ICU, with a percentage of hit to discharge between 0.919 and 1.000. When we evaluated the probability of hit to death, the models showed low probability of hit, ranging from < 0.001 to 0.296. The multiple model, M4 was the best for predicting patients who died in the ICU (Table 4).

In all situations evaluated in model 4, the presence of chronic obstructive pulmonary disease associated with the presence of thyrodopathies is the worst-case scenario for the patient. And regardless of these, the increased concentration of urea in the blood worsens the prognosis of the patient in ICU. (Figure 1).

Table 4. Quality and adjustment measurements of some logistic regression models for the prediction of death in the intensive care unit (ICU) patients admitted on mechanical ventilation at least 48 hours.

Model	R^2	Likelihood Ratio Test			Hosmer and Lemeshow Test			Probability of hit		
		X^2	*d.f.*	*P*	X^2	*d.f.*	*P*	Discharge	Death	Both
M1	<0.001	0.03	1	0.853	2.370	7	0.937	1.000	<0.001	0.634
M2	0.064	9.26	1	0.002	6.990	8	0.538	0.919	0.141	0.634
M3	0.001	0.15	1	0.699	4.610	8	0.798	1.000	<0.001	0.634
M4	0.162	24.52	3	<0.001	1.99	8	0.981	0.951	0.296	0.711

Legend: M1: Model 1 for admission workload measured by NAS (Nursing Activities Score), *d.f.*: degrees of freedom; M2: Model 2 for SAPS3; M3: Model 3 for APACHEII; M4: Model 4 for SAPS3 plus additional admission variables; X^2: Chi-square statistics; *p*: probability; R^2: Nagelkerke coefficient of determination.

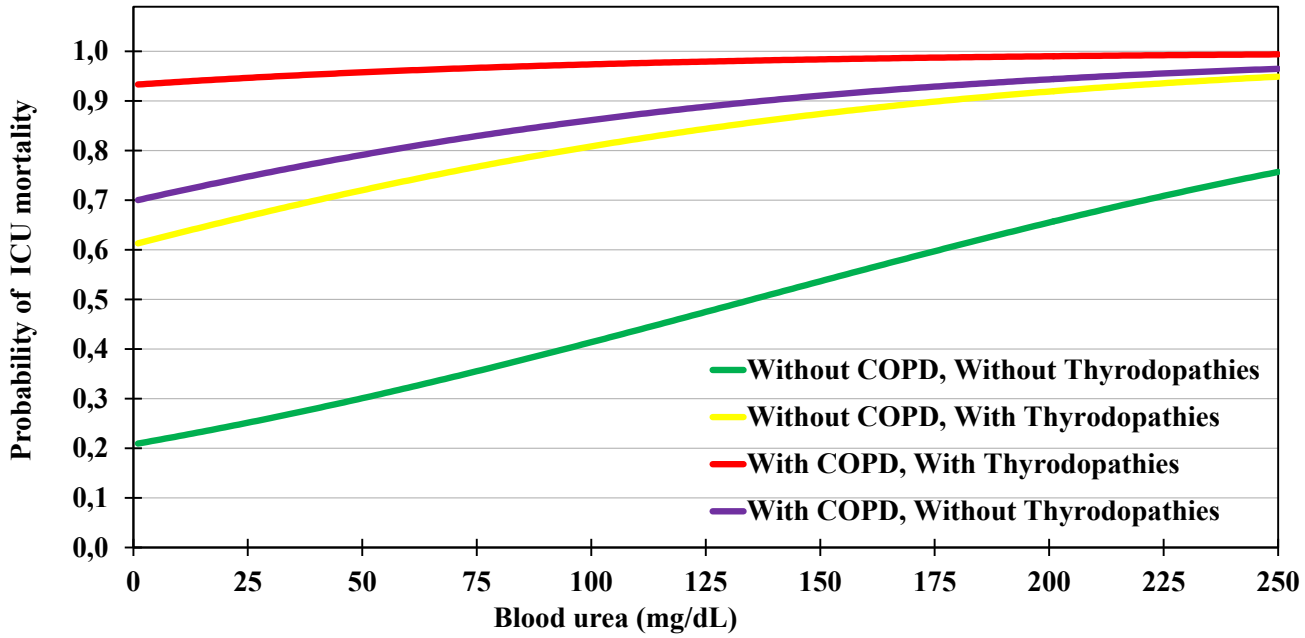

Figure 1. Expected probability of mortality in the Intensive Care Unit (ICU) in patients admitted in mechanical ventilation at least 48 hours, obtained by multiple logistic regression model for the four fixed possible scenarios of presence and absence of obstructive pulmonary disease and thyroid diseases, and oscillating blood urea levels.

4. Discussion

There is a predominance of middle-aged men with a significant percentage of admissions for trauma resulting from accidents. The profile of the patients was similar to other ICUs, and a discussion of the profile of the patients can be seen in detail in GOMES et al. (2019, 2020).

Although we did not observe an effect of NAS alone on ICU mortality, a higher workload measured by NAS has been associated with a higher incidence of VAP and other infections related to health care

(NOGUEIRA et al., 2017; GOMES et al., 2019) and even associated with a higher risk or mortality rate (MARGADANT et al., 2019). Regarding mortality, the NAS has also shown a positive correlation with APACHEII (NOGUEIRA et al., 2007), a correlation not observed here between the NAS and the two predictors of mortality. GOMES et al. (2019) describes that NAS-ad was a predictor for the occurrence of VAP in this same population, with higher risk of VAP in patients with higher NAS-ad, and who did not have adequately offered the workload during hospitalization. The Nursing workload during hospitalization is probably a better predictor for outcomes than only the value observed at admission, and further studies are still needed.

There are not many options available for the direct measurement of the workload dispensed to a patient for other health professionals than Nursing, which hinders its inclusion in studies that assess its impact on the patient. Nevertheless, its impact is noticeable in the results of care, as perceived by physicians (MICHTALIK et al., 2013). Most of the time, this workload is measured by the ratio of the number of professionals in each category by the number of beds in the unit or number of patients attended, which allows only unit-level analyses and ecological studies.

APACHEII did not show predictive capacity for ICU mortality, as observed in other studies (OLIVEIRA et al., 2010; LENTSCK et al., 2020). In neurological ICU patients, it has been associated with the ability to predict healthcare associated infections and the time of devices use (LI et al., 2014), which is indirectly associated with higher mortality and increased hospital costs. APACHEII's low predictive capacity may be related to its validation exclusively in the U.S. population, which may restrict its applicability in other populations (MORENO & NASSAR JR, 2017), or even subpopulations as observed in ours. While this, SAPS3 is valid in the Brazilian population of surgical patients (SILVA JUNIOR et al., 2010) or even in adult ICUs (ARÊA LEÃO et al., 2018), being useful to indicate severe patients and determine greater care in this group. Predictors of mortality may be dependent on the studied group, for example, neurological patients in the same unit evaluated here had good predictive capacity of SAPS3 for mortality (COSTA, 2020).

The use of these indicators can also be influenced by the administrative choice of the unit and have no relation to a group or to the profile of the unit. The choice between the two indicators is more due to the ease of use of one or the other or even the familiarity of the doctor with their use (SOARES & DONGELMANS 2017). Such situations make it difficult to compare them, since most units only calculate one, and not always the information for calculating both is available in the medical records.

Although we observed that the admission variables are more important than predictors of mortality, these results have not been constant in the literature. COSTA (2020) observed that the variables NAS-ad, SAPS3 and the presence of diabetes mellitus are admission variables that were associated with higher risk of mortality in neurological patients in the same unit evaluated by us. The presence of COPD has also been observed as a risk factor for death in elderly ICU patients, along with the concomitant use of SAPS3 and APACHEII. In this study, the mean blood pressure was also a predictor of mortality (LUCENA et al., 2019). PERES et al., (2015) also found urea levels as a predictor for ICU death in patients and the APACHEII predictor did not remain in the significant multiple model. Acute kidney injury is also common after major traumas, and is associated with increased mortality in critically ill patients (HAINES et al. 2019). Patients with acute kidney injury diagnosed by increased serum creatinine had a higher risk

of hospital mortality after non-cardiac surgery, accompanied by several aggravated short-term outcomes and higher total medical costs (XIE et al. 2020). Thyroid hormone dysfunctions and or levels associated with the APACHEII mortality predictor have also been associated with increased probability of predicting the mortality of ICU patients (WANG et al., 2012; GUTHC et al., 2018; MOHAMMED et al., 2020).

It is evident that each patient population may present different predictor variables and indicators for mortality and health care requirements even within the same unit or between different services. It is important to note that, in the literature, we observed several proposals for the inclusion of variables and or approaches for predicting mortality, reinforcing the need to improve existing predictors. Even these variables can be better predictors than the indicators already validated, as we observed. We can highlight, for example, the inclusion of variables related to nutritional status (KATO et al., 2020), not evaluated by us. For the population of patients admitted to mechanical ventilation, there is still a need to evaluate other possibilities of predictors, especially those related to hospitalization. Here, we will not explore the causal relationships of the presence of COPD, thyrodopathies and level of urea in the blood have with mortality, since the design and objective of the study were not to show these causes, but to look for new risk factors for mortality in this population. Other studies need to explore how these risk factors act in these patients and demonstrate their causal relationship or not. Eventually, the inclusion of other variables in the models could change the efficiency of the two predictors evaluated here, like the axillary temperature that differed in both groups. One study suggests that increased body temperature in patients seen in the Emergency Services and ICU is associated with lower mortality in patients with sepsis and fever was associated with a better quality of care (INGHAMMAR & SUNDEN-CULLBERG 2020), perhaps because it serves as a warning sign. Note that this variable was not included in our model by its use in SAPS3.

Our models obtained low ability to determine ICU death, with intermediate determination coefficients. GOMES (2018) obtained Nagelkerke coefficient of determination values higher than 0.700 for the prediction of VAP in this same population. While studies for mortality prediction have observed lower values, and for trauma victims, values of 0.253 (OLIVEIRA, 2020) and models applied to critically ill patients with acute renal failure obtained 0.585 (SOUZA et al., 2014). These low values may reflect the greater difficulty of knowing all predictors of mortality, but reference values are not stipulated or are not yet available by all studies, making generalizations on the quality of adjustments difficult. Another possibility is the need to evaluate other independent variables that are more efficient in discriminating patients who die in the ICU.

As a limitation of the study, we have the data from a single ICU, with restricted number of patients and large losses of variables, which did not allow the inclusion of a large quantity of predictor variables and generalizations of the results obtained for other scenarios. More recent studies have used extensive databases with large samples to construct these relationships and models. NEEDLEMAN et al. (2020) evaluated 78303 admissions to evaluate the association of Nursing dimensioning and patient mortality. NOGUEIRA et al. (2017) included 1,717 subjects to evaluate the impact of Nursing workload on care and on some outcomes in Brazilian ICUs. KÜNG et al. (2019), working in a much more restrictive scenario that is Neonatology, included 908 research subjects. BRUYNEEL et al. (2019) included 3,377 subjects to evaluate the NAS and the patient nurse ratio in hospitals in Belgium. It is evident the need to

expand the database for greater generalizations and proposition of a predictive model that can be applied in other realities. Another limitation is the high loss of data and variables from data collection, although the low quality healthcare records, for example of Nursing, are common even in ICUs (ANTUNES et al. 2018).

5. Conclusion.

We conclude that nursing workload measured by NAS at admission and APACHEII predictor are not predictors for ICU mortality for patients admitted on mechanical ventilation for at least 48 hours. Only the SAPS3 predictor alone is significant. And from the multiple logistic model we demonstrated that the presence of COPD, the presence of thyroid diseases and the increase in the blood urea level are the only risk factors for ICU mortality identified. In addition, these risk factors observed in the multiple model were more effective in predicting than SAPS3, reinforcing the need to assess predictors of mortality in specific patient populations.

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THE POLICE POWER OF THE BRAZILIAN ARMY:

Prevention and repression operations in border areas in the State of Rondônia

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ABSTRACT

This work deals with the legal frameworks that manage the exercise of the police power granted to the Armed Forces, addressing the attributions and situations in which they can be employed. The legal provisions are found in the legal system in force, among the precursors the complementary laws of n. 97/1999, n. 117/2004 and n. 136/2010, which brought significant changes in the general rules for the

organization, preparation and employment of the Armed Forces. The basis of this work is the study of the use of the Brazilian Army in law and order guarantee operations, as well as ensuring Brazilian territorial sovereignty. The activities called patrolling and policing operations in the border area of the Brazilian territory are exposed throughout the work. Such activities are subsidiary duties conferred by the Armed Forces. At first, a brief exposition will be made of the legal and doctrinal foundations that deal with the power of police, distinguishing it in what is the "administrative police power" and "the power of security police", although coming from state power, both have different purposes.

Keywords: Police power, Brazilian Army, Border Patrol, Military Operations, Guarantee of law and order, Subsidiary Assignment.

1. INTRODUCTION

The Federal Constitution of Brazil, the country's basic and supreme law, in article 142, chapter II – Of the Armed Forces, the Navy, the Army and Aeronautics specifies the Armed Forces, which has a permanent and regular character, organized in a hierarchical and disciplined manner, with the purpose of defending the Homeland and guaranteeing constitutional powers, having as supreme authority the President of the Republic.

The Armed Forces, acting in a subsidiary manner, in the actions of law and order guarantee operations, together with the public security agencies. Observing the territorial extensions and the need to maintain national security, the State began to delegate attributions to the Armed Forces so that they can act in operations according to legality.

This dual constitutional mission must be analyzed based on the concept of national security, since the first refers to external security and the second refers to the internal security of the country. Decree No. 5,484 of June 30, 2005, promulgated the National Defense Policy, adopted the following concepts: "Security is the condition that *allows the country to preserve sovereignty and territorial integrity, to carry out its national interests, free from pressures and threats of any kind, and to guarantee citizens the exercise of constitutional rights and duties";* whereas by National Defense it is conceptualized *as being "the set of measures and actions of the State, with emphasis on military expression, for the defense of territory, sovereignty and national interests against preponderantly external, potential or manifest threats".*

It is considered that when we provide security to society, we reduce the chances of using the necessary elements to ensure defenses as a means of repression of an attack. It is up to the Armed Forces to ensure the maintenance of constitutional powers, bases of the democratic rule of law, and to comply responsibly with the maintenance of national security in an integral way in the external and internal spheres.

As a means of promoting effective public security the State has created different bodies to carry out this activity, so the Major Charter, in the following sections of art. 144, provides that: the federal police, federal highway police, federal railway police, civil police and military police and military fire brigades will act as responsible for preserving public order and the safety of people and property , provided citizens with security to exercise their constitutional rights and duties. The bodies responsible for public security are divided into: administrative police, aimed at the protection of freedom and property; and in security police,

which is subdivided into two categories: ostentatious police, which was given the task of avoiding damage and dangers caused by human beings, as well as diminishing them, and the judicial police, which has as competence the investigative services related to criminal offenses, to provide satisfactorily to the Public Prosecutor's Office, essential elements to make criminal actions of their jurisdiction.

According to the teachings of The Minister of the Supreme Federal Court Gilmar Ferreira Mendes, who at the time of the publication of opinion no. 025 of August 10, 2001, published in the Official Gazette n. 154.de August 13, 2001, when he held the position of Advocate General of the Union, conceptualized the meanings of the terms: Maintenance of Public Order, as being "the dynamic exercise of the Power of Police, in the field of public *security, manifested by predominantly ostentatious actions, aiming to prevent, deter, restrain or suppress events that violate public*order publicorder"; and Public Order as:

"Set of formal rules, which emanated from the legal system of the nation, having as scope to regulate social relations of all levels, of the public interest, establishing a climate of harmonious and peaceful coexistence, supervised by the Police Power, and constituting a situation or condition that leads to the common good".

In this way, we can analyze that the competence for the conservation of public order lies with the police, who use ostentatious actions, with the purpose of preventing, deterring, preventing and suppressing activities that violate public order. It is observed that the Armed Forces incubate such attributions only in exceptional situations, according to the understanding of the Former Minister of the Supreme Federal Court Gilmar Ferreira Mendes, in opinion n. GM - 025, when addressing the theme:

The use, emergency and temporary, of the Armed Forces, in the guarantee of law and order - it was seen - occurs -after exhausted the instruments intended for the preservation of public order and the incolumidade of people and property, related in art. 144 of the Federal Constitution- (cf. Complementary Law No. 97 of 1 999, art. 15, § 2). In other words: the alluded use of the Armed Forces aims at preserving (or restoring) public order, including ensuring the incolumidade of people and property (public, and private). And the enhanced preservation (or reinstatement) is the competence of the Military Police, under the Terms of the Major Law.

In such situations, therefore, the Armed Forces, because they are responsible (emergency and temporarily) of the preservation, or re-establishment, of public order, must play the role of military police, have the duty to exercise - at every step, as if necessary - the competence of the Military Police. Certainly, under the terms and limits that the Constitution and the laws impose on the Military Police itself (see, for example, art. 5 of the Charter, the items: II; III, final part; XI and XVI).

In an exhibition at the Symposium that had as its theme "The Armed Forces and Public Security" Mr. Márcio Thomaz Bastos, Former Minister of Justice, evaluated Decree No. 3,897 of August 24, 2001, which sets out the guidelines for the use of the Armed Forces in the guarantee of law and order, and provides other measures, in the following terms:

According to the legal text, the military forces that assume the function of guarantors of the internal order become responsible whenever necessary for the actions of ostentatious, preventive and repressive policing, of original responsibility of the military police. It is worth noting that, once this responsibility is assumed, they must always be in accordance with the terms and limits imposed on the police by the legal system. The avocation of the prerogative of guarantor of internal security must also respond to an emergency request and, therefore, always be temporally limited and territorially specified. Decree No. 3,897 determines that we can only consider exhausted the means provided for in art. 144 – the guarantee of internal public order by the state police

and the Federal Police – when, at a certain time, the staff of security institutions are unavailable, nonexistent or insufficient to the regular performance of their constitutional mission.

It becomes evident the existence of legal provision for the action of the Armed Forces together with the public security agencies, in order to defend the interests of the State. We should mention that the meaning of the non-existent term used in the cited text refers to regions in which public security agencies are not present or if present have an effective amount smaller than that necessary for the appropriate operational provision, as is the case in several areas of the Amazon region. It is emphasized that the performance of the safety agencies requires operational capacity that consists of specific personnel, material and training to deal with adverse situations of the daily routine to which many are inserted. If there are security agencies, the Armed Forces will act in accordance with Article 4 of Decree No. 3,897/01:

In the employment situation of the Armed Forces object of Art. 3 o , if insufficient means are available of the respective Military Police, this, with the consent of the Governor of the State, will act, partially or totally, under the operational control of the military command responsible for operations, whenever so require, or recommend, the situations to be faced.

§ 1- The operational control is the authority that is conferred, to a military commander or chief, to assign and coordinate specific missions or tasks to be performed by police officers under this degree of control, in such authority not including, in principle, disciplinary and logistical matters

Some military units located in the Amazon border areas are the only representatives of the State in the area of security, allowing them to act in accordance with LC no. 117/04, operating in the repression of cross-border offenses.

This confluence of responsibility in the sphere of public security has raised questions about the limit of the police power that members of the Armed Forces have for the execution of Law and Order Guarantee missions, in addition to the subsidiary competencies provided for by law, such as air, sea and land patrols. Determined the mission imposed on the Armed Forces in the Federal Constitution, the National Congress sought to promote its standardization regarding preparation and employment, which took place through Complementary Law No. 97 of June 9, 1999, which provides for general rules for the organization, preparation and employment of the Armed Forces, currently in force, its implementation repealed Complementary Law No. 69 of November 19, 1990, two other laws were enacted to promote necessary changes on the provisions of the general norms: Complementary Law No. 117, of September 2, 2004 and Complementary Law No. 136, of August 25, 2010.

These changes inserted by complementary laws cause ambiguities as to the understanding of matter. The modifications produced by Complementary Law No. 97/99 sought, among other purposes, to specify the use of the military's police power in law and order guarantee operations, in the subsidising actions of repression and prevention of cross-border and environmental crimes, as listed in articles 15 and 16 of LC no. 97/99, modified by LC no. 136/2010.

The term police power is not mentioned in LC no. 97/99, although this power is intrinsic to the operations defined in it and conferred on members of the Armed Forces. The power of police according to a brief analysis of Article 78 of the National Tax Code is the discretionary power available to the Public Administration, to impose the way the use and enjoyment of each individual's goods and rights should be carried out, prioritizing

the collectivity and interest of the State. It is characterized by determining a certain limitation to the essential rights and freedom, aiming at the rights of the collective. It is a power for the implementation of state-run activities.

With regard to border areas, the implementation of the law has brought great contributions, such as the cooperation of civil and military authorities for the elaboration of specific legislation snaantis that establish standards of conduct. However, when taking charge of a Law and Order Guarantee operation, the law requires that the person responsible for the public security agency surrenders operational control to the federal military commander along with all the powers indispensable for the success of the necessary missions and activities. Given this event we can say that the delegation of the police power has been made explicitly.

If the duties of the Armed Forces in a Law and Order Guarantee operation are arranged, we find that not only sporadic public security actions are employed, but are also used in actions to prevent and repression of transnational and environmental crimes.

Considering the proposal of the article, we focus on the actions and operations carried out by the Brazilian Army, which acts as subsidiary with the security agencies, whenever necessary and requested. In the field of research we are found in the scope of Administrative Law, Constitutional Law, Criminal Law, Criminal Procedure Law, Military Criminal Law, Military Criminal Procedure Law,

The main purpose of this project and to resolve doubts about the activities performed by the Brazilian Army through its Police Power, acting as a subsidiary force. Considering the national territorial extension, and an insufficient number of federal agents (Federal Police), whose competence and migration control, border surveillance and the fight against transactional crimes.

The increasing participation of the Armed Forces in public security, with predominant actions in border areas, in the execution of prevention and repression operations, has raised questions regarding its police power to ensure law and order.

With regard to the legal system, the powers exercised by the Armed Forces have a legal basis, grounds in the Federal Constitution, as well as specific legislation. However, there is the question, is there a limit in the performance of the police power employed by the Armed Forces?

Considering the territorial extension of Brazil, as well as its border area, it is evident the fragility in the protection of border areas. The State does not have sufficient quantitative security agencies to ensure the execution of crime prevention and repression activities in these areas, with this in recent years the Armed Forces have been granted several attributions for its performance as a subsidiary force in places and situations that require a technical device and effective coercive attitude.

As in the entire legal system the action of the Armed Forces must be based on the legality and limits imposed in specific laws and in the Federal Constitution, due to the emergence of some inquiries, this work will seek in a way that raises them through the approach of legal provisions.

2. Limits and Borders - Federative Republic of Brazil

The concept of frontier is not something finished, since it has been building and adapting throughout history. However, the idea of concept that we know today is based on the formation of the Nation State,

especially with regard to the post-French Revolution, when the feeling of fidelity and nationalism was founded. We can say that this conceptual evolution did not happen. According to the ideas contained in the work entitled The Origin and Evolution of Frontier Theory, MATTOS, 1990, p. 15, we have the following understanding:

Each nation state cultivates the sense of sovereignty. The possession of the national territory, its defense, becomes the sacred duty of the citizen. The delimitation of territorial rights becomes imperative. The border acquires exceptional importance – it is the limit of national sovereignty.

Once the concept of national states, the border, is consolidated, it is emphasized that there is a difference in the line and border strip, while one refers to the dividing line between two countries from an established landmark or a geographical landmark (river, lake, mountain, forest, etc.), the other refers to an area that extends within the territorial space , crossing the border established and entered within the state, "The range of up to one hundred and fifty kilometers wide, along the land borders, designated as a border strip, is considered fundamental for the defense of the national territory, and its occupation and use will be regulated by law", according to § 2, Article 20, of the Constitution of the Federative Republic of Brazil.

Border areas have become vulnerable and extremely important regions, because it is in these regions that there is contact between sovereign rights of states. The frontier began to be analyzed from the perspective of another category: that of *territory,*which accordingto the definition of the geographer Bertha Becker, is confronted with the concept of Geopolitics: "it is a field of knowledge that analyzes relations between power and geographical space." (BECKER, 2005: 71).

Based on the constitutional definition of land border strip (Art. 20, §2, of the Federal Constitution of 1988), we can obtain the following information: *extension of the strip* - up to 150 km wide, along the land borders; *purpose - defense* of the national territory. Stabilizing understanding and concern with the border region, the National Defense Policy (PDN **(**Decree No. 5,484, of June 30, 2005), sets out:

Defense planning includes all regions and, in particular, vital areas where the greatest concentration of political and economic power is found. In addition, it prioritizes the Amazon and the South Atlantic for the wealth of resources and vulnerability of access across land and sea borders.

The National Defense Strategy (END) refers to this question about national territorial limits, when it inserted in its guidelines: Deter the concentration of hostile forces at land borders and at the limits of Brazilian jurisdictional waters, and prevent them from using national airspace. The following is a table to demonstrate the extent of Brazil's border limits with its border countries:

Table 1. Physical characteristics of Brazil's border limits

Country	TOTAL (KM)	DRY LINE	RIVERS, LAGOS AND CANALS	Frames
French Guina	730	303	427	10
Suriname	593	593	_	60
Guiana	1.606	908	698	134
Venezuela	2.199	2.199	_	2.682

Colombia	1.644	835	809	128
Peru	2.995	992	2.003	86
Bolivia	3.423	751	2.672	438
Paraguayan	1.366	437	929	910
Argentina	1.261	25	1.236	310
Uruguay	1.069	320	749	1.174
TOTAL	**16.886**	**7.363**	**9.523**	**5.932**

Source: BRAZIL. Ministry of Foreign Affairs, 1999. In. BARCELLOS *et. al*., 2001 *apud* ABREU, 2008.

3. THE DEFENSE OF THE HOMELAND, THE CONSTITUTIONAL POWERS AND THE LAW AND THE ORDER IN THE FEDERAL CONSTITUTIONS

3.1 The Police Power assigned to the Armed Forces in the Federal Constitutions

Over the centuries there have been significant changes that have altered historical contexts and contributed to the drafting of constitutional charters. In an in-depth study it is possible to realize that there were limitations, restrictions of rights, freedoms, as well as so many other events, however in a brief approach we can see that the constitutional mission of the Armed Forces in our country was present in all our Constitutions, some brought few changes and others did not change in almost nothing. In all of them was assigned the Armed Forces the Defense of the Homeland, the Constitutional Powers and the Law and Order, as we can analyze below.

The Constitution of 1824, known as the Political Constitution of the Empire of Brazil, among all was the one that remained in force the most, had in its creation French influence, its marks are administrative and political centralism, having the figure of the Moderator Power. It provides in its article 148, *"The Executive Branch is privately responsible for employing the Armed Force of Sea, and Earth, as it seems convenient to* the *Security, and defense of the Imperio"*.

Next we have the Constitution of 1891, which was given as rapporteur Senator Rui Barbosa, and suffered great influence from the U.S. Constitution, consecrated the system of presidential government, the form of federal state. Such was the influence that the name given to Brazil in the Constitution of 1891, was the United States of Brazil. In your text we can find the following layout:

"Art. 14 - The forces of land and sea are permanent national institutions, aimed at the defense of the Homeland abroad and the maintenance of laws in the interior. Armed force is essentially obedient, within the limits of the law, to its hierarchical superiors and obliged to sustain constitutional institutions."

As a result of the economic crisis of 1929, several social movements emerged that pushed for better working conditions, on July 16, 1934, the third Constitution was promulgated. According to his preamble his creation was *"to organize a democratic regime that guarantees the nation unity, freedom, justice and social and economic well-being"*. Becoming the one that stayed in effect the least, only three years. The 1934 Constitution was strongly influenced by the Weimer Constitution of Germany of 1919. The mention of the Armed Forces is given in Article 162 "*The armed forces are permanent national institutions, and,*

within the law, essentially obedient to their superiors. They are intended to defend the homeland and secure the constitutional powers, and order andlaw."

The Constitution of 1937 was promulgated in the midst of a political context marked by the antagonism between the fascist right – Brazilian Integralist Action, which defended an authoritarian state and the leftist movement with socialist, communist and union ideals – The National Liberating Alliance. It became known as "The Polish", for having been based on the authoritarian constitution of Poland. With regard to the defense of the state we can mention:

"Art. 166 - In the event of external threat or imminent internal disturbances or existences of concert, plan or conspiracy, aimed at disturbing public peace or endangering the structure of the institutions, the security of the State or citizens,the President of the Republic may declare throughoutthe territory of the country, or in the part of the territory particularly threatened, the state of emergency. As long as it becomes necessary to use the armed forces for the defense of the State,the President of the Republic shall declare throughout the national territory or in part of it the state of war."

In the midst of World War II, the Government of Brazil assumed to be an ally of the "Allies" and against the "Axis" countries, faced with such an attitude Getúlio Vargas lost the support of Minas Gerais, since when entering the War aiming to eliminate nazifascist dictatorships it was understood that fascism would be eliminated in Brazil, because it would not be permissible to have an internal policy with a Constitution based on fascism and externally fight against the regime. On February 1, 1946, the Constituent Assembly was established, which originated a text signed in liberal ideals and social ideals as in the old Constitutions, beginning the so-called redemocratization of the country, moving away from the totalitarian state. Again we can see in the constitutional text the attributions of the *Armed Forces "Art. 177 - The armed forces are intended* to defend the Homeland and to guarantee constitutional *powers, law andorder."*

Following the same line of creation of the 1937 Constitution, the 1967 Constitution concentrated power at the federal level, conferring broad powers on the President of the Republic. As for the duties of the Armed Forces:

"*Art. 92 - The armed forces, constituted by the Navy of War, Army and Military Aeronautics, are national institutions, permanent and regular, organized on the basis of hierarchy and discipline, under the supreme authority of the President of the Republic and within the limits of the law.*

§ 1 - The armed forces are intended to defend the Homeland and to guarantee the powers constituted, law and order."

The 1969 Constitution (Constitutional Amendment No. 1, of October 1, 1969, which amended the entire 1967*Constitution),* was not signed by the then President of the Republic Costa e Silva, as it was in health care. Its text contains in article 91 *"Armed Forces, essential to the implementation of national security policy, are intended for the* defense of the Homeland and the guarantee of the constituted *podêres, law andorder."*

On October 5, 1988, the Constitution of the Federative Republic of Brazil was promulgated, based on ensuring different constitutional guarantees, sought to provide greater effectiveness to fundamental rights, allowing the participation of the Judiciary whenever there is injury or threat to the injury to rights. Again this listed in his articles the attributions of the Armed Forces:

"Art. 142. The Armed Forces, constituted by the Navy, the Army and the Air Force, are permanent and regular national institutions, organized on the basis of hierarchy and discipline, under the supreme authority of the President of the Republic, and

are intended for the defense of the Fatherland, the guarantee of constitutional powers and, on the initiativeof any of these, of law andorder."

Regardless of the reasons that have resulted in constitutional changes over the years, the concern in ensuring national defense is noticeable, promoting means that seek to effect such constitutional attributions, and it is up to the Armed Forces to guarantee law and order.

In the article entitled "Power of Police and National Security", Hely Lopes Meirelles, carried out an evaluation of the right and duty of self-defense of the State:

The defense of the homeland, the preservation of institutions, the protection of the citizen is the right and duty of the State. No nation can survive independently, if it is not recognized as the prerogative to defend, with power and force, if necessary, its territory, its people, its political regime and its constitutional system, against the violence of the nonconforming minors and the attack of ideologies contrary to the current legal order.

The defense of the homeland involves activities that aim at preserving, maintaining territorial integrity, sovereignty and national independence. Preventive actions to defend the territory are based on the valorization of diplomatic actions as the first requirement to be adopted for the resolution of conflicts. We can divide combat actions as follows: offensive and defensive actions, which will be addressed later. It is reiterated that the competence to guarantee constitutional powers are exclusive activities of the Armed Forces.

3.1.1 Armed Forces

The Army, Navy and Air Force form the Brazilian Armed Forces. They are responsible for ensuring the integrity of the national territory; defend Brazilian natural, industrial and technological interests and resources; protect the country's citizens and property; and ensure the sovereignty of the nation.

a) Brazilian Navy

The Brazilian Navy has been operating in the defense of national sea and river waters since the 18th century, during the colonial period.

According to IBGE data, published in DOU no. 124 of 06/30/2017, the surface of Brazil has an approximate value of 8,515,759,090 km2. It has the largest watershed on the planet, with 4.5 million km² of maritime area and a coastline of 7,400 kilometers long.

It is up to the Navy to execute a broad strategy and control for the protection and defense of the country, as well as to improve knowledge about the maritime environment and to relocate the operational means available to immediately counter the occasional crises or emergencies in the Brazilian territorial sea. Brazilian Jurisdictional Waters (AJB) are considered, those listed in Art. 20, III and VI of the Federal Constitution, and mentioned in Decree No. 4,136/02 that regulated Law No. 9,966/00.

Art. 20. They are union assets:

(...)

III - lakes, rivers and any streams of water on land within their domain, or which bathe more than one State, serve as limits with other countries, or extend to foreign territory or come from it, as well as marginal land and river beaches;

(...)

VI - the territorial sea

The use of the Brazilian Navy, in a subsidiary way, is provided for in Art. 17 of LC no. 97/99, as a means of cooperation with federal agencies, in crimes of wide repercussion, national or international. In such a way, the article in question establishes:

Art. 17. It is up to the Navy, as private subsidiary assignments:

(...)

V – cooperate with federal agencies, when necessary, in the repression of crimes of national or international repercussion, regarding the use of the sea, inland waters and port areas, in the form of logistical support, intelligence, communications and instruction.

Taking as a reference point the Cape Orange, on the coast of Amapá to the Arroio Chuí, on the border between Brazil (Rio Grande do Sul) and Uruguay, Brazil has a total area of 7,408 kilometers bathed by the Atlantic Ocean.

However, if the overhangs are considered: beaches, dunes, reefs, mangrove islands, bays, cliffs, among other areas, this extension rises to the number of 9,198 kilometers.

Performed adistribution, considering the extensions by state, the percentage over the total, ordering by the size of the coastal strip, we have the following order:

Table two. Extension of the coastal strip by region

EXTENSION/REGION	AREA (KM)	Percentage
Bahia	932 km	12,4%
Maranhão	640 km	8,7%
Rio de Janeiro	636 km	8,6%
Rio Grande do Sul	622 km	8,5%
Sao Paulo	622 km	8,5%
Amapá	598 km	8,1%
Ceará	573 km	7,8%
Stop	562 km	7,6%
Santa Catarina	531 km	7,2%
Rio Grande do Norte	410 km	5,7%
Holy Spirit	392 km	5,3%
Alagoas	229 km	3,1%
Pernambuco - 2.5%	187 km	2,5%
Sergipe	163 km	2,2%
Paraiba	117 km	1,6%
Paraná	98 km	1,3%
Piauí	66 km	0,9%
TOTAL	**7.367 km**	**100%**

Source: elaborated from research data.

Given the coastal areas corresponding to the Brazilian state, we have a notion of which the brazilian navy's operation is important and necessary. In such a way that in 1955, law no. 2,419/1955 was established by Law No. 2,419/1955, the Coastal Patrol, known as PATCOS, subsequently regulated by Decree no. 64.063/1969, this legislation lasted until the edition of LC no. 97/99, after a few years it became evident the need to create mechanisms that would suit and meet the new reality, thus giving rise to the edition of Decree No. 5,129/2004, which came to designate the old service by the new naval patrol nomenclature, PATNAV.

The Brazilian Navy pioneered preventive and repressive patrol actions, invested by constitutional powers, police power, and respecting legal limits, and began to carry out the necessary actions to protect our waters from international attacks and national actions that contravene established legal norms. According to Ordinance 018/2000 of the DPC - Manual of the Naval Inspector, we have the following concept of Patrol executed by the Navy:

Naval Patrol "Activity conducted by naval and air means, with the purpose of supervising and implementing national legislation in the AJB. Control the maritime areas under Brazilian jurisdiction with regard to the innocent passage of merchant ships and the transit and transit of warships and compliance with Brazilian legislation; cooperate with services aimed at monitoring the preservation of sea resources and inland waters, and; cooperate with the services of repression of smuggling, the way of trafficking and the illicit trade. Action in case of flagrante de (Ordinance 018/2000 of the DPC - Manual of the Naval Inspector).

To improve the understanding I note an excerpt from the Instruction Letter of PATNAV/Command of Marine Operations n. 003/09:

PATNAV and the Police Power: PATNAV is recognized the necessary administrative police power to fulfill the subsidiary attributions determined by the Supplementary Law in reference. It cannot be accepted the existence of a power to "implement and supervise compliance with laws and regulations, at sea and in the inland waters, in coordination with other organs of the Executive Power, federal or state, when necessary, due to specific competences" (Art. 17, item IV), without the consideration of the tacit authorization to adopt measures, which the result of the inspection indicates. This understanding is corroborated by the document in reference l, in which the Deputy Legal Consultancy of the Navy Command (CJACM) expressed favorably that the ship in PATNAV **may "exercise and develop law enforcement activities, which are characterized as**administrative police power and are implemented in the inhibition of unlawful conduct that relates to the occurrence of rights that may occur in Brazilian jurisdictional waters and on the highseas." (my griffin)

b) Brazilian Air Force

It was in 1941, during World War II, that the Brazilian Air Force (FAB) was created. Through the gathering of equipment and personnel from the Navy, the Army and the now defunct Department of Civil Aviation (DAC), the Ministry of Aeronautics was established, with the FAB having its main support.

The Brazilian Air Force, as well as the other members of the Armed Forces, has as its subsidiary mission to cooperate with federal institutions in crimes of great national or international repercussion in the form of logistical, intelligence, communications and instruction allocated as provided for in Article 18 of Complementary Law No. 97/99.

Art. 18. It is up to the Aeronautics, as private subsidiary assignments:

(...)

VI – to cooperate with federal agencies, when necessary, in the repression of crimes of national and international repercussion, regarding the use of airspace and airport areas, in the form of logistical, intelligence, communications and instructional support;

(...)

The FAB is responsible for ensuring and maintaining the sovereignty of national airspace, preventing and preventing the practice of acts invasive or opposed to the interests of the country, acting in surveillance, combating crimes involving the trafficking of drugs, weapons, ammunition and illegal passengers at the time the aircraft remains in the airspace, since after landing the action is up to the competent supervisory bodies, as provided for in item VII, of article here:

Art. 18. It is up to the Aeronautics, as private subsidiary assignments:

(...)

VII – to act, continuously and permanently, through the actions of control of Brazilian airspace, against all types of illicit air traffic, with emphasis on those involved in the trafficking of drugs, weapons, ammunition and illegal passengers, acting in combined operation with competent inspection bodies, which will be the task of acting after the landing of aircraft involved in illicit air traffic.

(...)

It is noteworthy that both the Brazilian Navy and the Brazilian Air Force did not have police power, being assigned to them through LC n. 136/ 2010, received as attribution the police power to operate against cross-border and environmental crimes in the border strip, a power that was previously delegated only to the Brazilian Army. The actions of the Armed Forces will remain carried out in the same way that the Army performed, through preventive and repressive actions, being allowed to perform several typical police activities, such as: carrying out patrols, magazines of people, vehicles, vessels and aircraft. However, the imputation of combating these crimes was not delegated to the Armed Forces to the detriment of the constitutional attribution of the Federal Police, which has the title to act as a border police, besides having the competence of judicial police exclusive to the Union.

In 2010, with the edition of Complementary Law 136, which modified LC no. 97/99, we noticed the concern of the authorities regarding the international air routes of trafficking became more evident, making more stringent measures could be taken to curb such crimes.

The LC edition. n. 136/2010, modified LC no. 117/2004, which in turn had been created to pacify the controversies about the constitutionality of Law 9.614/98, known as the "Slaughter Law" or "Law of Shooting and Destruction", considered for years as unconstitutional because it was created through ordinary law.

Law 9.614/98 amended Article 303 of the Brazilian Aeronautics Code, and its application was regulated by Decree no. 5,144/2004. Now having the following composition:

Art. 303. The aircraft may be owned by aeronautical, state-owned or Federal Police authorities in the following cases:

I - if you fly in Brazilian airspace with violation of international conventions or acts, or authorizations for this purpose;

II - if, entering Brazilian airspace, disrespect the obligation to land at an international airport;

III - for examination of certificates and other indispensable documents;

IV - to check its cargo in the case of legal restriction (Article 21) or prohibited carrying of equipment (single paragraph of Article 21);

V - for investigation of illicit.

§ 1 ° The aeronautical authority may use the means it deems necessary to compel the aircraft to make the landing at the aerodrome indicated to it.

§ 2 ° Exhausted the legally provided coercive means, the aircraft will be classified as hostile, being subject to the measure of destruction, in the case of the caput items of this article and after authorization of the President of the Republic or authority delegated by him.

§ 3 The authority mentioned in § 1 shall be responsible for its acts when acting with excess power or with an emulator spirit. (Renumbered from § 2 to § 3 with new wording by Law No. 9,614, 1998) *(our* griffin)

To provide greater support for military actions in airspace patrol actions, in a possible trial for unlawful conduct the legislator delegated the Military Justice of the Union the jurisdiction to process and judge the acts committed in compliance with said law.

We note that in Article 9 of the CPM, several modifications have occurred, and the following text is included:

Art. 9 Military crimes are considered in peacetime:

(...)

§ 2 The crimes that this article deals with, when committed against life and committed by military personnel **of the Armed Forces against civilians, will be the competence of the Military Justice of the Union,**if committed in thecontext: (Included by Law No. 13,491, 2017)

I – the fulfilment of tasks established to them by the President of the Republic or by the Minister of State for Defence; (Included in Law No. 13,491, 2017)

II – action involving the security of a military institution or military mission, even if not belligerent; or (Included by Law No. 13,491, 2017)

III – of military activity, peace operation, guarantee of law and order or subsidiary attribution, carried out in accordance with the provisions of art. 142 of the Federal Constitution and in the form of the following legal documents: (Included by Law No. 13,491, 2017)

(...)

a) Law No. 7,565 of December 19, 1986 - Brazilian Aeronautics Code; (Included in Law No. 13,491, 2017). (my griffin)

This modification was well received, since it delegated the specialized justice to the assessment of acts that have specific peculiarities.

c) Brazilian Army

The history of the Army is intertwined with the historical evolution that the country has undergone regarding the creation of its identity. Active throughout the national territory, it has its mission appropriate according to the continental dimensions and geographical spaces to which they are located.

To ensure compliance with its constitutional duties, it maintains an effective of more than 222,000 men and women.

Its activities range from collaboration with the Civil Defense, participating in relief actions and providing assistance to victims of natural disasters, to employment of the means necessary to promote recovery and reconstruction of affected areas.

The PolicePower, assigned to the ArmedForces, needs to be executed based on the state's police power, since it is up to it to the function of distribution and organization of competencies among the security agencies. For a better understanding of what has already been mentioned, it is suggested that you divide the police power of the Armed Forces into two groups: the first that refers to the administrative-military police power and the second that covers the power of the judiciary-military police.

The judiciary-military police power is executed in times of war or peace, considering that the Armed Forces have absolute competence to investigate police-military investigations (MPI), in addition to military crimes. Endowed with a Military Penal Code (CPM), which typify crimes in times of peace (art. 9), as well as those practiced and wartime (art.10º), it also expands the jurisdiction of the Federal Court.

With regard to peacetime performance, similar attributions are considered to be the activities developed by the Civil Police, however they are subject to a procedure established in the Military Criminal Procedure Code (CPPM).

It is noteworthy that it is not absolute the police power attributed to the Armed Forces, regardless of whether it is time for peace or war, it is not allowed to face the individual guarantees predicted in art. 5 of the Federal Constitution/88. We can highlight as fundamental guarantees that must be safeguarded:

"Art. 5 º All are equal before the law, without distinction of any nature, guaranteeing brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, in the following terms:

(...)

II - no one will be obliged to do or fail to do anything but by virtue of law;

III - no one shall be subjected to torture or inotheror or degrading treatment;

(...)

XI - the house is inviolable asylum of the individual, no one can penetrate it without the consent of the resident, except in case of flagrant crime or disaster, or to provide help, or, during the day, by judicial determination;

XII - the confidentiality of correspondence and telegraph communications, data and telephone communications is inviolable, except, in the latter case, by court order, in the cases and in the form that the law lays down for the purposes of criminal investigation or criminal procedural instruction;

(...)

XIV - everyone is guaranteed access to information and the confidentiality of the source is protected, when necessary for professional practice;

XV - is free to locomotion in the national territory in peacetime, and any person, in accordance with the law, enters, remains or leaves him with his property;

XVI - all may meet peacefully, without weapons, in places open to the public, regardless of authorization, provided that they do not attend another meeting previously convened for the same place, being only required prior notice to the competent authority";

It must be said that, in cases of state of defense, of the State of Siege or in which there is a Federal Intervention, the instrument that decrees these situations will bring limitations or reduction of such guarantees, considering the circumstances of time and place.

Also on the state competence to delegate powers, the Armed Forces received administrative powers that form the power of administrative-military police, which originates in special legislation, in the adjustments between art. 142 of cf with LC no. 97/99, and also of LC no. 117/04, which altered LC n. 97/99.

This dichotomy in which the power of police is divided and only to assist in the explanation. In practice there is no way to speak in division, being performed in a unitary way, starting from administrative acts depending on the type of action, omissive or activity, progresses to the field of the judiciary.

4. THE POWER OF POLICE AS A MEANS OF MAINTAINING SECURITY AND DEVELOPMENT

The Federal Constitution of 1988 demonstrates in its article 142, §1, that "Complementary law will establish the general norms to be adopted in the organization, preparation and employment of the Armed Forces". Although, in the year 1999, LC no. 97 was approved, establishing the general standards mentioned above, it was in the year 2004, with LC no. 117, that the EB finally received the attributions of the police power to be exercised in the land border strip:

" It is up to the Army, in addition to other relevant actions, such as private subsidiary attributions: IV – to act, through preventive and repressive actions, in the land border strip, against cross-border and environmental offenses, alone or in coordination with other organs of the Executive Branch, performing, among others, the actions of: a) patrolling; (b) a review of persons, land vehicles, vessels and aircraft; and c) arrests in flagrante delicto." (Art. 17-A, item IV, of LC No. 97 of June 9, 1999).

Subsequently, the police power exercised in the border regions were extended to the other Armed Forces through LC n. 136, of August 25, 2010**.**

"Art. 16-A. It is the Armed Forces, in addition to other relevant actions, also as subsidiary attributions, the exclusive powers of the judicial police, act, through preventive and repressive actions, in the land border strip, at sea and in the interior waters, regardless of possession, property, purpose or any record that falls on it, against cross-border and environmental crimes, alone or in coordination with other organs of the Executive Branch, performing, among others, the actions of: I - patrolling; II - magazine of persons, land vehicles, vessels and aircraft; and III - arrests in flagrante delicto.

Police power does not necessarily mean the use of physical violence, nor the use of weapons and equipment that can embarrass individuals, although this power is present daily in people's lives.

Professor Hely Lopes Meirelles, in his work proposes that police power "[...] it is the faculty of the Public Administration to condition and restrict the use and enjoyment of individual goods, activities and rights, for the benefit of the collectivity or the State itself" (2002, p. 127). The legal definition of this power is found, even, in the National Tax Code:

Art. 78. It is considered a power of police activity of the public administration that, limiting or disciplining the right, interest or freedom, regulates the practice of act or abstention of fact, due to the public interest concerning security, hygiene, order, customs, the discipline of production and the market, the exercise of economic activities dependent on the concession or authorization of the Public Power, public tranquility or respect for property and individual or collective rights.

It is important to note that the legal basis for the brazilian army's performance in the border strip should not be compared with the legal basis of GLO operations in other areas of the country, such as those performed in metropolises and elections. While in GLO operations it is necessary the order of the Chief of executive power, exercised by the President of the Republic, the police power of the EB, in the border strip, is independent of such an order. Below is a table that summarizes that such differences:

Table three. Subsidiary Actions in the Border Strip and GLO

Items	ACTIONS IN THE LAND BORDER STRIP	LAW AND ORDER GUARANTEE (GLO)
CONSTITUTIONAL AMPARO	Art. 142, and §1, CF/88; Art. 91, §1, III, CF/88.	Art. 142, and §1, CF/88; Art. 91, §1, IV, CF/88.
AMPARO LEGAL	LC/97, as given by LC/136, art. 16.	LC/97, art. 15 and §§ 1 and 2, and LC/117.
PRESIDENTIAL DECREE	Strategic Border Plan (Dec.n. 7496/2011)	Dec. n. 3897/2001.
GUIDELINE /ORDINANCES	Nr 061/2005, Cmt EB Nr 736/2004, Chapter 5(g)."	Nr 736/2004, Cmt EB.
BASIC ASSUMPTIONS/CHARACTERISTICS	in the land border strip (art. 20, §2º, CF/88); against cross-border and environmental offences; alone or in coordination with other organs of the Executive Branch; the exclusive powers of the judicial police are excluded.	throughout the national territory; after the exhausted instruments for the preservation of public order and incolumidade of people and property (art. 144, CF), after formally recognized as unavailable, nonexistent or insufficient by the Head of the Federal or State Executive Power; decision of the President of the Republic, on his own initiative or not, by means of a Message.
Missions	patrolling; persons, land vehicles, vessels and aircraft; arrests in flagrante delicto.	ostentatious police actions, preventive or operative (repressive) nature, such as the Military Police; intelligence and social communication actions.
Character	preventive and repressive	presence and dessuasion.

Source: elaborated from research data

According to Ordinance No. 061/2005, which approves the Strategic Guideline for Action in the Border Strip against Cross-Border and Environmental Crimes, part of the Army Strategic Guidelines (SIPLEX-5),

and provides other measures, we have the following legal bases for the performance of the EB in the border areas:

A. Constitution of the Federative Republic of Brazil.

b. Complementary Law No. 97 (LC 97/99), of June 9, 1999 – Provides for the general rules for the organization, preparation and employment of the Armed Forces (FA).

c. Complementary Law No. 117 (LC117/04), of September 2, 2004 – Amends LC 97/99 by assigning subsidiary shares to the Brazilian Army.

d. Law No. 6,634 of May 2, 1979 - Provides for a border strip.

And. Law No. 9,605 of February 12, 1998 – Provides for criminal and administrative sanctions arising from conduct harmful to the environment.

F. Decree-Law No. 2848 of December 7, 1940 - Penal Code. Army Bulletin No. 07 of February 18, 2005. - 19

G. Decree-Law No. 3689 of October 3, 1941 - Code of Criminal Procedure.

H. Decree-Law No. 1001, of October 21, 1969 - Military Penal Code (CPM).

i. Decree-Law No. 1002 of October 21, 1969 - Code of Military Criminal Procedure (CPPM).

J. Decree No. 85,064 of August 26, 1980 – Regulates Law 6.634/79.

K. Decree No. 3,897 of August 24, 2001 – Sets out the guidelines for the use of FA in the guarantee of law and order.

In the context of Constitutional Law, the doctrine has been used from the Theory of Implicit Powers for the application of laws from a logical-rational interpretation. The legal world became aware of this theory during the trial of *McCulloch v Maryland* and *Myer v. United States,*when the American Supreme Court, in the first half of the 19th century (MORAES and TRIGUEIRO, 2009), ruled that there must be a coherent relationship between the functions instituted to the organs of the Constitution and the instruments used to carry out its mission and that the instruments used cannot be vetoed by the Constitution itself.

This theory defends the idea that once the objectives and competencies are established to each body of its jurisdiction, it is implicitly granting it authorization to adopt the necessary measures to fulfill its tasks, so we cannot talk about sealing the adoption of the essential means for success in fulfilling its duties.

Following this understanding, the Public Administration would cease to be the way and would become only the guide of the actions of the public agent. Such a theory should not be applied in feeling contrary to the laws and the legal system, nor the law that regulates the specific case.

Considering the Laws of Introduction to the Civil Code, which in its normative text Article 4 indicates that "when the law is omitted, the judge will decide the case according to analogy, customs and general principles of law", (BRASIL, Decree-Law 4.567, of September 4, 1942, 2012), in this way we can understand that the theory of implicit powers has the task of integrating the legal system, when there is no specific legislation for the case.

About the doctrinal understandings present in the Brazilian order, the lesson of Alexandre de Moraes and Oswaldo Trigueiro (2009, p. 605) stands out:

Our legal system was therefore incorporated into our legal system, the peaceful American constitutional doctrine on the theory of implicit powers – inherent powers– by which in the exercise of its listed constitutional mission, the executive body should have all the necessary functions, even if implicit,

provided that they are not expressly limited (Myers v. United States – US 272-52, 118), thereby consecrating itself and among us applicable to the Public Prosecutor's Office , the recognition of implicit generic powers that enable the exercise of its constitutional mission, only subject to the prohibitions and structural limits of the Federal Constitution.

The Supreme Court has already issued an opinion on the applicability of the theory of the principles of implicit powers in our order, as concluded from the statement pronounced *in judgment in verbis:*

"HABEAS CORPUS. CRIMINAL PROSECUTION LOCK. LACK OF JUST CAUSE. EXISTENCE OF MINIMAL PROBATORY SUPPORT. REVIEW OF FACTS AND EVIDENCE. Inadmissibility. POSSIBILITY OF INVESTIGATION BY THE PUBLIC PROSECUTOR. OFFENSES COMMITTED BY POLICE OFFICERS. ORDER DENIED. (...) 7th. **It is the basic principle of constitutional hermeneutics that of "implicit powers", according to which, when the Federal Constitution grants the ends, it gives the means.** If the end activity - promotion of public prosecution - was granted to the parquet in a privileged forum, it is not conceived as not to provide him with the collection of evidence for this, since the CPP authorizes that "pieces of information" base the complaint. (...). (STF, HC 91661-PE, Rel. Ellen Gracie, 2nd Class, j. 10/03/2009)". (ourgriffin).

Repeatedly, the theory of implicit powers has been applied to the Public Prosecutor's Office with regard to the powers of investigation, considering that it has the ownership of criminal proceedings and external control of police activities.

In this perspective, the delegation of a mission to any of the constitutional powers or public service institutions implies the simultaneous and implicit granting of powers to carry out the activities. What we see when we analyze the police power of the Armed Forces, when they perform GLO operations, whether the actions developed are carried out to ensure law and order, nothing more natural than launching the legal means and necessary to execute the mission and achieve the planned result.

5. STATE OF RONDÔNIA

5.1 Border Areas of the State of Rondônia

The State of Rondônia was created through Complementary Law No. 041, issued on December 22, 1981, approved by the National Congress and sanctioned by the then President of the Republic João Baptista de Oliveira Figueiredo. Having as first governor the Colonel of the Army Jorge Teixeira de Oliveira, appointed on December 29, 1981, by the President of the Republic João Baptista de Oliveira Figueiredo. The installation of the State, together with the inauguration of the governor and secretariat, took place on January 4, 1982.

In the year of its creation the State of Rondônia consisted of 13 municipalities; being: Porto Velho, the capital, Guajará-Mirim, Ariquemes, Jaru, Ouro Preto do Oeste, Ji-Paraná, Presidente Medici, Cacoal, Espigão do Oeste, Pimenta Bueno, Vilhena, Colorado do Oeste and Costa Marques.

Regarding geographical aspects, the state has a geographical area of 238,512.8 km2, representing 6.19% of the North and 2.80% of the country. Becoming the 3rd State in territorial extension of the Northern region.

At the national level, it ranks 15th in territorial extension and 23rd in population terms. Having as limits to the North and Northeast, state of Amazonas; to the South and West, Republic of Bolivia; east and southeast, state of Mato Grosso; to the Northwest, the states of Acre and Amazonas. The expansion of the border of the State of Rondônia with the Republic of Bolivia is 1,342 kilometers.

The municipalities of Rondoni, located along the Bolivian border are: Alta Floresta do Oeste, Alto Alegre dos Parecis Cabixi, Costa Marques, Guajará-Mirim, Nova Mamoré, São Francisco do Guaporé and Pimenteiras do Oeste

5.2 The Army in the State of Rondônia

According to history, the presence of the Army in this part of the Western Amazon dates back to the eighteenth century, first with the Fortim of Nossa Senhora da Conceição, created in the year 1760, located on the banks of the Guaporé River, and, from 1783, with the Royal Fort Príncipe da Beira, erected about two kilometers ahead.

Although it has few historical records, and knowledge that the Fort Prince of Beira maintained a constant garrison until the end of the nineteenth century, when it was deactivated under the claim of measure of economy.

The 17th Jungle Infantry Brigade originates from the Special Border Contingents, founded in 1932, from the 27th Battalion of Hunters, current 1st Jungle Infantry Battalion, located in Manaus-AM, which reoccupied the area of Fort Príncipe da Beira and werelocated in the cities of Guajará-Mirim and Porto Velho.

The Special Contingents were subordinated to the Inspectorate of the Special Contingents of Guaporé-Mamoré Border, which had as inspector Capt. Aluízio Ferreira, who also performed the function of Director of the Madeira-Mamoré Railway.

In 1933, after its implementation, the Porto Velho Contingent took shelter in a shed of the Madeira-Mamoré railway.

During 1934, the Inspectorate transformed the name from Guaporé-Mamoré to Madeira-Guaporé.

Due to the need for expansion, in 1935, part of the current Barracks of the 17th Bda Inf Sl was implemented, where the facilities of Cia Comando are currently located, until then occupied by the Porto Velho Contingent.

The 3rd Company/2nd Frontier Battalion was created in 1937, was created in Porto Velho. At the time, the Contingents of Guajará-Mirim, Forte Príncipe da Beira and Porto Velho were transmuted into platoons subordinated to the Company. Until then, the 2nd Frontier Battalion was located in the city of Cáceres-MT.

Following an evolutionary process that transformed and installed new companies in the 1940s, the 3rd Company/2nd Frontier Battalion was designated 3rd Independent Border Company, which in 1948 originated the 3rd Frontier Company; In 1954, the Shooting of War 191 was inaugurated in Rio Branco, which would be transformed in 1956 into the 4th Frontier Company.

In 1955, the 5th Border Platoon, located in Guajará-Mirim, was changed to 6th Frontier Company. As a result of a reorganization of the Army, in 1969 it was created in the municipality of Porto Velho, by extinction of the 3rd Border Company, the Acre/Rondônia Border Command, which had the following

military organizations as subordinates: the Command and Service Company of the Acre/Rondônia Border Command; the 4th Border Company, current Acre Border Command/4th Jungle Infantry Battalion; the 6th Border Company, currently designated as Rondônia Border Command/6th Jungle Infantry Battalion; and the 7th Border Platoon, in Fort Príncipe da Beira.

The 17th Logistics Base has its origin linked to the creation of the Supply Deposit of Porto Velho, which was later established in the facilities of the 3rd Border Company, its beginning was limited, this in 1968.

However, in November 1975, the Minister of State for War Affairs, according to what recommended the Army General Staff, decided to organize and create the Porto Velho Subsistence Deposit (DSPV), expanding its support capacity.

From September 1, 1992, the said deposit began to occupy the accommodations located at Pinheiro Machado Nr street 2243 - São Cristóvão, in Porto Velho. In 1993. The DSPV was transformed into the 17th Logistics Base, which has the mission of supporting the organic units of the 17th Bda Inf Sl and the garrison units of Porto Velho and Rio Branco.

The 54th Jungle Infantry Battalion originates from the 1st Jungle Infantry Battalion. On September 27, 1973, the 1st BIS referred the precursor detachment, worth a Jungle Marine Company, the 3rd Cia Fuz Sl/1º BIS to Humaitá-AM, which would give rise to the 54th Jungle Infantry Battalion.

On December 31, 1974, the 1st Company of the 54th BIS became the 54th Jungle Infantry Battalion, reporting directly to the CMA. Years later, in 1976, the 54th Jungle Infantry Battalion was transferred to the Acre/Rondônia Border Command.

In addition, 1976, the Acre/Rondônia Border Command changed giving rise to the 3rd Border Group, commanded by the General Officer, the Border Companies were transformed into Special Border Battalions and the 7th Frontier Platoon had its subordination delegated to the 6th Special Frontier Battalion, currently the 6th Jungle Infantry Battalion.

Finally, in 1980, the 3rd Frontier Group became called the 17th Jungle Infantry Brigade and, in 1988, via ministerial decree, the historical denomination of "Brigade Príncipe da Beira".

The 17th Army Police Platoon was established in 1984, based in Porto Velho, and is due to subordinate directly to the Command of the 17th Jungle Infantry Brigade. The 17th Jungle Infantry Company is a subunit directly subordinated to the Command of the 17th Jungle Infantry Brigade.

The Company's activities began in 1997, with the arrival of the contingents that constituted it, being a contingent from the CFRON-AC/4º BIS, a contingent originating from the 54th BIS and contingents from Cia C/17ª Bda Inf Sl, the 17th Pel PE and the 17th Ba Log. Having received the current nomenclature in 2014, no longer being named 3rd Company/54th BIS.

The 17th Pel Com Sl was created in 2004, parting from the staff of Cia Cmdo of the 17th Bda Inf Sl.

Considered a pioneer in the discovery of the Western Amazon, with a past worthy of glory and recognition to the 17th Jungle Infantry Brigade Brigade Forte Príncipe da Beira has developed a service for the benefit of society, aiming to ensure sovereignty, nationality, main factors of national harmony, on the northwest border of Brazil.

5.2. Patrolling the border strip in the State of Rondônia

5.2.1 Limits of Police Power in Operations carried out by the Army at the border

In a state that develops on the aegis of democracy it is necessary to understand that there is a limit to our actions, and this is based on the legality and permissibility imposed by the law.

As for the Armed Forces, since, the CF/88, did not check its attributions, it was up to the complementary laws to explain them, in this way we can use LC no. 97/99, modified by also Laws Complete no. 17/2004 and n. 136/2010, whenever it is necessary to understand the police power of THE in border areas.

The actions of the Ground Forces will not always be carried out in border areas, even if they are located in the region, it is emphasized that in order to carry out operations to prevent and repression of crimes listed as cross-border and environmental, it is necessary that there is no action of the public security forces. In this way, ft assumes subsidiary the powers of the Federal Police, which has the duty of prevention and repression of crimes in border areas. It is noted that although the FA carry out the actions, mentioned herein, it has to communicate to the PF, since it belongs to it the role of exercising the judicial police.

According to the teachings of José Afonso da Silva (2011, p.704 and 705), which addresses the competencies established in art. 144, I, § 1º CF, incubate the Federal Police:

(1) to investigate criminal offences against the political and social order (...) or to the detriment of goods, services and interests of the Union or its municipal entities and public undertakings, as well as offences whose practice has interstate or international repercussions and requires uniform repression, as provided by law;

(2) to prevent and suppress illicit trafficking in narcotics and related drugs, smuggling and misdemeanor, without prejudice to the action of the child and other public bodies in the respective areas of competence; (...);

(3) to carry out maritime, air and border police functions;

(4) to exercise exclusively the functions of the Judicial Police of the Union.

Although acting in a subsidiary way with regard to the competencies of the Federal Police, the Ground Forces may act only in certain situations, not being allowed to perform all the duties in a broad way.

The conditions of employment of the Armed Forces in GLO operations are disciplined in Article 3 of Decree No. 3,897/01:

Art. 3 **In the event of the use of the Armed Forces for the guarantee of law and order, aiming at preserving public order** and the safety of people and property, because the instruments provided for in Article 144of the Constitution areexhausted, **it will be up to them, whenever necessary, to develop the actions of ostentatious police, such as the others, of a preventive or repressive nature, which are included in the constitutional and legal competence of the Military Police, observed the terms and limits imposed on the latter,**by the legalsystem.

Single paragraph. The means provided for in Article 144 ofthe Constitution are consideredexhausted, including with regard to the Military Police, when, at a certain time, unavailable, non-existent, or insufficient to the regular performance of its constitutional mission. (our griffin).

In additionto the s attributions already mentioned we can see through a brief analysis of the article cited above that the Armed Forces were also invested with the power of ostentatious police.

Two aspects of ostentatious policing are considered, the following being:

a) Preventive ostentatious policing: occurs in situations of regularity, through programmed actions whose objective is to prevent the occurrence of crimes and the affront to public order. It can be carried out by means of inspection or inspection, its realization can be given by provocation *or ex oficcio;*and
b) Repressive ostentatious policing: we can succinctly define it as a policing that occurs when public order has already been anafated, when the situation is no longer seen as regular, has as peculiarity the sanctioning character, repressive in view of transgressions, disturbances or incidence of crimes. Using self-execution, a means in which the Government grants to impose on the individual, even with the moderate/adequate use of force that fulfills a certain conduct, with the purpose of restoring the order.

The military, since exercising the power of police should be aware of the conduct typified in the law of abuse of authority, according to the teachings of Hely Lopes Meirelles (2002, p.117), "The abuse of power occurs when the authority, although competent to perform the act, exceeds the limits of *its attributions or strays from administrative purposes".*

Overpowering and diversion of purpose are two means in which abuse of authority can take part. Let us take the following understanding of excess power:

Excess power occurs when the authority, although competent to perform the act, goes beyond what is permitted and exorbits the use of its administrativefaculties. It therefore exceeds its legal jurisdiction and thereby invalidates the act, because no one can act on behalf of the Administration outside of what the law allows it to do. Excessive power makes the act arbitrary, unlawful and null. It is a form of abuse of power that removes the legitimacy of the conduct of the public administrator, placing it in illegality and even the crime of abuse of authority when it focuses on the criminal predictions of Law 4.898, of 9.12.65, which aims to better preserve the individual freedoms already guaranteed in the Constitution (art. 5) (MEIRELLES, 2002, p. 118) (griffin ours) (griffin)

The law of abuse of authority is an instrument that should be known to all heads/commanders of operations in order to be adopted measures that address individual rights or the principles of public administration, and that an authority that has knowledge will be easier to impose limits on its subordinates and organize operations within the required legalities, preventing excesses, and the possibilities of civil, criminal and administrative liability.

5.2.2 RONDÔNIA BORDER COMMAND / 6TH JUNGLE INFANTRY BATTALION - "BATTALION FORT PRINCE OF BEIRA"

The 6th Battalion of Jungle Infantry Battalion Forte Príncipe da Beira/6º BIS originated from the Special Border Contingent, established by deliberation of the Ministry of War, on September 23, 19932, had an effective composed of thirty-three squares, remaining subordinate to the Border Inspectorate Madeira Mamoré, established in Porto Velho. In the same year, the group was in fact established in the city under the command of Second Lieutenant Raimundo Zeno Ferreira.

On March 30, 1977 became the 6th Special Frontier Battalion, and on May 99, 19992 was named Rondônia Border Command and the Sixth Jungle Infantry Battalion.

In the year of one thousand nine hundred and ninety-seven, it received the Banner and the historical designation of "Battalion Fort Prince of Beira", according to the publication in the Army Bulletin of the

same date, and published in the Internal Bulletin of the Sixth BIS on October thirteen of one thousand nine hundred and ninety-seven.

The 6th Battalion of Jungle Infantry Battalion Forte Príncipe da Beira/ 6º BIS is formed by the General Staff, a Command and Support Company, two Jungle Marine Companies and an Administrative Base, also counting on the First Platoon of Jungle Marines, deployed at The Prince of Beira Fort, located in the city of Costa Marques.

The RO/6º BIS Border Command, in accordance with Provisional Instructions No. 72-20, has the following missions:

- In the Offensive, destroy the enemy located in your area of activity and/or achieve specific objectives on the ground;
- In the Defensive, maintain capital accidents, especially those that allow blocking and/or controlling river and land circulation routes;
- In the context of Integrated Security, pacifying or participating in the pacification of an area;
- As border command that is, watch over the border strip under your responsibility;
- In Resistance Combat, operate in a combat area, employing, alternately, their Jungle Marine Companies.

In addition to these missions of its task, the Battalion participates in the missions triggered by the Military Command of the Amazon (CMA), and the 17th Brigade of Jungle Infantry Brigade Prince of Beira. Are the operations Ágata, Curare, Ibama, Boiadeiro, Guaporé, among others, making security and supporting Ibama in the inspection of deforestation, and loggers that operate illegally in the State of Rondônia, also work together with IDARON, to curb the entry of unvaccinated cattle into Brazil, coming from neighboring parents, carry out operations in conjunction with the federal police to combat drug trafficking in the border area , going to its limit of action that is on the border with the state of Mato Grosso, on the cabixi river near the municipality of pimenteiras. Where the two battalions meet the 6th BIS and the 2nd Jungle Infantry Battalion (2nd BFRON) based in the prison city in MT. In these operations, the riverside community also provided medical and dental care, as well as lectures with an emphasis on national security and environmental education.

Due to the geographical location, located in a border area, the Battalion carries out river and land exercises, for the training of the troops and at the same time to inhibit cross-border crimes.

The Border Command – Rondônia / 6th Jungle Infantry Battalion is currently commanded by Lieutenant Colonel Of Infantry Fábio Pinheiro Lustosa.

5.2.2.1 Prevention and Repression Operations

According to the concept brought in the publication "Integrated Security" (DUARTE, 2007), we can understand what are the preventive and reprehensive actions that can be carried out by the Brazilian Army in law and order guarantee operations. They are:

1. Those triggered on a permanent basis in order to prevent premature use of force and prevent or hinder the outbreak and aggravation of a situation of disturbance of order ....

2. Those triggered, on an episodic character, when preventive actions have no effect. They aim to reverse a situation of serious commitment of public order, to a situation of peace and social harmony.

In the publication Integrated Security I, it is highlighted that repressive actions will be triggered both in normal situations and in a framework of cooperation with state governments or with the Ministry of Justice, providing support or assisting in the coordination of security actions carried out by public security agencies. It is also sought that the actions occur in an integrated way, with the participation of the other Forces, involving other powers, promoting an effective action of *Integrated Security.*

The actions to be developed are provided for in Article 17a, inc. LC no. 97/99 (in accordance with art. 16-A of LC no. 136/2010). According to the text mentioned:

Art. 16-A. It is up to the Armed Forces, in addition to other relevant actions, also as subsidiary attributions, preserved the exclusive competences of the judicial police, to act, through preventive and repressive actions, in the land border strip, at sea and in the interior waters, regardless of possession, property, purpose or any record that falls on it, against cross-border and environmental crimes, alone or in coordination with other organs of the Executive Power , performing, among others, the actions of:

I - patrolling;

II - magazine of persons, land vehicles, vessels and aircraft; And

III - arrests in flagrante delicto.

Single paragraph. The Armed Forces, by ensuring the personal security of national and foreign authorities in official missions, alone or in coordination with other organs of the Executive Branch, may exercise the actions provided for in items II and III of this article.

In this understanding, Ordinance no. 061/2005, brings an example list of the police power attributed to the Brazilian Army:

Preventive: among others: a) intensify the activities of troop preparation, intelligence and social communication, considered permanent in nature; b) cooperate with federal agencies, when necessary, is desirable and by virtue of request, in the form of logistical support, intelligence, communications and instruction; and c) provide security to the activities of federal agencies, when requested and desirable, based on the item that this Guideline deals with;

Repressive, among others: a) install and operate locking and control stations for roads and river and static security posts; b) conduct patrolling and magazine of persons, vehicles, vessels, aircraft and facilities; c) making arrest in flagrante delicto; d) support the interdiction of illegal airstrips and berths, proven to be used for illicit activities; (e) inspect controlled products.

We can have as examples of preventive and repressive actions, carried out by the Brazilian Army in the Border Strip, The Ágata and Curare Operations, in addition to the Integrated Border Monitoring System - SISFRON.

Operation Ágata, which is already in its 12th edition (referring to the State of Rondônia), aims to carry out patrols throughout the land border area, working together with the other members of the Armed Forces and public security agencies in order to reduce the practice of cross-border crimes, which in a case of illicit drug trafficking and weapons, smuggling and misway of goods.

As for Operation Curare, as with Operation Ágata, it takes place in a period of not more than one year, they are part of the Strategic Plan of | Border of the Federal Government, created to prevent and suppress criminal actions that may occur on the border of Brazil with South American countries, in the second half

of 2017, occurred the 9th Operation Ágata-Curare, which covered the states of Mato Grosso do Sul to the border between the states of Amazonas and Pará. In addition to the troops of the 6th BIS Battalion, the operation had the participation of the Federal Revenue, Military Police, Environmental Police, Civil Police, IDARON and SEDAM Agents, as well as the military personnel in the 1st Special Platoon of Frontier and Platoon Royal Forte Príncipe da Beira.

During the operations, the military carried out tactical missions aimed at cracking down on cross-border crimes, which due to regional circumstances that facilitate the occurrence of entry and exit, are recurrent the crimes of drug trafficking, smuggling and descamides, trafficking in arms and ammunition, environmental crimes, illegal mining and immigration.

Ordinance No. 061, of February 16, 2005, of the Commander of the Army, provides a definition of the main cross-border crimes in its item 6. IMPLEMENTATION of this rule brings an enumeration, exemplified, of the main illicit objects of prevention and repression. They are:

- *Cross-border offences:* the illegal entry (and/or attempt to leave) weapons, ammunition, explosives and other related products into the national territory; illicit trafficking of narcotics and/or substances that determine physical or psychological dependence, or raw material intended for their preparation; smuggling and mistransport (Brazilian Penal Code, art. 334); the trafficking of plants and animals, in the form of the Environmental Crimes Act (L. 9,605/98), the Forest Code (L. 4,771/65) and the Wildlife Protection Code (L. 5,197/67); the entry (and/or attempted exit) into the national territory of vectors in disagreement with epidemiological surveillance standards.

- *Environmental crimes:*the practice of acts harmful to the environment, thus defined by the Environmental Crimes Act (L. 9.605/98); the predatory or illegal exploitation of natural resources; the practice of acts harmful to the diversity and integrity of the country's genetic heritage, as defined in Provisional Measure No. 2,186-16, of 23 Aug 01.

For an effective action, foot patrols, motorized patrols, in addition to aerial and river patrols carried out in the main rivers and roads are used.

When we mention military operations, we tend to misunderstand that these are only preventive and repressive operations, however, together with the actions carried out, the populations involved are offered civic and social services, ranging from medical to dental care.

The Federal Government sought through a strategic project to monitor the borders, thus emerging the SISFRON, composed of a set of sophisticated technological resources and communication systems to intensify the human presence in some places of the border.

Patrolling

Through a previous organization, the Ground Forces carry out preventive and repressive actions through patrolling, which is legally expected at LC no. 136/2010, art. 16-A, I.

As already mentioned, the performance of these activities can take time in isolation or together with the other security agencies. Pursuant to Article 15, § 2, of LC No. 97/99:

Art. 15. The use of the Armed Forces in the defense of the Fatherland and in the guarantee of constitutional powers, law and order, and participation in peaceoperations, is the responsibility of the President of the Republic, who will determine to the Minister of State of Defense the activation of operational organs, observed the following form of subordination:

(...)

§ 2º The action of the Armed Forces, in the guarantee of law and order, at the initiative of any of the constitutional powers, will take place in accordance with the guidelines downloaded in act of the President of the Republic, after exhausted the instruments intended for the preservation of public order and the safety of persons and property, listed in art. 144 of the Federal Constitution.

Patrolling is one of the means adopted to intensify actions is to make them effective in order to achieve the predefined objectives.

The Journal of Persons, Land Vehicles, Vessels and Aircraft

With regard to personal reviews, it must be carried out in accordance with the provisions expressed in the Codes of Criminal Procedure and Code of Military Criminal Procedure, in addition to the other relevant laws dealing with the subject.

Basically the personal magazine consists of the search carried out in the clothing, suitcases or objects that can serve as a guard for the transport of illicit material, of the person searched. The journal to be executed must meet certain legal assumptions, as a rule, must be carried out in compliance with a court order for search and seizure, or if there are reasoned indications that the individual brings with him means or products of the crime and evidence of materiality. The exception, which excludes the need for a court order, is provided for in the Code of Military Criminal Procedure - Decree Law No. 1002/69:

Art. 182. The magazine is warrant-independent:

(a) when made at the time of the capture of a person to be arrested;

b) when determined in the course of the home search;

(c) where the case provided for in point (a) of the preceding article occurs;

d) when there is a well-founded suspicion that the searching brings with it objects or papers that constitute the body of crime;

(e) when made in the presence of the judicial authority or the chairman of the investigation.

The well-founded suspicion mentioned in the device points out that the police authority needs to be attentive to the grounds that the search, since, not meeting the requirements required, agents may be called in court to resolve doubts about the reasons that led to such action, which does not exempt him from criminal accountability for abuses in the acts committed.

We must pay to the advantage that the Code of Criminal Procedure regulates the procedures pertaining to personal search when carried out in women, *"Art. 249. The search for a woman will be done by another woman, if it does not matter delay or injury of diligence"*. However, to consider the possibility of not having a woman to carry out the journal, in this case it is necessary to carry out the search and in the impossibility of doing it by a female military can the male agent perform it meets the legal requirements being vetoed to pass hands in private parts, since such attitude constitutes a crime typified as libidinous act and abuse of authority.

As for the use of the term "domicile" the country jurisprudence admits the understanding contained in Article 173 of the CPPM, and article 171 of that code should be analyzed together: *Art. 173. The term*

"house" comprises: a) any inhabited compartment; (b) occupied room of collective housing; (c) compartment not open to the public, where someone exercises profession or activity.

It is advisable that the journal be carried out with due caution, in possession of a judicial warrant for search and seizure, which is not necessary in exceptional cases provided for by law, since it has express protection in the Federal Constitution, Article 5, item XI:

Article 5 º All are equal before the law, without distinction of any nature, guaranteeing brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, in the following terms:

(...)

XI - the house is inviolable asylum of the individual, no one can penetrate it without the consent of the resident, except in case of flagrant crime or disaster, or to provide help, or, during the day, by judicial determination; (See Law No. 13,105, 2015) (Term) (our griffin)

In the delegation of the police power to the military for the execution of GLO operations, not only the powers are conferred, they must act in compliance with the legal precepts.

Arrests in flagrante delicto

According to Articles 301 and 302 of the CPP, as well as the devices 243 and 244 of the CPP, any person of the people can make an arrest in flagrante delicto, following the list of requirements that must be observed so that an illegal arrest is not made.

When the act of the arrest in flagrante must be read the constitutional guarantees of the prisoner and collected his signature in the Science Note, such guarantees are duly included in Article 5, items LXII, LXII, LXIV, LXV, LXV, CF, are they:

Article 5 º All are equal before the law, without distinction of any nature, guaranteeing brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, in the following terms:

(...)

LXII - the arrest of any person and the place where he is located shall be immediately communicated to the competent judge and the family of the prisoner or to the person indicated by him;

LXIII - the prisoner will be informed of his rights, including to remain silent, being assured the assistance of the family and lawyer;

LXIV - the prisoner is entitled to the identification of those responsible for his arrest or for his police interrogation;

LXV - the illegal arrest will be immediately relaxed by the judicial authority;

As already said, the arrest report should be sent to the Federal Police, along with the prisoner, when it comes to civilians the same should be incarcerated in prison pf, in the absence of the prison establishment must wait in an appropriate place until the transfer is carried out.

Still on the requirements necessary for the legality of the arrest in flagrante, the Supreme Court (STF), has already established an understanding about this modality of imprisonment, deciding that: "Summary 145: There is no crime when the preparation of the blatant makes it impossible to consummate".

Another issue that caused repercussions is the use of handcuffs, which could characterize nullity of the act of imprisonment. The matter was the subject of binding summary of the Supreme Court, according to the provision sumular:

It is only permissible to use handcuffs in cases of resistance and a well-founded fear of escape or danger to the physical integrity of the prisoner or others, justified by the exceptionality in writing, under penalty of disciplinary, civil and criminal liability of the agent or the authority and nullity of the prison or the procedural act to which it refers, without prejudice to the state's civil liability.

The use of handcuffs, weapons and the use of forces at the time of imprisonment is also disciplined in the CPPM, art. 234, where it contains the provisions and means in which such instruments of coertion should be applied. See:

Art. 234. The use of force is only allowed when indispensable, in case of disobedience, resistance or attempt to escape. If there is resistance on the part of third parties, the means necessary to overcome it or to defend the executioner and his auxiliaries, including the arrest of the offending officer, may be used. Of all the self-written by the executor and two witnesses.

Employment of handcuffs

§ 1 - The use of handcuffs should be avoided, provided that there is no danger of escape or aggression on the part of the prisoner, and in no way will be allowed, in the prisoners referred to in Art. 242.

Use of weapons

§ 2 - The use of weapons is justified only when absolutely necessary to overcome the resistance or protect the incolumidade of the executioner of the prison or to assist his.

The concern is in the use of the means used in prison, since, the excess the restriction of freedom, the cruel and inhuman treatment will be criminally typified as torture. Considering that torture is expressly prohibited in the national legislation and in the international treaties ratified by Brazil, once committed the agent if convicted may suffer the loss of office, function or public employment and the prohibition for its exercise for twice the term of the sentence applied. It is note: The crime of torture is indefinable and insusceptible to grace or amnesty, according to Article 1, § 5 and 6 of Law No. 9,455 of 7 April 1997.

FINAL CONSIDERATIONS

Given the mission of guardian of constitutional powers, law and order, it would not be plausible thatthe means that could successfully perform them were not offered in conjunction with the tasks.

These means are called police power that originates from state power. The Power of the State has the power to use force when necessary and when the situation justifies such use, but this force should not be the way to maintain power, it must exist to promote security, the defense of national interests and assist in the development of the State.

The preservation of public order is a generic assignment granted to all security agencies. Having to seek the maintenance of law and order, to promote peace and social well-being. A company with security tends to breach social norms in a smaller number and violate legal provisions.

And notorious the performance of certain security agencies in daily life, which can contribute to the erroneous thought that the Armed Forces only act in times of war or exceptional events in the national territory. It should be emphasized that the Armed Forces must act when exhausted: the means, if the staff

is non-existent or insufficient, the equipment is not suitable for situations of disorder established, and also in situations of prevention and repression.

Due to the rate of violence and situations, a more effective repression operation is necessary, in some regions there is a need to convene the Armed Forces to act in a subsidiary with local public security agencies.

The action in the border areas occurs due to the extension, the difficulty in controlling and supervising the entry and exit of people in national territory. Due to the geographical characteristics of the Amazon and the border areas it understands, the police force is insufficient to promote adequate and effective control regarding the movement of people and goods, thus occurring a high rate of cross-border illicit goods.

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Applying Digital Arts Experience to Strengthen the Organizational Culture in Higher Education During the Pandemic

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Abstract

During the COVID-19, schools were faced with changes in organizational culture under the digital education model. It is a new challenge facing higher education universities to promote cultural competitiveness, enhancing the confidence of educators in organizational culture, and communicating the cultural atmosphere to educators through digital technology. This concept paper mainly emphasizes the introduction of Digital Arts experience into organizational culture, thereby enhancing the appeal of the university organizational culture. This requires the university to combine both ideology and technology, highly advocating the organization's core concept through the global digital trend during the pandemic. This concept paper provides a new perspective of change for constructing organizational culture in universities facing education and digital challenges during the pandemic. The Digital Arts experience will be an essential part of the global university organization culture after COVID-19.

Keywords: Digital Arts Experience, Organizational Culture, Higher Education in Pandemic

Introduction

After COVID-19, most universities were transformed overnight, adopting online courses that used any available technology that the teachers are familiar with. Although universities have provided some digital ways to continue courses online, some practical courses face significant difficulties such as laboratory, physical education, art, music, and dance. Art students cannot participate in practical creation, while teachers cannot give feedback on time, and managers cannot implement instructions efficiently and quickly. All educational institutions were affected by the health crisis. Universities quickly established new specifications and shifted education to synchronous and asynchronous modes, using e-learning and digitalization, consequently, the institution's critical personnel experienced difficulties, frustration, pressure, and conflict. Moreover, some of the new challenges facing the reform of universities are building the school's cultural atmosphere and conveying sympathy, care, and concern to the staff, teachers, and students, or the stakeholders (Romero-Ivanova et al., 2020).

The success of an organizational culture comes from its robust decision-making. To successfully carry out digital art projects in universities, organizations must understand how to effectively implement digital

art technology strategies (Grajek, 2016). Consultations must be done to elicit the correct information and make the right decision.

This concept paper mainly emphasizes the introduction of Digital Arts experience into organizational culture, thereby enhancing the appeal of university organizational culture. The introduction of digital arts into the college culture requires creating a new way of thinking and applying practical solutions to specific problems (Grajek, 2016). It requires the universities to combine both ideology and technology, highly coordinating the organization's core concept with the global digital trend during the pandemic. The paper will provide a new perspective of change for constructing organizational culture in universities facing digital challenges during the pandemic. Digital Arts experience will be a vital part of the global university organization culture after COVID-19.

Literary Reviews

Digital Arts Experience in Higher Education Organizational Culture

The development of universities largely depends on the culture of the organization (Tsiring & Sizova, 2018). The organizational culture influences the behavior to enable the organization to have a sustainable competitive advantage (Martínez-Caro et al., 2020).

The cultural atmosphere of the organization forms the stability and innovation of the organization. It also builds a unified symbolism and valuable environmental space among leaders, educators, and students. The value of environmental space endows organizational culture with different levels of continuity and identity (Tsiring & Sizova, 2018).

Although the organizational culture of higher education may use core digital technologies, they have not fully adopted the practice in their organizational culture. The ecosystem of universities has unique components and diverse needs. The operation of universities relies on standardized management methods and a creative workforce. Therefore, the use of digital capabilities in higher education is different from other institutions. Higher education needs its own set of functions, which should be based on existing processes and adapted to the industry (Grajek, 2016).

In the past ten years, the successful transformation of technology in teaching, the assumption of practice promoting cultural improvement, and the successful development of new ideas translate into products, procedures, objects, and services relied on the solved problems in organizational culture (Zhu & Engels, 2014).

Organizational culture is considered a factor that may ultimately affect the effectiveness of the organization's implementation of digitalization (Martínez-Caro et al., 2020). The organizational culture of higher education must respond to this digital trend (Almaiah et al., 2020).

The COVID-19 pandemic has forced universities to implement digital teaching management. Universities will face the challenge of considering all possible changes and managing them appropriately (Almaiah et al., 2020).

Universities are experiencing a digital revolution, acquiring knowledge and skills through digital media technology. The standardized learning environment and learning tools that the universities adhere to

cannot adapt to the changes in the new digital media environment, which has prompted education reformers to evaluate the quality of previous digital learning tools (Halverson et al., 2016).

The study of Martínez-Caro et al. (2020) stressed that digital technology can stimulate the behavior of organization members and enhance their trust in the organization by guiding them to accept digital technology as the source of organizational value. Moreover, digitization can be introduced into the organization through activities, policies, and procedures. Furthermore, it must be fully integrated in the organization by merging organizational culture with digitization. This process can result in making better decisions and innovations, shape new business infrastructure, influence the new internal coordination model and create value for the organization.

There is more evidence that digital technology is applicable to organizations, and the development and application of digital functions can improve the viability of organizations. The value of digital technology to organizations extends to the improvement of learning, collaboration, and decision-making abilities. Universities strive to upgrade classroom art through digital technology and reduce the cost of higher education (Grajek, 2016).

Indeed, digital tools not only play a vital role in the sustainability of teaching but it also established a new digital cultural atmosphere among college-related organizations and personnel through digital communication throughout the pandemic (Almaiah et al., 2020).

Value and Effectiveness of Digital Arts Experience

Digital Arts is part of culture under the trend of global digitalization (Nederob, 2020). It is a description of digital technology and art, which is associated with new media created by digital. Digital Arts experience is to convey digital art of physical space or virtual space to visitors through visual or interactive forms (Danae, 2018).

Digital media technology allows users to have a new timely interactive experience and participate in social interactions on a global scale during this pandemic. Moreover, these experiences enable users to explore and learn new problems through synchronous or asynchronous learning and use visual presentations and products to evaluate the quality of digital technology and new knowledge. Conversely, new media technology depends on the tools and interfaces used, which are generated according to users' needs and can stimulate users' interest (Halverson et al., 2016).

Chowdhury (2020) expressed in his study that with the global trend of digitalization, digital technology provides a positive teaching environment for universities and promotes team cohesion. That is why during the pandemic, the virtual classroom online learning environment created by digital technology has become the mainstream globally.

Virtual education has transformed from a one-way structure to a two-way interactive, three-dimensional learning environment driven by digital technology. The perceptual experiences that technology brings to users are its value and ease of use, feedback, and clarification of information, affecting their beliefs and attitudes towards technology (Chowdhury, 2020).

Furthermore, Chowdhury (2020) highlighted that the interactivity of the virtual classroom creates an active learning environment and positive experiences for teachers and students since technical aids create a collaborative environment for users in universities and provide users with an overall experience through

physical and online modes. Therefore, the artistic virtual interface can satisfy the user's desire for exploration and lead to a positive attitude.

Finally, the development of digital technology has promoted the transformation of digital art expression (Nederob, 2020). Digital arts promote more innovative thinking and discussion through the design process of technology and generates new assumptions and interpretations that produce better works. It increases student interest by measuring students' attitudes to promote organizational change through improving educational technology (Ezell et al., 2020).

Conclusion and Future Directions

This concept paper aims to make universities and other educational institutions aware of how to use existing digital technologies to effectively promote the organizational culture and consolidate the cultural status of university organizations in the current educational environment. Universities are facing the challenge of establishing new norms to adapt to the era of digital teaching during the epidemic. In the international situation where the educational environment is rapidly changing, teachers, students, and various institutions also suffer from anxiety and pressure. Although universities respond to the pandemic on time with online teaching, organizational culture and digital education models are not fully integrated, which hinders the sustainable development of universities in building their organizational culture.

Therefore, this paper provides a new perspective on future organizational culture construction for universities facing digital challenges during the pandemic, and universities can apply this ideology and technology to enhance their cultural competitiveness.

Universities need to quickly catch up with the trend of digitalization, implement new digital technology, the visual effect of art, virtual communication mode and positive interactive experience, and the Digital Arts Experience to help universities establish new cultural connections. Researchers in the universities may apply the qualitative methods to determine the satisfaction and impact of digital arts experience on students.

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The Day Our School Went Pitch Black and the Nights We Reclaimed the Light

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Abstract

I will never forget that a year ago, last March 2020, we had to close our school suddenly. It feels like someone just turned off the light without warning, and everything went pitch black. Confused and scared, we tried to make sense of and confront the endless challenges that the COVID-19 pandemic brought upon our school organization. The virus caused significant interruptions to our processes, policies, people, technostructure, and financial resources. However, with each tiresome blow, the school leaders and teachers navigated through and around those challenges. The only comforting thought was we were not alone in our quest to survive, for every organization around the world was thrown into this catastrophic state and was fighting hard to persist and endure.

Looking back, I reflect on the extraordinary challenges our organization experienced akin with most organizations using Kurt Lewin's Three-Step Change Model and the three ways we responded to COVID-19.

Keywords: School Organization, Lewin's Three-Step Change Model, COVID-19 Pandemic

1. Introduction

I will never forget that a year ago, last March 2020, we had to close our school suddenly. It feels like someone just turned off the light without warning, and everything went pitch black. So dark that the place we call our second home ended up without a glimmer of light. Instead, it covered every area with deafening silence, a far contrast to the usual sounds of students' boisterous laughter and shoes clattering around the playground and along the corridors as teachers caringly reminded them to be careful. The stillness in the air robbed away the joy of classrooms' buzzing with life and intellectual noise from students collaborating in differentiated activities.

Confused and scared, we tried to make sense of and confront the endless challenges that the COVID-19 pandemic brought upon our school organization. The virus caused significant interruptions to our processes, procedures, policies, people, technostructure, and financial resources. However, with each tiresome blow, the school leaders and teachers navigated through and around those challenges. The only comforting thought was we were not alone in our quest to survive, for every organization around the world

was thrown into this catastrophic state and was fighting hard to persist and endure.

Looking back, I reflect on the extraordinary challenges our organization experienced akin to most organizations. Using Lewin's Organizational Development Change Model, I agree with Hussain et al. (2018) when their study highlighted that change is imperative for organizations' growth, especially when Lewin's Three-Step Change Model is deployed to analyze the stages for managing organizations' processes. Moreover, the authors underlined that leadership styles affect the organizational change processes.

2. Application of Lewin's Three-Step Change Model

Organizations are dynamic and constantly evolving. Organizations change to solve problems, create strategies, and seize opportunities. What drives the changes are the people inside the organization. When the crisis unexpectedly happened, the first response of organizations world-wide was to set aside their agenda and implement the mandate on self-isolation, social distancing, and observance of other health and safety protocols immediately. This resulted in closures of businesses forcing everyone to work remotely from home.

This new normal ushered in the second response of organizations to the coordinated first response to COVID-19, preparing the organization for the needed changes. Using our smartphone devices, we communicated and collaborated with all our stakeholders as we began with the **Unfreezing process,** the first step in the Change Model. We had to rethink our plans, procedures, and policies and outline key aspects to redesign the organization to function efficiently. We realized early on that the business landscape had been severely altered. There was no assurance of certainty on how the succeeding days or months would unfold; therefore, we were compelled to adapt, transform, and innovate processes to carry them out in a compressed time frame. The change management needed to mobilize the people to transform the organization overnight.

As the dark days continued, time was a precious commodity. It was evident that the faster an organization embraces and adapts to the current situation, the better for all leaders and staff to move forward to innovate for solutions and find opportunities. This was how the phase called the **Change process** of the Change Model was implemented in our organization. Our leaders and employees adopted a paradigm shift, a mindset to persist regardless of the challenges. Like most organizations, we have to reevaluate our policies, process, and procedures, particularly in delivering education and providing social, emotional, and psychological guidance. Organizations like ours found creative strategies that were forward-thinking to drive alternative ways to continue work efficiently at an accelerated pace.

Effective leadership and management are critical components to the survival of organizations. Effective leaders and managers guided the team to the transition phase during this pandemic. We took steps to maintain a resemblance of normalcy by fostering credibility through transparency, creating order and consistency, exuding confidence and compassion but cautiously engaging in quick and decisive action. Responsive and fast decision-making was a crucial factor in transforming our organization. To achieve this, we had to redesign our organizational structure by removing boundaries and cutting across bureaucracies. We revised our hierarchal structure to a flatter type to foster quicker communication and decision-making. Response turnover was immediate; all matters were treated urgent and important. Consultations were an

ongoing scenario using technology.

The most difficult challenge we encountered was the capacity building on ICT Literary training. During the lockdown, we relied on crude technological devices to aid in the remote training; the majority struggled to accomplish the needed performance tasks that ran throughout the day and ended at 10 pm every night. Each night we converged online to reflect and analyze the accomplishments of the day. This routine reinforced our commitment to our goals, maximized our potentials, refined new processes, and procedures, and magnified our faith that soon a ray of light would shine amidst the gloom and darkness.

When the lockdown eased up, we started the **Refreeze process**, the third step of the Change Model. We embraced the new normal, continued supporting each other, refined our strategies, and seized innovative opportunities. In comparison, our third response to COVID-19 was to initiate specific changes in the organization that would shape our new future. We started investing in technostructure to provide digital connectivity and the best online teaching and learning experience. Almost all organizations had no recourse but to procure or upgrade their software applications and hardware equipment to ensure continuous working conditions.

However, part of being sustainable is to be financially secured in the future. We applied strategies and cost-cutting measures to remove unnecessary processes and cut our losses. We had to retrench teachers who opted not to undergo ICT training, for they did not have the expertise to conduct online teaching. Also, we had to adopt different schedules for our staff and streamlined operational processes to improve efficiency, reduce expenses, and promote organizational growth.

3. Conclusion

As our school organization emerges slowly from the darkness, surpassing the myriad of extraordinary challenges which have strengthened our resolve to adapt and embrace the new normal making our organization agile, flexible, and resilient to change. It matters to have responsive leadership able to steer the organization in the right direction during this dire time. Courage is not the absence of fear but the willingness to face challenges to seize opportunities. To survive, our organization chose to look for possibilities, not limitations. In the end, organizations that shine even in darkness will soon be basking in the light.

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Organizational Diagnosis in a Brazilian Food Industry - Londrina / PR. / Brazil

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ABSTRACT

The study made an organizational diagnosis in a Brazilian industry in the food segment. The research was submitted to the company's management taking into account the organization's assessment from six perspectives: structure, marketing, production, people, finances and society. Despite the analysis, using the Averange Ranking method, reaching a general neutral index (n = 3.0), the study warns that a company must urgently consider the areas of production, marketing and people; considering that several items in the areas were identified as defined points.

Keywords: *Organizational Diagnosis. Industry. Family business. Management.*

INTRODUCTION

A well-structured analysis, consistent and detailed analysis in all sectors of the company, makes business diagnosis an important managerial tool to understand the organization as a whole and identify: strong points, weak points, threats and opportunities. Detect which sectors are most productive and which need improvement provides managers with the possibility to plan activities in a more realistic way; provided, of course, the diagnosis is based on objective and impartial data and information.

When an organizational diagnosis is managed correctly, its reflexes are perceived at all structural levels, organizational and administrative of the company; creating opportunities to product development, services and people. Therefore, it will be necessary to use a methodology that takes into account the optimization and enhancement of the organization, in particular, and taking into account the specificities of family businesses in the case of diagnoses in this type of organization.

The organizational diagnostic model proposed in the present study and adapted by the authors, has the

intention of: complement the gaps left by previous models, analyzing the organization's management to then implement strategic planning more effective.

THEORETICAL REFERENCE

The organizational diagnosis can be understood as a process of temporal and spatial verification that analyzes a given process or company as a whole. In this process it is possible to verify deviations in performance, internal and external conditions and diagnostic symptoms of inadequate procedures. (NEWMAN & WARREN, 1980).

The diagnosis corresponds to the first phase of the strategic planning process and seeks to answer the basic question: What is the real situation of the company in terms of its internal and external aspects?

Some fundamental premises that must be taken into account in the diagnosis: analyze the environment and its relevant variables, in which it is inserted in the organization; whether this environment provides opportunities that need to be enjoyed and threats that need to be avoided; knowledge of the internal strengths and weaknesses, to face the situation of the external environment; this process of analyzing internal variables (strengths and weaknesses) and external variables (opportunities and threats) must be integrated, continuous, evolutionary, systemic and evaluated. (OLIVEIRA, 2009).

As a diagnostic process develops, skills and competences develop that lead to a form of reflection about the object of study, and the process ends up becoming an intuitive part, through which the nature of the character of organizational life is judged. (MORGAN, 2009).

MATERIALS AND METHODS

As for the approach, the research was characterized as qualitative and as for the objectives, exploratory and descriptive. As for the data collection procedures, the research was characterized as bibliographic and case study.

The study was limited to analyzing a small family-owned food industry headquartered in the city of Londrina, State of Paraná, Brazil; that produces salt, spices and barbecue sauces.

The field research was carried out through the organizational diagnostic model proposed by Silva (2010), through a detailed and global analysis of the organization. The model was adapted by the authors on a Likert scale, totaling 600 questions submitted to the company's management. As for data analysis, the Averange Ranking (AR) method was used.

Figure 1: Organizational Diagnostic Model proposed by Silva (2010).

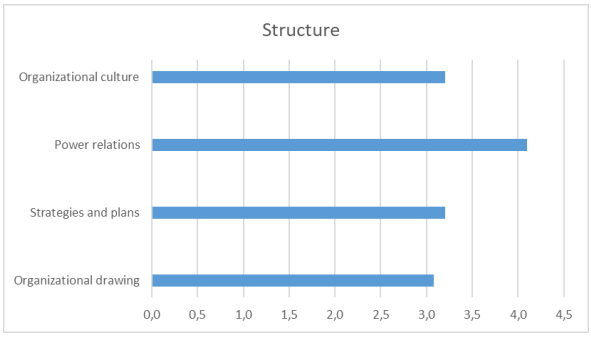
Source: Silva (2010).

DISCUSSION

Next we will present the results achieved in the first major axis of the model called “structure”. The Likert scale presents items in the form of statements about a category of analysis on which respondents are asked to state their position. As for the analysis of the responses to the questionnaires, the Averange Ranking (AR) method was used, which measured the degree of agreement of the respondents.

The results with an averange < 3 mean an evaluation below the reasonable in the researched item (weak point). Results with an averange = 3 mean a reasonable assessment with potential for improvement (neutral point). From another perspective, the referred index with an averange = 3 (depending on the case) in a short period of time may become a weak point. Therefore, the index with a mean = 3 should be considered as a warning sign. Results with an averange 3 mean a good and above averange assessment (strong point). To obtain the values, the weighted averange WA = sum (frequencies of responses x marked scales) was initially considered, and then the Averange Ranking, expressed by AR = WA / Σ frequencies of the responses, was calculated.

Graphic 1: Big block structure.



Source: Elaborated by the authors.

As can be seen in Graphic 1, the researched company has the “organizational culture” as its strong point (n = 3.2). The organizational culture brings together beliefs, ethical and moral values, habits, behavior and everything that involves internal and external policies of the company. An organizational culture refers to the way in which employees see the company itself and how they should act within it. The above-averange index (n = 3.2) demonstrates that the organizational culture in the researched company can

motivate employees and help them to grow together with the organization. However, it is important for the company to align values, visions and ideas for all employees; so, the direct involvement of all with the objectives of the organization. In this sense, it is necessary to develop manuals containing the standards and regulations, values and code of ethics in detail; as well as creating communication channels so that all levels have access to the board.

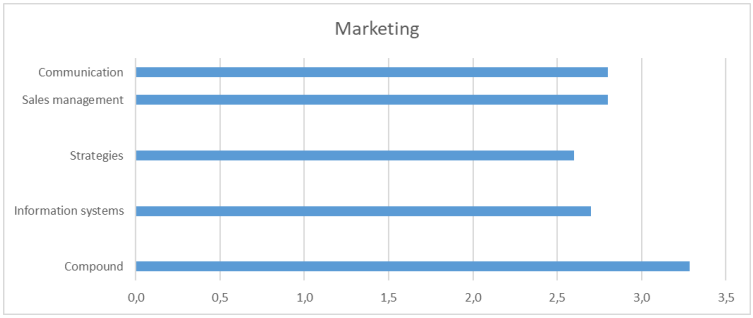
The researched company also has the item “strategies and plans” (n = 3.2) as its strong point. Planning is one of the main functions of the administrative process and its function is to indicate the direction to be consolidated by the company. (OLIVEIRA, 2009). Planning is the conscious determination of courses of action and encompasses decisions based on objectives, facts and an estimate of what would happen in each available alternative. (LACOMBE, 2009). The present study demonstrates that the researched company established a direction to be followed in order to achieve its goals. Therefore, the probability of success in making decisions may be greater, providing the company with greater competitiveness. Planning consists of making early decisions about what to do, before the action is taken; that is, to simulate the desired future and to establish in advance the necessary courses of action and the appropriate means to achieve the objectives. (CHIAVENATO, 2003).

The company's strong point is the item “organizational design” (n = 3.1). The organizational design addresses the configuration of the company's organizational structure and the processes used to make it work and achieve results. The organizational design involves the definition of the basic structure of the company and how the administrative referrals will be divided and assigned between departments, divisions, units, teams and positions. Through the research it can be considered that the referred company will be able, through the organizational design, to define how the organization will work and how its resources will be distributed and applied. If the researched company chooses to improve aspects related to organizational design, it will be bringing together and making compatible the four characteristics that involve this process: differentiation, formalization, centralization and integration.

The researched company has as a strong point the item “power relations” (n = 4.1). Organizations are characterized by situations of uncertainty; therefore, the analysis of the decision-making process shows the different manifestations of power and politics and their analogies with the culture of organizations; in this way, the analysis reveals who decides, what the process is, who loses and who wins. (BERTERO, 1989).

Despite the good performance in the “structure” block, it is necessary for the company to: update the organization charts and make them accessible and visible to everyone; improve lateral communication and integration between departments; formalize the mission, vision and values; try to correct immediately the deviations between what was planned and what was accomplished; detail the rules and regulations in printed form in manuals that are available to everyone; formalize the professional code of ethics.

Graphic 2: Big block Marketing.



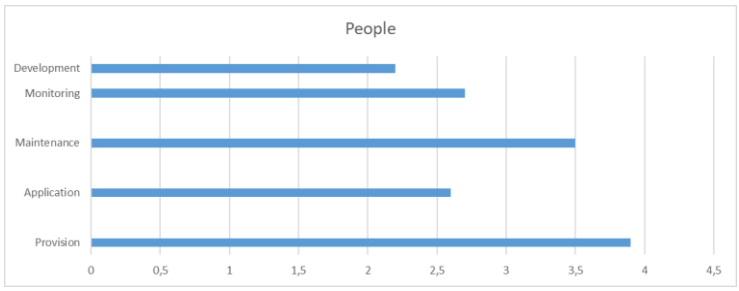
Source: Elaborated by the authors.

As can be seen in Graph 2, the researched company has as its strong point “the marketing mix” (n = 3.3). Despite this important aspect where the four major areas (price, point, product and promotion) seek to meet the needs of consumers; we highlight as weaknesses in the company: the “Market Information System” (n = 2.7); “Strategies and Positioning of the Company” (n = 2.6); "Sales Management" (n = 2.8); and “Marketing Communication” (n = 2.8).

In a highly competitive environment, companies need to deepen their analysis and marketing strategies and not only persist in the basics of what they are made of (price, point, product and promotion). Companies that are satisfied with a basic marketing approach create a certain illusion and are doomed to stagnation and extinction. When properly applied, marketing enables: competition understanding; greater and better capture, relationship and customer loyalty; strategy planning; monitoring and strengthening the brand; better understanding of consumer behavior and desires; raise trends and etc.

In view of the several specific negative points pointed out in the research, the company needs to: analyze the possibility of implementing a CRM (Customer Relationship Management); conduct market research regularly; use a competitor monitoring information system; regularly research customer satisfaction; review the participation of the marketing manager in the strategic management process; implement a sales planning flowchart; analyze sales targets weekly; define criteria for selecting suppliers; analyze the possibility of the sales manager constantly accompanying salespeople; use a professional third-party company to launch advertising campaigns.

Graphic 3: Big block People.



Source: Elaborated by the authors.

The “people” block concerns the conduct that the company adopts towards internal and external employees, promoting a mix between society and how it is impacted by the organization.

As can be seen in Graph 3, the company's strengths are “provision” (n = 3.9) and “maintenance” (n = 3.5). While the provision refers to the recruitment and selection of employees; maintenance is linked to retention and motivation.

Recruit, select and retain good professionals is an apparently simple task for most managers; however, making these processes operational requires basic care that avoids mistaken hiring, troubled dismissals and the loss of good professionals.

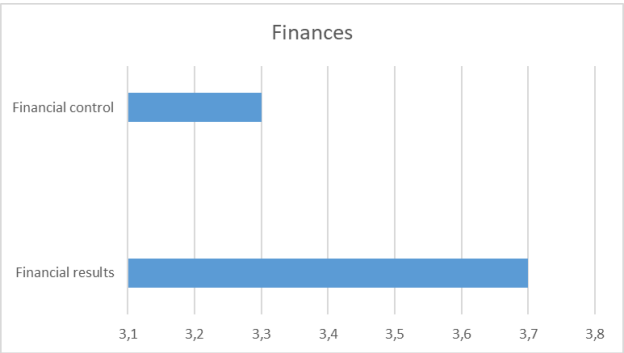
Although the provision and maintenance are aspects very well managed by the company; we highlight as weaknesses in the research: “development” (n = 2.2), “monitoring” (n = 2.7) and “application” (n = 2.6).

The retention of good professionals also goes through the “development” process that aims to implement organizational policies focused on human talents, through practices that enhance skills and competences. However, “developing” employees is not enough; it is necessary to “monitor” even to be able to know if development policies are actually having a practical effect. Monitoring is to control, guide, observe and maintain people's behavior within certain limits of variation, organization or established limits.

The process of “applying”, means integrating people in order to assess their performance and thus, put in positions more effectively that achieve the best possible result. This process includes organizational design, job design, job description and analysis, people orientation and performance evaluation. (CHIAVENATO, 2011).

In view of the specific negative points pointed out in the research, the company is necessary: analyze the possibility of partnerships with universities and support agencies; provide procedure manuals; work for the socialization of employees; elaborate job modeling; analyze the possibility of centralizing the performance evaluation in the Human Resources Sector; analyze the possibility of implementing the 360º technique; analyze the possibility of the team evaluating its managers; analyze the possibility of implementing life insurance and health insurance for employees; offer development opportunities to employees; analyze the possibility of developing a career plan; develop a compensation plan considering the achievement of goals; constitute a Internal Accident Prevention Committee (CIPA); develop a program of suggestions with employees, as well as recognition for employees who provide contributions to the company; develop a standardized method for conflict management; analyze the possibility of setting a percentage for investment in training; analyze the possibility of acquiring specific software for HR; establish individual performance indicators.

Graphic 4: Big block Finances.



Source: Elaborated by the authors.

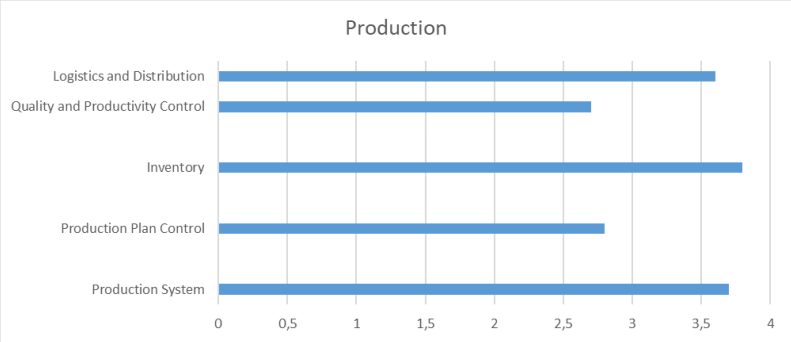
The “finance” block was the second best evaluated, behind only the “structure” block.

As can be seen in Graph 4, the researched company has both “financial results” (n = 3.7) and “financial control (n = 3.3)” as its strong point.

While the "financial results" are linked to the profit or loss existing among the non-operating activities of the organization; “financial control”, in turn, refers to the set of actions used to verify that what was established in the planning is being carried out and what are the necessary measures to correct possible flaws and errors. The company revealed responsibility and zeal for the financial area; a situation that needs to be continued and that must be increasingly improved.

In view of the specific negative points out in the research, it is necessary that the company: analyze the possibility of outsourcing accounting; implement an adequate financial plan and aligned with the other areas of the company; implement financial and economic indicators.

Graphic 5: Big block Production.



Source: Elaborated by the authors.

The survival and development of an industry's production sector depends on strategic and operational decisions. In this process, some questions are fundamental: What to produce? How to produce? When to produce? What resources to use to produce?

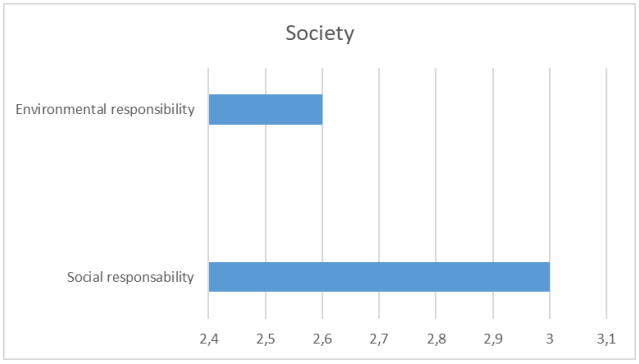
More than simply producing, the central function of the production sector must be to add value to the final product. Therefore, it is essential to identify bottlenecks, analyze processes, formulate and implement improvements.

As can be seen in Graph 5, the researched company has as strengths the items “inventory” (n = 3.8), “production system” (n = 3.7) and “logistics and distribution” (3.6). As a weak point of the items "production planning and control" (n = 2.8) and "quality and productivity control" (n = 2.7).

In view of the several specific points pointed out in the research, the company is necessary: analyze the possibility of automating processes; analyze the possibility of increasing the installation, if necessary; analysis of the possibility of creating the res R&D (Research and Development) area; analyze the implementation of CAD (Computer Aided Design), CIM (Computer Integrated Manufacturing) and CAM (Computer Aided Manufacturing); use a master production plan; deploy a PCP; formalize a maintenance structure and routine; analyze the role played by the employee responsible for quality control; analyze the alignment of quality control with the other sectors of the company; analyze the possibility of certification; review the process flowchart; review forms and communication systems; implement performance

indicators for decision-making.

Graphic 6: Big block Society.



Source: Elaborated by the authors.

Social responsibility refers to the company's commitment to issues that involve attitude, internal behavior and actions that promote or the well-being of its internal and external public. Environmental responsibility, in turn, is linked to actions that respect the environment and as policies that they obtain as one of the main sustainability objectives.

As can be seen in Graph 6 called “society”, the company has “social responsibility” as its neutral point (n = 3.0) and “environmental responsibility” as its weak point (n = 2.6).

In view of the several specific negative points pointed out in the research, it is necessary for the company to: analyze the possibility of preparing institutional material that exposes the organization's ethical, social and environmental commitments; analyze the possibility of making physical exercise practices available to employees in the work environment; appoint a person responsible for environmental policies; elaborate mapping of environmental preservation analysis and waste monitoring program; prioritize the hiring of environmentally responsible suppliers.

Painting 01: Classification of the sub-blocks in decreasing order.

Classification of the sub-blocks in decreasing order	RM = MP / Σ	Result	Result
Power relations (Structure)	n=4,1	> 3	strong point
Provision (People)	n=3,9	> 3	strong point
Inventory(Production)	n=3,9	>3	strong point
Financial results (Finances)	n=3,7	> 3	strong point
Production System (Production)	n=3,7	> 3	strong point
Logistics and Distribution(Production)	n=3,6	> 3	strong point
Maintenance (People)	n=3,5	> 3	strong point
Compound (Marketing)	n=3,3	> 3	strong point
Financial control (Finances)	n=3,3	> 3	strong point
Strategies and plans (Structure)	n=3,2	> 3	strong point
Organizational culture (Structure)	n=3,2	> 3	strong point
Organizational drawingm (Structure)	n=3,1	> 3	strong point
Social responsability (Society)	n=3	= 3	alert
Production Plan Control(Production)	n=2,8	< 3	weak point
Sales management (Marketing)	n=2,8	< 3	weak point
Communication (Marketing)	n=2,8	< 3	weak point
Logistics and Distribution(Production)	n=2,7	< 3	weak point
Information systems (Marketing)	n=2,7	< 3	weak point
Monitoring (People)	n=2,7	< 3	weak point
Strategies (Marketing)	n=2,6	< 3	weak point
Environmental responsibility (Society)	n=2,6	< 3	weak point
Application (People)	n=2,6	< 3	weak point
Development (People)	n=2,2	< 3	weak point

Source: Elaborated by the authors.

What draws the most attention in table 01 (general classification of sub-blocks), as it is an industry, is that within the 05 (five) items analyzed in the production area, 02 (two) were considered weak points. Therefore, the distortions pointed out in production need to be analyzed urgently by the company, especially those related to planning and quality control.

Another aspect that draws attention in the general framework is in relation to the marketing area. Of the 05 (five) items analyzed, 04 (four) were considered weak points (sales management; communication; information systems; strategies). If producing with quality is fundamental, guaranteeing "who to sell to" becomes essential.

In the same way, the "people" block. Of the 05 (five) items analyzed, 03 (three) were considered as a weak point (monitoring, application and development); having development as the worst item evaluated in the study. It is important to note that it is only possible to produce with quality, maintain an economic and financial health in the company, ensure the sale of the product and meet the expectations of customers, through trained and motivated employees; otherwise all the efforts of the managers will be in vain.

FINAL CONSIDERATIONS

According to the analyzes carried out in the researched company and taking into account the index of all blocks and sub-blocks for the effective diagnosis, a general neutral index is reached (n = 3.0).

Therefore, the present study reveals itself as an alert point for the organization, mainly in the areas of production, marketing and people; emphasis on the production area because it is an industry.

It is concluded, therefore, that the objective of the study was achieved. However, it is considered as a limitation of the research the absence of analyzes in the scope of knowledge management and family succession; which are extremely important aspects so that in fact the diagnosis can cover the organization in its entirety.

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Multiple Languages and the process of the Teacher Formation in Early Childhood Education

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Abstract

The formation of the Early Childhood Education teacher is a recurring theme in many studies, showing the concern for the quality of the activities carried out with early childhood children. In pedagogy courses, in which future teachers are qualified, there is a concern with training strategies for the appropriation of multiple languages, a theme also studied due to proposals related to Childhood Pedagogy. This research aims to investigate and analyze how teachers of the pedagogy course of a private university in the city of São Paulo, in their educational practices, consider the multiple languages in the formation of teachers of early childhood education. A qualitative approach was chosen. to carry out the research, and as a methodological procedure, we have interviewed ten teachers from the pedagogy course and thirteen students from the sixth semester. The theoretical background adopted is based on the conceptions of children and early childhood education from the perspective of multiple languages. The results showed that teachers use different strategies when working with multiple languages in their disciplines. Nevertheless, such practices or strategies are aimed much more at preschool children than at daycare children.

Keywords: Multiple languages, Early Childhood Education, Teacher training.

Introduction

The work with multiple languages in early childhood education has been deeply studied recently. Thinking about multiple languages (ML) in the context of early childhood education means to be sensitive to the movement of children, their visual, gestural, musical, and artistic body language, having children's playtime as the main axis.

The present study, based on qualitative research, aimed at answering the following question: which are the training strategies that collaborate for the formation of early childhood education professional in the appropriation of multiple languages in pedagogy course? The article is structured presenting, first, the concept of multiple languages, seeking to relate it to the education of early childhood teachers. In the sequence, we present generated and analyzed data from the field research, which were primarily the speeches of the teachers about what they think of the multiple languages and how this content is taught. Then, the speeches of the students of pedagogy trying to highlight how they conceptualize such languages and how they learned their concept. Finally, we present some considerations about the study.

1. The multiple languages and the formation of the teacher of early childhood education

Before presenting the concept of multiplicity we emphasize our understanding that language is the means people express themselves, interact with one another verbally or non-verbally. CITELLI (2006), referring to verbal language, systematizes the concept, stating that in the constitution of the senses some developments give it a peculiar role in the communication processes.

FRIEDMANN (2005), in her text "The symbolic universe of children", uses the term "symbolic language", before deepening into the subject, stating that "language is a means through which human beings communicate, or try to communicate, expressing themselves". She states that the most direct language is the word, the verbal language and that this is not always the most authentic. The author says that, in addition to verbal language, there are other languages, the "symbolic" ones, which are non-verbal, permeated with symbols that are not always understandable, presented by images. Thus, man can "enter the world of the human being with depth" (FRIEDMANN, 2005, p.36). The author goes on: "Among them, we can mention the language of sounds, of touch, of speech, and writing, of smells, of flavors, of art, of play, of gestures, of dreams" (P. 36), stating that children have several symbolic languages.

JUNQUEIRA FILHO (2006) brings a new meaning to the concept of language as "programmatic content". The "content-languages" to which the author refers could be, among others, "oral language, space-time language, plastic-visual language, sound-musical language, sign-body language, symbolic game language, visual and verbal language, logical-mathematical language" (2006, p.18). Other languages can appear in children's universe, such as:

> crying, biting, disputes over objects or places to sit, verbal or physical aggression for several reasons, laughter, singing, running, refusals from situations proposed by the teacher, children who refuse to speak, the noise of seeking organization, falls, injuries, escapes from the classroom, destruction of collective materials, etc. (ibid., p. 18).

In his study "Multiple, different and conflicting languages: a study on language and work organization in early childhood education", JUNQUEIRA FILHO (2011), analyzing two publications in the area of early childhood education which bring the concept of language as a central theme - National Curricular Reference for Early Childhood Education (1998) and The hundred languages of children: Reggio Emilia's approach to early childhood education (1999) - concludes that, although both publications imply language as human expression and communication, the theoretical reference of both of them are ambiguous. He argues that the consequences of this conception of language concerning work organization are antagonistic and conflicting, that is, as we assume the importance of working with multiple languages in the context of early childhood education, some care is necessary. It is not our intention to discuss working strategies with children in this article but to analyze how multiple languages are treated in the pedagogy course.

In a contemporary approach to childhood pedagogy, FOCHI (2015) presents a proposal on the role of children in institutionalized spaces, specifically babies, as a self-constructed and constituted being in socio-cultural relations and questioning the world as active and curious agents. According to him, teachers should specialize in another language "that is not the word" to deal with babies. Body language is used by the researcher to propose an approach that reflects the baby as the protagonist, for without a word, without a sound, they establish communication that teachers usually cannot understand. They would, then, need to be trained to do so.

We consider it of fundamental importance, to recognize in language the element that constitutes children allowing the construction of their history. Through social and physical interactions, children will build their knowledge of the world, which will enable new actions, expanding their language for communication with a global function.

The children concept that we adopted for this reflection is based on seeing children not only as a subject who has rights granted to them by official documents but above all as real human beings who are also in a real-world, in a given context; as we know, there are several types of childhood, due to the economic-cultural diversity and territorial immensity in which we live in. That is why it is of singular importance to reflect on who this child is, what are his peculiarities, his age, his cultural background, his experiences, his relationships, etc.

We support the idea that the early childhood teacher is trained to be involved with multiple languages and that sensitivity and perception are guides to his practices in institutionalized environments so that they meet the needs of children. Therefore, as teachers, we need to understand the bodily character and behavior of our children, experienced in the social dimension, in the relational sphere, understanding that language is

related to the expressive movement. In this expressive phenomenon, it is possible to have an openness to ourselves with the world and with everything that surrounds us. According to FURLAN AND BOCCHI,

> The body is the expression of conduct and, at the same time, the creator of its meaning from an intention that is outlined and demands its complementation. Before the expression, there is only a determined absence that the gesture or language seeks to fill and complete. (2003, p. 449).

It is possible to say that through these gestures and bodily movements we dance life while communicating with beings in the world, living in a dimension of human relationships, the way art is lived and perceived: in a state of happiness that involves feelings and perceptions capable of captivating, as well as changing perspectives and worldviews. Therefore, we believe that specific training is required for teachers who will work with young children - a sensitive training, which considers the individual needs of each one, an activating training of that look that understands what they express through their bodies, their gestures, their airs, their cries... Hence, the uniqueness and particularity of children in early childhood education require the experience of different languages.

2. Field research

The objective of the field research was to investigate how the pedagogy course teachers in their educational practice work the multiple languages in the formation of the teacher of early childhood education. The target-audience taking part in the research were ten teachers and thirteen students from the pedagogy course at university X. Our option was semi-structured interviews as they provide interaction with the investigated subject, which are teachers and students from university X pedagogy course, thus favoring the approach, and the apprehension of what they live, know, think, do, feel and represent.

The interview was conducted from the recording of the teachers' statements which were later transcribed in full. To collect data with the students, we also used a semi-structured interview with closed and open questions. We believed that, through the interview, we would achieve the objective of investigating how students identify in the studied subjects, the apprehension of the importance of working with multiple languages in the school context.

2.1 The students

After collecting the research subjects' data, it was necessary to delimit the information for the organization of categories, focusing on the central question of the research. The transcription of the interviews carried out with the teachers and students was a movement that required great care in order not to miss any speech. To transcribe them, we listened to the recordings several times, stopping and writing, resuming, listening again, to be faithful to the voice of each one. That done, we created large tables to analyze the responses. From this writing, we pondered the categories, as the interviewee does not always answer what was asked. To study such interviews, we have used content analysis which is a widely employed investigative

technique in qualitative research. Its purpose is to describe, objectively and systematically, the content manifested by the subject.

The class chosen for the semi-structured interview was the sixth semester's, class A, Barra Funda unit, morning period – graduated in 2017, because it is a more accessible class, as such students have already been through with all the subjects of the course which made them able to participate in the research more appropriately than the students from previous semesters. Thirteen were those who cooperated with the research. Most of the students are more mature being between 30 and 39 years old as they concluded their first graduation later than the average. Most of them have come from public schools, both elementary and high school. Most of them have also completed their studies in regular high school; only one of them has a teaching profession, one has completed supplementary education and two of them have the Youth and Adult Experience (EJA).

The data present a target-public that reads little, half of which are used to reading scientific articles; they rarely read the newspaper - only two of them do it daily - and the Internet is used by most of them to be updated on events. Regarding the use of the library, six have stated that they use it fairly and five of them have stated that they seldom use it. All of them use the computer frequently and one of them said she rarely uses it. Regarding cultural-artistic activities, eight students declared that they prefer to go to the cinema, and only one is a theater and museum-goer. Such information made us consider the outdated cultural formation of teachers and how to foster it in Pedagogy courses so that young children may have access to different cultural events. Regarding contact with multiple languages, most students have stated that the course provided knowledge of multiple languages. Only one of them has disagreed. On the inquiry if all subjects were essential for training, the majority fully agreed; one disagreed. On the inquiry if all the teachers provided contact with the different languages, seven students fully agreed, three agreed, two disagreed and one totally disagreed. On the question, if the course has expanded the knowledge of arts and culture, all of them agreed. The last question was whether the course has provided contact with elements of arts and culture, eight students fully agreed, four agreed and one student disagreed.

Observing the collected data related to multiple languages we have found that in the responses of the students there is an understanding that the Pedagogy course has contributed to the training, providing contact with the understanding of such languages.

2.2 Work with multiple languages in the context of initial training

After a thorough reading of the generated data, we organized them as follows: In the first part we present the teachers' speeches about what they think on the multiple languages and how this content is taught; in the second part, we present the students' speeches, trying to highlight how they conceptualize the multiple languages and how they have learned this concept.

2.2.1 Conceptions of multiple languages: the teachers' speech

To deal with this category, we believed it was necessary to know the conceptions that teachers had about what multiple languages are and what they think about their contribution to the training of their students. After checking the teachers' speeches, we did the same with the students' speeches. The question we have asked the teachers was: what do you understand by multiple languages? Of the interviewed teachers, 60% has answered that multiple languages are "the different forms of communication and expression of the human being", and also, "they are different ways for the human being to communicate, to express himself", "ways of communicating, of being and feeling, not only through orality". The remaining 40% did not respond clearly. The teachers' speeches below exemplify this statement:

> They are already part of the human being's life because they are inserted in several contexts. (T1).

> It is when there is a diversity of opportunities for stimulation, interaction, and mediation of cognitive capacities within a person's conjunction or circumstances of efficiency. (T6).

The teacher T7 understands that they refer to different approaches, as we can see in her speech:

> the interaction in different approaches, expanding the perception and conception in communication and the whole development. When several means are offered, different approaches broaden the person's perception. (T7).

The last teacher interviewed conceives the multiple languages as "resources":

> I understand by multiple languages the different resources or ways to express a certain subject/theme. (T10)

Despite not defining, some interviewees exemplified what it could be:

> Oral and written language, mathematical language, nature, and society. (T1).

> I think it is when we offer several means, you know? Different approaches will broaden the person's perception. I understand that it is it! (Laughs). (T7).

> As an example: film, painting/image, theater, music, dance, body expression, poetry, etc. (T10).

In the speech of the teachers who did not define the multiple languages, but gave some examples of it, we can see that there is a mixture of "things" apparently some specific areas, called "different means or approaches" or also understood as "differentiated resources" that can promote the expression or communication of a certain subject, making classes more interesting and dynamic. As we observed with T6:

> For the daycare teacher, working with multiple languages is essential, in addition to knowledge, mastery of content, interaction with students, the relationship between theory and practice, use of didactic and technological resources, are just some of the strategies that will facilitate the teaching and learning process (It seems that she is not referring to children from zero to three years old.) (T.6)

If we have found in those speeches an uncertainty about what was asked, this work would not be clear in their practices as we understand it, since the multiple languages are neither "approaches" nor "resources". They are all the personal dimensions that we use for our communication with the world in their different contexts, and all the human possibilities that we find to express our wishes, needs, wants, longings, feelings ...

Regarding the conception that most of the interviewees have, even the teachers who understand multiple languages as "the possible ways of expressing themselves and communicating which did not limit the areas or actions of the teacher", we have realized that some showed the axes of knowledge proposed in the National Curriculum Reference for Early Childhood Education (RCNEI in Portuguese). Thus:

> Oral and written language, mathematical language, nature, and society, that is, all of these are present in our lives and what we have to do is to interconnect them in the educational context so that they can be developed in all aspects. (T1).

> Multiple languages are the different languages that exist, specific to the development of the subject, for example, the child will develop such multiple languages in early childhood education through axes like music, oral and written language, movement, art, so I think the multiple languages in this way. (T2).

> So, I understand that multiple languages are all expressions of the child and they can be visual, musical, artistic, oral, written, so it is necessary to see the child as an integral being who has all the languages ready to be developed. (T3).

Based on the responses of the teachers, we have realized that they understand multiple languages as pedagogical activities, as resources and ways of learning whose purpose is to know, learn ways to represent, and transform. Concerning the importance of working with multiple languages for the training of early childhood education teachers, especially in daycare, the teachers understand how important is for the students of the pedagogy course to have good training with multiple languages to attend the development of the child as a whole, as we have seen in their statements above. However, it should be observed that only teachers T4 and T8 have highlighted this importance, referring specifically to early childhood children.

> [...], but the child is hardly able to express, verbalize, what he is actually feeling [...] He expresses himself much more by the body, the drawing, the movement, so for the teacher who goes to work in the daycare it is very important to understand these multiple languages. Picture a baby, a nursery

> teacher, the baby doesn't speak. How is the teacher going to interpret that baby, talk to him, stimulate him, the crying, the tantrums, so it's necessary the body contact, the bond? It is to pay attention to everything, the crying, the bite, the tantrum, in short, affectivity as a whole. It is fundamental. A baby does not speak, so the teacher will read through these other languages and then sees a little of the child's playfulness in playing, the child reveals himself, he is telling you about him, [...] it is up to you to know how to read it. (T4).
>
> [...] because it is important to value the multiple languages of this small child, this baby that we work with so much in early childhood education. Before working with these children, I need to work with these future teachers, right? So that they can experience, so that they can understand that it is not just the verbalization, it is not just the writing, that brings an expression, that brings a communication in form of an image, of a message. So I think it is totally relevant for this adult, this future teacher to know, to use his own multiple languages, as well as he can explore it well with children. (P8).

We emphasize as well that teachers of this modality would need to have a keen sensitivity and perception so that they were able to know the forms of communication of young children. The response of a teacher who had the experience of running a public school reveals her concern with offering multiple languages in her work as a teacher. While managing the school she identified the absence of artistic and linguistic repertoire in her staff of teachers. Her discomfort reveals that:

> This deficient situation in the training of early childhood teachers experienced as a manager has constantly led me to seek and offer different possibilities in my classes in teacher training. In any allocated subject, I always look for music, an image, a canvas, something that can contribute culturally to these students. (T5).

We understand that this concern is plausible, as it shows the interest of the teacher in providing a cultural immersion to her students with the intention of awakening in them the aesthetic look - which may favor a greater perception and sensitivity while increasing the interest in other ways of expressing such languages - and awakening the reflection on them, thus contributing to the teacher's formative work. We understand that the invitation to immerse in the cultural world requires efforts and willingness to "think", because, as we have already said, "when our eyes are opened to new looks, they transform us and provide us with a reflection on our actions and pedagogical practices".

Although T7 talks about the "manipulation" of different materials and does not clarify the term. We can infer that they are materials that mobilize expression, such as paints, clay, ceramics, collages, colored pens, crayons. Yet, those examples are far from the possibility of babies making themselves understood with their multiple languages.

> "[...] dance, music, drawing, writing, handling different materials, playing, among others." (T7).

In short, there seems to be some difficulty in understanding what multiple languages are, as they are explained only from what the older child is capable of doing, "artistic, musical, bodily languages", that is, the visible means that enable communication.

2.2.2 Multiple languages in the pedagogy course: the practices carried out by the teachers

To handle this category, we have sought to understand and identify the training strategies used by teachers at work with multiple languages in the school context. To this end, they answered two questions: in the disciplines offered by you, throughout your experience, what strategies do you use to offer multiple languages to your students, and in which disciplines? Could you exemplify how they are worked on in your classes?

Only one teacher out of ten interviewed did not refer to a specific subject; the others mentioned and exemplified their strategies. Among the responses, we highlight:

> [...] I work with many reports, I work with a lot of written production in the classroom, I even work with the issue of interpretation because they often have to make representations in the classroom. I love to bring music because the analysis of music also makes them understand that the child is musical by nature, so having this understanding, they are able to offer it to children, recognizing and valuing everything they have of personal production. In this regard, that they bring experience, so in the classroom, I have used many strategies, including in the anthropology discipline, which is a very different discipline from what I was used to working with. I have done this and one of the things I have used that comes out even a little bit of what is normally done in the classroom is ... meetings. We have small picnics inside the classroom as a moment of interaction among them, so that they get to know each other better and they see the teacher as someone who is an ally to them, who is helping in this process. (T1).

> I asked an interview with an early childhood teacher to find out he works on the tripod of early childhood education, which is to educate, care and play, and on how he worked it, in early childhood education and specifically with the educational angles. They interviewed the teachers and then had to elaborate the pedagogical angles and then we have made an exhibition. (T2).

> [...] we did a survey at the beginning and we used several languages, then the visuals. I highlighted all possible answers, we put them on the wall, and then the students should answer those questions by going to the wall, visualizing, going to the wall, so they were also expressing themselves, walking, moving. We took pictures, these pictures were exposed and shown to students. So we also used this dynamic [...] we did, the dynamics of candies; so they moved around, they interacted with each other, and they could, I don't even remember what the strategy was specifically, not the strategy, the objective. Oh it was to form groups so that they would know each other, and nothing is cooler than this interaction and when the student puts himself in the child's shoes, it is more interesting for him to understand how the child thinks, how the child acts [...] (T3).

> I form groups, I ask them to choose people who are not in that group, people from another group and try to represent these people by drawing, they have to talk about how they see this person, both by appearance and by physical and personal characteristics. Thus, so-and-so is shy, outgoing, so she has the opportunity to present how she sees the other physically and how she feels about that person, what does that person say to her, if she is a shy person if she is an extrovert one if she is a calm person if he is a person who communicates well. Then they have this opportunity to speak, to draw and then those who are portrayed end up liking it too because they often do not see themselves that way and they receive this kind of affection too. (T4).

> Verbal and written language, for example, are two fundamental parameters in the work of multiple languages. The observations, possibilities, and criteria that are chosen make all and any difference when we seek interaction and mediation starting from contents that will take the skills and competencies of the students' learning. (T6)

> Well, to exemplify the multiple languages that worked in class, I will take some recent ones. For example, when I was working in the areas of knowledge in early childhood education, where, as the main axis I highlighted the arts. So I gave some images that were acquired at the Pinacoteca de São Paulo, distributed them to the groups, worked on the oral exhibition first, you know, asking questions about the works they knew. After that they read the files, you know, shared what they had understood of the files with, you know, information inside them, then we worked with photography, you know, where the students positioned themselves, produced those positions, you know, they reproduced those works of art from their own images and they photograph I also photographed, and from there, we started to make a painting, oh, it would be an idea to re-read the works, but then, not in the sense of copying, you know, as many of them understood that way, it was their idea to recreate those works of art from their authorship. Then I worked with ink, I worked with charcoal, I worked with different materials so that they could better understand the work for early childhood education. I can also exemplify, based on games, as when, for example, the issue of movement with children is worked on, I always try to bring those languages to the adult, you know, to the teachers, future teachers who are in training. And the idea is for them to move, to make games. It is the idea of the video. Recently I also worked with them on the idea of making resources, that is, pedagogical resources for daycare, right, for children from zero to three years old. And then the idea was not just that they make those resources, those pedagogical resources, as objects for children to move around, using those toys, mobile, that we normally use a lot in early childhood education. (T8).

It is necessary to highlight the concern and reflection of a teacher about her pedagogical practice:

> I think my classes need to be even more dynamic, I will have to explore this further, I intend on other meetings, you know, now we have the National References for Early Childhood Education, we have meetings to do, to understand the axes of the referential, so see the society, mathematics, music, to art, everything that has in the referential that helps us to understand this child and these

> languages. And we, and I intend, in each one to bring this language for them, forming groups, working the axes, instead of talking about music, working on music, instead of talking about mathematics, working on practical math language for them to understand that. (T3).

We have observed that, among the teachers interviewed, two of them, T1 and T4, mention their subjective actions as strategies that are not listed in the teaching plan, but are part of their pedagogical action, as they see this as a possibility of ML.

T1 mentions “meetings or picnics” within the classroom, as he understands that this provides “moments of interaction between the students so that they get to know each other better and they see the teacher as someone who is an ally who is helping in this process. ”. And T4 said that he performs “empathy exercises”, going around the class and talking to the students:

> Do you have children? An example, “So, how are the kids doing”? “ Say why are you late today?”, “ I think you’re in this or in that way” and then I’m going to show them how much they say things without actually verbalizing, and how important that look of the teacher is, actually an exercise in empathic ability, empathy ... and many times we don’t notice that in children. The children come to class tired, they don’t say anything, they’re sleepy. Just come to them and ask “what happened?”, “Did you sleep late?”, “Did you have a nightmare?”, “Are you sad?” The child doesn't say anything, but you see it because you read multiple languages. In a drawing made by the child, you can see that. (T4)

Only one teacher, despite speaking in verbal and written language, did not exemplify how she works, did not make this clear despite being asked to give an example, as we can see in her speech:

> Verbal and written language, for example, are two fundamental parameters in the work of multiple languages. The observations, possibilities, and criteria that are chosen make all and any difference whatsoever when we seek interaction and mediation starting from contents that will lead to the student's learning skills and competencies. (T6).

Two teachers, T7 and T10, gave examples of their strategies, but did not details, as we can see:

> with readings of articles, movies, huh ... internet searches, huh ... use of images, you know, I use a variety of resources to make this happen ... that's it ... in my routine, I use games with rules a lot when I can. I promote different activities, among others. (T7).

> a theater/dramatization, a song, or another form of artistic presentation helps the student to translate the content into other languages, facilitating the understanding of the subjects worked on in the classroom. (T10).

Seven out of the ten teachers supported their strategies taking advantage of the studied contents or themes, especially those related to multiple languages in early childhood education, as we can see in some of the statements recorded:

> For example, in the nursery and daycare discipline, I have asked the students to do field research. They had to visit an early childhood education institution, basically, the daycare center, to observe how to work with the children was done and how they could identify the axes of early childhood education, in this case, the multiple languages. (T2).

> [...] we have meetings to understand the axes of the references, then to see nature and society, to see the mathematics, to see the music, the art, everything that has in the references that work there, that help us to understand this child and these languages. And we, and I intend, in each one to bring one, this language for them, dividing the groups, working the axes, instead of talking about music, working on music, instead of talking about mathematics, working on the practical language of mathematics so that they understand this (P3).

> Well, I remember that when I worked with the discipline of early childhood education: nursery and daycare, I worked on the issue of psychomotricity contributions, which I talk about in all areas of psychomotricity, I talk about the formation of the self, of self-image, of body image, and then I say that we constitute this image, not only the look we have about ourselves but what the other also tells us, so I form groups [...] (T4).

> When I taught a certain discipline, I have always used works of art as reflection triggers. I selected very specific works related to the themes that I would like to debate, shock, disturb. (T5).

As we can see, the teachers talked about the most diverse strategies and exemplified their practices showing how they offer multiple languages in their disciplines throughout the semester. Thus, we have observed that they follow a good part of the methodological indicators of the teaching plans, showing rigor in considering the indications exposed in them. The teachers work the multiple languages in the pedagogy course. It is noteworthy that all of them dominate the concept according to the proposal in the official documents: multimodality activities, use of documentary, diverse textual genres, readings, theater, scientific dissemination magazines, use of images, and other documents point out that they are verbal, artistic, plastic, musical, bodily languages, among others. For this reason, all teachers try to promote those languages in the offer of their subjects.

2.2.3 The conception of multiple languages and teacher education: the students' speech

When studying the responses of the students, we understand that this category is for both teachers and students, as both groups answered the same questions, which were: what do you understand by multiple languages, and what is their importance for a teacher education daycare center?

Only two out of thirteen students interviewed - despite giving examples - did not respond explicitly:

> The multiple languages come from our birth, the language about crying, then we go on talking about body language, then the speech comes, asking for things until we reach adulthood and it always keeps going. (S11)

> So, the written language, the written language, art, which is included music, dance, visual art, verbality as well. (S12)

We could observe that four students out of thirteen refer to multiple languages as "the various ways of teaching a certain content", "ways of approaching a subject", or the possibility of "presenting a subject in different ways". In their speeches, we can see that they relate to the teacher's didactic work, because their examples name resources, strategies, or used proposals:

> Ah, that's when, huh, the teacher works like this, works theater, works music, works dance, all kinds of language, I believe that is it? (S6).

> It can be through videos, music, different ways of expressing. (S1)

> You can work on a subject through books, through music, through theater, so it would be an approach in many ways. (S2)

> [...] video, theater, music and continue on that subject in different ways so that the undergraduate or student understands that there are several ways for you to explain the same content. (S3)

Only four students did not refer to multiple languages in the strict sense of the school environment as we see respectively below:

> a means of interacting, understanding (S4).

> it is a form of expression that you are not tied to a single language, where everyone has been intermingling, they are always in a new creation (S8).

> ways to represent what one thinks (S7)

> different forms of communication, of expression. (S9)

What differentiates their responses from the others is that they did not link what they understand by multiple languages to the school environment, as the students below also did when they answered:

> they are the forms that are used to represent what is thought, then, inside the classroom. (S7)

> to be able to expand the student's knowledge through those multiple languages, to present several languages, not only to be stuck with only one type of language, so to make available to the child this multiplicity of languages of different learning. (S10)

> they are the different ways of learning, not only that expository class but the practical class, the classes in loco, the coexistence with the object of study, the different ways of applying a discipline. ” (S13).

It is interesting to note that student S7 refers to multiple languages as a possibility of “emancipation” from language. She says:

> the teacher uses, from the written language, that we are moving from - how can I say – archaic, which would be a blackboard, to technology, using slides, using videos, in addition to the teacher's own speech. ” (S7).

Student S5 seems to have a confused understanding, but at the end of her speech she says that the teacher should use multiple languages, "for the more languages, the better the use of them". She says that:

> For me, multiple languages mean the way you can relate one thing to another, of knowledge, which the goal is to arrive at a synthesis of what you want to achieve, those languages talking to each other, you, for example, writing, reading, or interconnected with art, that is, you know how to internalize that part, you can absorb and pass on this larger content. So, the more languages, the better the use of them (S5).

S4, on the other hand, makes an effort to explain what it means by multiple languages, relating them to the contents worked in disciplines such as reading and writing skills and literacy. She refers to the disciplines of Brazilian Sign Language (LIBRAS) and braille. She sees the internet as multiple languages:

> Well, multiple languages, I think that in addition to the Portuguese language, that we learn, in college we learn with the acquisition of writing and also the reading and writing skills, there are other languages such as Braille or also Brazilian Sign Language (LIBRAS). I think that in addition to being written, it can be the oral part, the visual part, it can be storytelling, as I learned in college, I believe it can be the internet, which is another language, another way to interact, to understand. I think that's it! (S4).

In short, it has been clear that some students are unable to define multiple languages, and that most of them see ML as didactic resources or pedagogical strategies, which must be quite varied in the classroom. The students understand the multiple languages as means to teach content, as they mention: expository class, practical class, videos, dance, music, books, slides, theater, approaching a subject by the oral part, the visual, the storytelling, written language, art. It is clear that when they talk about ML, few students approach them

as forms of communication and expression, and this is always linked to the resources they understood as training facilitators, which should be used when they are working in their classrooms, which is still true, but the resources and strategies pointed out are always to assist more experienced children.

We have realized that only one student referred to multiple languages as something natural that develop independently of the use of pedagogical and didactic resources or strategies as we are referring to early childhood, that is, children who neither use verbalization nor visual, artistic, theatrical techniques to express themselves. She stated that

> "the language of crying, then we go on talking about body language, then the speech comes, asking for things until we reach adulthood and it always keeps going." (S11).

Regarding the importance of multiple languages for the training of the daycare teacher, two students said that children need to be seen in full and that if the teacher uses multiple languages in the daycare, it will lead to the children's development as a whole. The first student, S1, points to the practice of the teacher who should use resources (seen as ML) to teach the contents; the second student, S4, on the other hand, recalls the phases of child development and Piaget's contribution, since she recollected the sensory-motor phase, suggesting that the senses promote the expansion of multiple languages; the third student, S2, emphasizes the importance of promoting the teaching in different ways.

> The importance is that using those multiple languages you can develop the child in a more integral way, he can express himself in different ways than the ones you can achieve, as we also realized in the study of sciences that the more ways you use to attend a certain content, the easier it can internalize that learning. So, if you teach them colors, for example, if you teach colors visually, show, speak, sing a song, it will make it easier for them to develop and learn it. (S1)

> Essential, why? I think that, as the child is still in training, she is still very little, and when she is in this sensory, motor phase, in short, in which point of the senses he will start learning when you show a great variety of language, that is, through visual, auditive, through tactile, in short, yes, you can expand the development of this child a little more, this is how I imagine it. So, it's like you tell a story to the child, or you make a dynamic with some food that he can handle, or feel or smell, or pass a drawing that has something didactic, according to his age, I think that is extremely beneficial for her cognitive development. (S4)

> Well, I believe that when the teacher encourages what the student learns in different ways, he is preparing for his performance in the daycare center, because just reading about the theorists, about research, is just theory. I think it remains a very vague thing, even considering the internships, I think that if you worked with activities that you would do with children, it would make all the difference for when you graduate and act with this target public, you can develop it better. (S2).

When the students say that children should be seen in full, they are perfectly correct; when they say that they must learn in different and stimulating ways, they are equally correct. However, it seems that they speak only of the teacher's role as the protagonist while children are being placed as passive beings, who receive “teaching” through the multiple languages triggered by the teacher.

One student has presented a different view on the formative importance in the dimension of multiple languages, perhaps seeing as the possibility of establishing links and approximation.

> I think it's very important because, in addition to learning the theory, this part of multiple languages gives you room to get closer to the child. I think it makes you more comfortable with the child. It gives you the greatest coziness. Because the multiple languages give you other ways to work with, you will understand the theory of what is happening to children at this stage, but you will also know how to work with them if you get closer. Multiple languages make it possible for you, to be more comfortable with the child, to work in different ways. ”(S3)

Two students, S5 and S6, commented reflexively on their training, one of them referred to interdisciplinarity, giving an example of this type of work that the teacher must do at the daycare center; and the other recalled the question of the construction of the child and how the multiple languages favor this construction, adding how she intends to work it in the future.

> Daycare center? ... it is working with the interdisciplinarity of what the child brings from his home, this makes it much easier if working for example with music. Music represents several parts where the child can ... the professional can work with music in several areas, and it will introduce mathematics, it will introduce reading, even if the child is not suitable for that, but it starts to make sense because he brings that part from home, from other languages which will become one there, music works. So, these areas bring a lot of meaning to this learning as well, to my training. For my training, I will work in different contexts, I will not simplify a single context. What I can bring is, in my training, something that adds and that makes my student move from one stage to another, things that will mean something to him, [...] It has to make sense so that in the future he can add other things on top of what he has learned. Children's education is super important. It is a basis even to add other content, so if the teacher is aware of that, he will help in this area, collaborate. (S5).

> “So, I am currently working on my undergraduate thesis on the importance of playfulness. Despite being in elementary school, I believe that this importance has to be a continuous cycle. It is important for the teacher to understand that those languages favor the construction. I believe that there is no teaching-learning for children without those languages, I am defending this in my pre-project, and for me, in the future, I want to be this teacher, who will take all this language, all this knowledge to inside the classroom. (S6).

Two students, S8 and S11, talked about the child's expression. The first said that it is important because the teacher can deepen and develop a work focused on expression as an art; the second, referred to the importance of better understanding how the child expresses and communicates through the body:

> Ah, it is extremely important, for it is through those multiple languages that he can deepen, develop a work of importance with children, focused on an expression. I would say that of an invisible art. (S8).

> It is important for the child to develop and we understand the child because that child does not often speak, her body also speaks, if he is bad he will not say that he is bad, but his body will say that he is bad, then it is a way of language, and it is essential for the teacher to know all of this, to develop the student and also for him to develop himself. (S11).

Two other students, S7 and S10, referred to the creation of materials and other means: the first said that it is important as the multiple languages allow the teacher to create material to use with the children to develop their learning; the second student spoke of the importance of working with multiple languages for the daycare teacher, as it can provide other means than just play.

> The nursery teacher is very plastered in the fact that he only works with the care of children, so the multiple languages will allow him to create material, to promote this freedom in the classroom, to enjoy what already comes with the child daily to be able to develop some need in the classroom, to develop their learning. ”(S7)

> I see it as very important because sometimes we get too attached to some situations at school. The daycare center not so much because it is more the tripod to play, care for and educate, so he is supported in the playfulness, in the ludic, but presenting to the children, sometimes the teacher gets really stuck only in games thinking that sometimes children are not capable. So, presenting this to children, works of art, even the construction of mathematics, with blocks, logical blocks, then presenting this diversity to the child at all times. (S10).

In summary, we have found that most students realize that multiple languages are present in the course and that they are important for their training. They have talked about the possibility of multiple languages being deepened to develop a work that is focused on expression. They also have discussed the need for us to understand the child who does not speak yet, since her body speaks, understanding his attitude as a language of fundamental importance. The teacher “must know this to develop the student and to develop himself.” (S11).

2.2.4 Multiple languages in the pedagogy course: practices performed by teachers

In this category, we have sought to investigate how the students identify, in the studied subjects, the work with multiple languages. To this end, they answered two questions: “Point out the disciplines/teachers who

work and have worked the multiple languages in the pedagogy course and how the teachers have worked them; what strategies were used, giving examples.

Of the thirteen students interviewed, five responded directly to the subjects, their respective teachers and gave examples, while the others responded, commented on the work done by at least one of the teachers; two students have expressed how important this work was for their education:

> I remember that T has made the storytelling in literature. K has worked with reading and writing skills, showing us a lot, naming this area of languages a lot, the multiplicity of them. N has also worked with the literacy, with the acquisition of writing itself, making us prepare a portfolio, the activities, the look it must-have, the images, in short, the Braille in the execution of the exercises, and the tactile part[...] (S 1).

> [...] with NL, I had the acquisition of writing and there was a lot of storytelling there, the inferences have made a lot of sense for me, things that we have never paid attention to, as showing the book, the illustration of the book. For the child, it has to have a meaning, the inferences, so that they can participate in this storytelling, what kind of material you take to better work is when it is time to rewrite this story, [...] reading and writing skills and literacy with KR. (T5).

> Yes, teacher, he gave the art class, teacher K, with Literacy, N too, in the acquisition of oral and written language that has worked a lot this area of languages. L who taught LIBRAS - Brazilian Sign Language, G also who taught verbality, you can understand a lot. (T12).

> [...], but, among them, there is Professor K, that in the disciplines we had with her, there were three, the curriculum was one of the most important [...] It is art, I also believe that she works the multiple languages in a very extensive way, oh, there were many others [...] (T9).

> Hmm, I have in mind Professor K who gave us some work on AMORIM LIMA, who was a milestone in my training, as it made me understand a different way of teaching. I think if I hadn't been to Amorim Lima, if I hadn't researched about this school I would not have come with a different way of teaching, [...] Another way that also has helped me a lot was given by teacher J, for all the activities that she has proposed for us to do with our students, she has done with us, so we have worked together to do the activities, we know how it has to be done, because we have been through it, so it's interesting to know what the child goes through and we go through as well. So, it has happened with the activities and with the study. N's portfolio was also a very important influence in my training. (S11).

One student realized that throughout the course she had contact with the work with ML and was concerned to highlight the discipline Neuroscience with an emphasis on technologies:

> I believe that throughout the pedagogy course, teachers have used those languages that I have just spoken, mainly the technological ones. So, what is more recent is the discipline of Neuroscience, which was very interconnected with video lessons, speech and writing, and image representation in the history teaching methodology class. (S7).

The student (S10) has realized that the work with ML appeared in all subjects, but did not pay attention to it while fulfilling the subjects of the curriculum:

> Ah, literacy and reading and writing skills, reading acquisition, childhood studies also were important. Nursery and daycare, curriculum, have presented a little about something we were not used to, in a way it was multiple languages. I think that all the subjects that gave more emphasis to the child, the way children learn have shown those multiples. So, the child does not learn only in writing, he learns in different ways. (S10)

Considering how teachers have worked with ML and what strategies have been used, students talk about seminars and technical visits as strategies, others, activities that involve work with reading, theater, dance, puppet, logbook, portfolio, and storytelling, which sometimes appears as a strategy, sometimes as an activity. Three out of the thirteen students interviewed, have brought the theater with storytelling, as we can see in their speeches: S2, S3, and S5.

> [...] He was not only in theory, so we did not present slides, we did not do written work. He has proposed to do the theater the same way we would with the children. So, I believe it made all the difference. (S2)
>
> [...] the children's stories, we had to produce theater plays and present them in a classroom. Each group had the opportunity to present a different theater, in its own way, resulting in a super differentiated work, [...] we had to move our bodies, our emotions, our resourcefulness [...] (S3)
>
> The acquisition of writing had the interpretation that I didn't even mention. There had been the storytelling. There had been a portfolio that had a lot [...]of sense to me, because we work more with sound, the way such letter is pronounced, so, I think it helps a lot to facilitate the literacy of this child in that language. (S5).

Four students have spoken about the seminar as a strategy; the student (S6) replied that it was a strategy. Within the seminar, multiple languages appeared with dance, theater, puppet, and storytelling. Student S13 mentioned the seminar and the technical visits. And four students understood the technical visits as strategies that favor multiple languages:

> [...] I worked with lists, in a seminar. In that work, we had to explain how to teach children writing and reading using lists, [...] we were very restricted to that, literacy, writing and such and then she brought a song by Oswaldo Montenegro and we thought it was really cool to work with children as it brings a lot of reflection, as the song was to think about making a list about personal things like dreams, friends, not just as a segmented thing. (S 1)

> [...] both the exposition of classes and the content were passed in the form of videos, which is a type of language, in storytelling, or allowing how this storytelling is done, [...] lectures, seminars, video, class, I believe that even the part of the disciplines in distance learning, they are another type of language and a language even in a current modality that you can, finally, another type of language, the distance learning. (S4)

> Ah, at the seminar, we brought a lot of things like that, for example, we brought dance, we brought puppet theater, we worked storytelling in the educational corners, yeah, as I remember, I think that was it. (S6)

> The strategies used were visits, you know, visits to the study sites of the class, seminar work, and the importance of living the activity as if you were the student. It is to know what the student goes through to be able to know what to expect from the student. So I think those strategies were essential for my learning. (S13).

> [...] activity that we went to do at MASP, an activity that we did at the Memorial da América Latina, to visit an exhibition, that is, it was a different class, a class that was not just in the classroom, it was a class he taught us about arts, it was something new, so we had contact with a work of art. (S8).

> [...] yes, not only working in the classroom, going out on visits, museums, this helped a lot. I believe we can do that with our pedagogy students, not only as they did with us, adults, but with children too. (S9).

> Yes, with works, with drawings, with paintings, presentations of those works, did you visit the Memorial da América Latina, did you work a lot with slides? (S12).

> The strategies used were visits, visits to the study sites of the class, [...] (S13).

The concern of a student was to tell that the teacher used audiovisual resources as learning facilitators. She did not respond by mentioning a strategy; however, she did refer to audiovisual resources as facilitators of multiple languages:

> [...] when he used speech and the subject was not understood, he used video resource, or slide resource where he already had the subject, a little summarized, or a little more explanatory. (S7).

The logbook was pointed out by a student (S10), as being a job in which she checked multiple languages.

> We did last semester something really cool for me, which was the logbook, so we presented both written language and photos. In our logbook, we had the intention of taking the children to visit the space, so in a way you learn too, for me, it was very interesting, because I had never done this in-depth, in the discipline of geography methodology. (S10).

As we have seen, the students identified that the teachers worked with multiple languages, during the pedagogy course, in different disciplines. They spoke about the subjects, teachers, and strategies or audiovisual resources and gave examples of how this happened. Through the students' speeches, it was possible to notice that the teachers promoted contact with the students, holding seminars, using dance, music, theater, storytelling, using puppets; videos in expository classes, slides in explanatory content classes. The video classroom of the virtual learning space was also indicated as a promoter of a distinguished language. The students were put in contact with an art exhibition, lectures worked with a portfolio and slides, and made several technical visits, including museums. They commented on the logbook as a strategy for recording through writing, and with photos, the work with drawings and paintings, that is, they were basically the same strategies that the teachers answered when they were asked about which strategies they use to offer ML in the pedagogy course.

In summary, we observed that both teachers and students have the same understanding of training in multiple languages. We emphasize here that if we have our didactic intention clear, some teaching strategies favor multiple languages. For example, we highlight the logbook as a resource that favors reflection and recording, and we understand that it is formative as long as the students understand and experience the proposals.

As we have observed, both in the student's and teachers' statements, the technical visits to art exhibitions and museums were significant for them. We know that they are aesthetic experiences for both groups. An exhibition where you are not allowed to touch anything will not be a good place for children. Given what has been mentioned, it is observed that, although teachers and students know multiple languages, when we focus on the public of the daycare center, babies, most of the interviewees respond to multiple language practices only for older children, preschool children. This may indicate how difficult it is to understand those languages aimed at children at the daycare center.

3. Final considerations

With the analysis of the data generated in the research, we have found that, although teachers and students know multiple languages, it is still a distant knowledge from the work to be performed in the daycare center. Most interviewees have answered that multiple language practices were only for older children, that is, with the preschool segment. This could indicate how difficult it is to understand multiple languages for children in the daycare center. By observing the analyzed aspects, we have found that the teacher training with babies is still a recent issue in Brazil, and somewhat difficult to understand, because even if the contents proposed by the course subjects are studied, and indicators of official documents are known, it

seems that it is not yet clear the fact that babies are thinking beings- they will not become thinkers only when they grow up - that they have desires and intentions and that they can initiate communication through the senses.

Besides, it is necessary to broaden the view of both teachers and students, to consider that children are different from one another. This implies providing an education based on learning conditions that respect such differences. The concepts of phenomenology by Merleu-Ponty (1964) favor the expansion of this whole being, since the look and attentive listening are constitutive elements in the training of teachers. In the answers given by the teachers regarding the strategies that contribute to a teacher education committed to a view that values multiple languages, they have pointed out that they perform a diversified work, contemplating the artistic, plastic, visual languages and activities performed in the classroom, such as drawings, use of images, games, making pedagogical resources for daycare children, diverse textual genres, theater with storytelling, music ... Thus, all teachers try to promote those languages on the offer of their disciplines. However, such work is still directed at the preschool segment. Furthermore, with the answers given, we have found that the strategies are still unaware of what could be accomplished with the child who is in the daycare center. It seems that ignorance of childhood pedagogy, more specifically, of children's early years, could create obstacles to a more qualified performance in this segment.

Provisionally, we consider that multiple languages are all the personal dimensions that we use for our communication with the world in its diverse contexts and all the human possibilities that we find to express our desires, needs, wants, longings, feelings, thoughts, ideas, without limiting the areas of knowledge nor numbers that categorize them. Depending on the child's age group, those multiple languages will have a degree of greater or lesser complexity. According to Merleau-Ponty (1964), there should be no division in the human being. Therefore, man is a totality, a body that is in direct contact with the world in its feeling, in its thinking, and its action. Hence, solid professional training in multiple languages would be necessary for contact with young children. Therefore, some subjects, in the pedagogy course, could promote the aesthetic training of teachers, articulating sensory and integral formative experiences, through experiences in workshops, whose syllabus contents were intertwined in the dimension of teacher training, for the development of observation, reflection, an attentive eye to communicative manifestations, as well as through exercises and awareness-raising practices. We suggest that those experiences in workshops could compose the 400 hours of practice - curricular component - that are distributed throughout the formative process of the pedagogy course.

It is worth mentioning that the performance of actions that promote children's autonomy, which value the multiple languages, is only possible when the institutional space provides teacher autonomy. It is essential to value the actions to care for babies: the teacher also creates conditions and bonds that educate from touch, direct look, face to face, conversation, and affection. In this sense, we propose that those actions are perceived and experienced in the pedagogy course.

It is important to highlight the uniqueness and particularity of the children at the daycare center. Teachers would need to acquire those views on these specificities when they are teaching their subjects. We recommend a very consistent training of teachers considering the rights of children: they must have experiences of expressing themselves, of experiencing the different possibilities of languages, especially babies. We reinforce the proposal to make efforts to the pedagogy courses consider listening, attentive look, perception, and sensitivity as constitutive elements in the teacher training of early childhood education, especially in daycare. Finally, the relevance of the present research is because we could have more studies related to multiple languages - mainly babies' - and how they could be inserted in teacher training courses.

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Anatomical characteristics of the accessory hepatic lobe and its clinical-functional particularities

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Abstract

Riedel's lobe (ectopic lobe), also known as the accessory hepatic lobe, consists of an anatomical variation characterized by a tongue-shaped protrusion on the visceral surface of the liver right lobe, fixed by a pedicle. This variant draws attention in the clinical practice, as it can be mistaken for a tumor due to its elongated aspect. The aim of this research was to conduct a study on the anatomical characteristics and clinical and functional peculiarities of the accessory hepatic lobe. The paper is based on a integrative review and observational study on a cadaveric specimen. A cadaver with anatomical variation was used. Data were collected in PubMed, Scielo, and VHL. 257 articles were found in the databases, but only 13 were used for research. In careful review, two rare cases of the accessory lobe in the left lobe of the liver, hypoplastic left lobes, and agenesis of the right hepatic lobe, and often the clinical picture without changes in signs and symptoms were found. These morphological abnormalities' clinical impact is limited in the absence of underlying liver disease, cirrhosis, or known cancer. In case of complications or after the diagnosis of pedunculated tumors in the liver, laparoscopy is well indicated for removing these lobes or tumors.

Keywords: Riedel's lobe, Accessory hepatic lobe, Hepatic lobe anatomical variations.

1. INTRODUCTION

Riedel's lobe has this name because Bernhard Moritz Carl Ludwig Riedel (German surgeon, 1849-1916) reported it in 1888 in seven female patients who presented palpable masses in the right hypochondrium, which were later confirmed in a surgical procedure. This hepatic segment, defined as a supernumerary lobe of the liver, composed of the hepatic parenchyma, has continuity to the liver via a fixation stem (Figure 1). Its shape, size, and location are variable, often located in the right liver part, attached by a pedicle containing vessels and bile ducts, most of which are located on the underside of the liver or infrahepatic[1].

Also known as the accessory hepatic lobe, it consists of an anatomical variation, characterized by a tongue-shaped projection of the anterior border of the right lobe of the liver to the right of the gallbladder (Figure 1), in addition to the level of the lower costal cartilage when transmitted on cross-sectional images[2]. The prevalence is around 3.3 to 31% depending on the diagnostic criteria and used methods, and is more commonly found in women (H: M = 1: 3)[3]. Also, this anomaly can be mistaken for a tumor due to its elongated appearance[4].

This morphological lobulation is relatively asymptomatic, rarely found on physical examination, being diagnosed in an endoscopic procedure during abdominal surgery, necropsy[5], or cadaver dissection in the human anatomy laboratory.

Understanding this anomaly is essential for medical students and medical residents, especially clinical surgeons, due to the experience of several cases reporting malignancy and torsion involving Riedel's lobe, besides being a differential diagnosis for hepatomegaly and mistaken for a tumor mass. Therefore, this research aimed to perform a literature review and observational study on the accessory hepatic lobe's anatomical characteristics and its clinical-functional particularities.

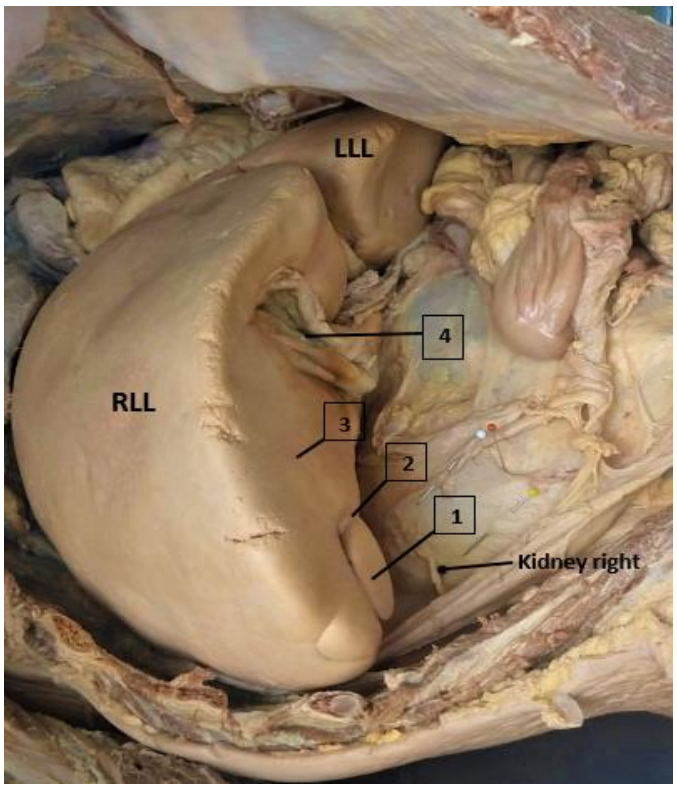

Figure 1. Accessory hepatic lobe. Legend: right liver lobe (RLL); left liver lobe (LLL); accessory hepatic lobe (1); fixation stem or pedicle (2); visceral surface (3); gallbladder (4), white pin (peritoneum); red pin (pararenal fatty body); yellow pin (Gerota's fascia).

2. METHODOLOGY

The paper is based on a integrative review and observational study using a cadaveric specimen. For the observational study, a cadaveric specimen from the Human Anatomy Laboratory of the Universidade Brasil, Campus Fernandópolis, SP, was used. It was a formolized male cadaver. According to Brazilian Law 8501, the material was used on November 30, 1992, which provides unclaimed cadavers for study or scientific research purposes. The review's data search focused on the following steps: review topic selection; literature search; literature selection/collection, reading and analysis; review writing; and references[6].

The scientific articles included in the study were obtained through the following platforms: Virtual Health Library (VHL), PubMed, and Google Scientific Electronic Library Online (SciELO). The titles and abstracts researched for the bibliographical survey were through the keywords: Riedel Lobe, Accessory Hepatic Lobe, and Anatomical Variation of the Hepatic Lobe.

The inclusion criteria were articles in the English language (2005 to 2021), available in their entirety, addressing the accessory hepatic lobe's anatomical and clinical characteristics, excluding articles that did not meet the established criteria. After the search criteria, the titles and abstracts were examined in total, so a series of articles for the review were found, 257 studies, and submitted to the eligibility analysis. Then 87 studies were selected for careful evaluation, and 13 were included and discussed in this study (Figure 2).

According to the search refinement, few studies were found on the subject. In the Virtual Health Library, 156 studies were identified, 30 articles with the descriptor Riedel's lobe, accessory hepatic lobe (101 articles), and hepatic lobe anatomical variation (25 articles). The publications from 2005 to 2020 were homogeneous, and no articles were found in the 2021 period. In PubMed, 100 articles were found, 20 with the descriptor Riedel's lobe, accessory hepatic lobe (42 articles), and hepatic lobe anatomical variation (38 articles). There was little research in the period from 2005 to 2014, totaling 37 articles. However, the prominence was found between 2015 to 2018, with 50 articles, already in 2019 to 2021, there is little progress in research, with 13 articles. Finally, in the SciELO platform, the publications found in this agency were heterogeneous, for having only one study related to the theme, being 1 article from 2008 related to the accessory hepatic lobe.

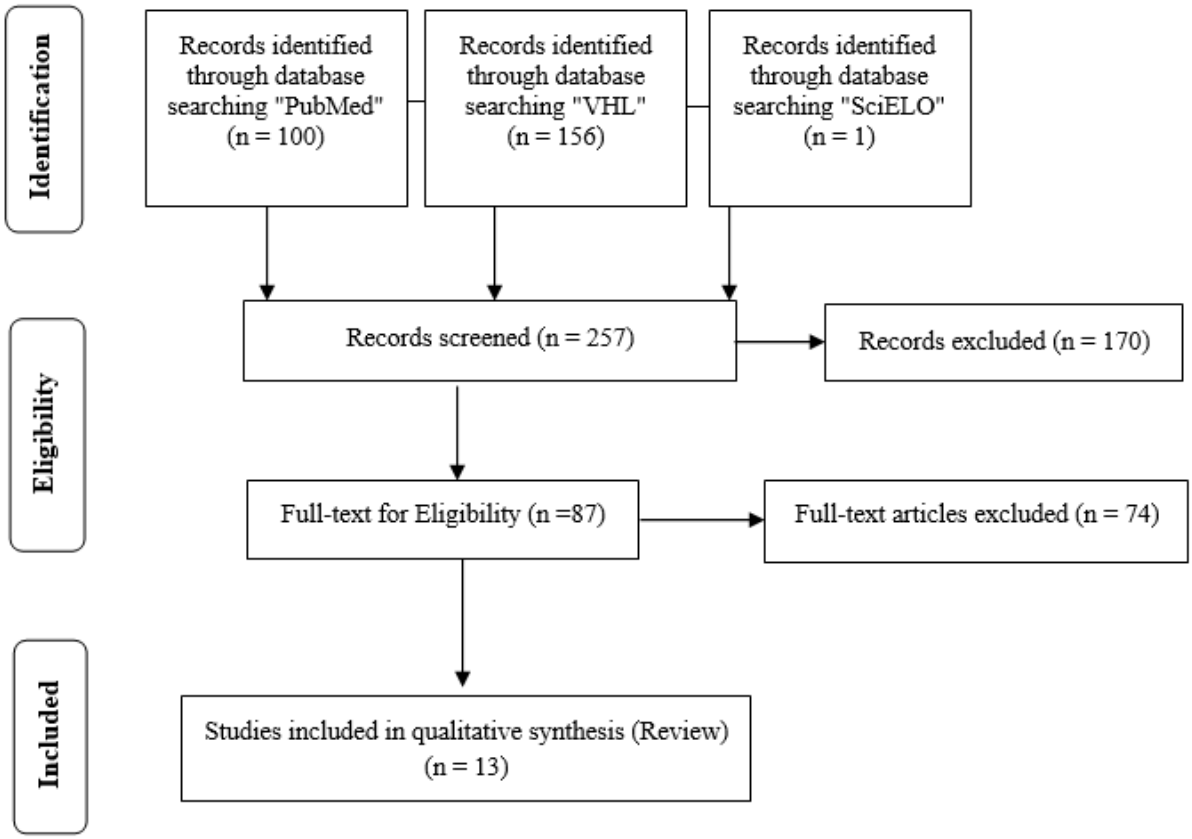

Figure 2. Flowchart.

3. RESULTS AND DISCUSSION

Figure 1 shows an increase in liver gland size, a characteristic defined as hepatomegaly. Due to this pathology, the lower border of the liver right lobe is very close to the iliac crest. This may confuse the health professional during the percussion in this area, presenting a change from a tympanic sound to a solid sound. In addition, the ectopic liver lobe is noticeable on the liver's visceral side in the right lobe. Note that the lobe is in the visceral surface's posteroinferior position, superior to the right kidney. As for the ectopic lobe location, clinically, it is believed that the sharp pain in the right upper quadrant can be confused with

severe abdominal pain when it is in the inflammatory process. This tongue-shaped liver morphology is an anatomical variation factor called the accessory hepatic lobe or Riedel's lobe.

Regarding the Riedel's lobe anatomical aspects, the study of Akbulut et al.[3] describes a rare case of an accessory lobe in the liver's left lobe. The patient, in this case, was an 81-year-old patient with cholecystitis, who presented a palpable mass in the right upper abdominal quadrant that extended to the epigastric region. It is important to emphasize that the imaging exams did not show the hepatic anomaly and were only discovered in the emergency laparotomy for acute abdomen due to obstruction of the pyloric region. Medically, Murphy's sign was positive in the presence of normal liver enzymes. Similar clinical case in an 80-year-old woman with similar clinical findings and anatomical changes[7].

Another relevant aspect is liver agenesis. Agenesis is a term used to designate a lobe's absence, but the missing segment is replaced by fibrous tissue. This anomaly is an uncommon condition and was observed in the studies of Nacif et al.[8]. The authors report that the finding is a rare congenital abnormality and defined as the absence of the right hepatic lobe. This type of situation can be diagnosed by ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI), or found during a surgical intervention in laparotomy maneuver.

In the study by Salzman et al.[9], A case report of an adolescent girl suffering from right upper quadrant abdominal pain worsened with body movements and ameliorated with ibuprofen. In this case, Murphy's sign was negative, liver enzymes normal, and the spleen was mildly enlarged. Imaging examinations showed a liver abnormality where the right lobe had an extension extending to the iliac crest.

Chien et al.[10] described the case of a 52-year-old patient with macroscopic hematuria and severe right flank pain. CT scan revealed a right renal mass of 7.8 ± 7.4 cm, and a laparoscopic right radical nephrectomy was planned. CT scan review revealed a Riedel's lobe extending caudally past the lower pole of the right kidney to the greater pelvis, compressing this region. The authors' reported difficulty was that Riedel's lobe obscured the operative field during right renal transperitoneal laparoscopic surgery, determining that failure to diagnose the accessory lobe may be an intraoperative complication.

The study by Savopoulos et al.[11], described the case of a 71-year-old patient, referring for hypergammaglobulinemia, with a clinical history of bilateral total hip arthroplasty that required a revision due to a local infection four years ago. The physical examination was unremarkable, and the patient was afebrile, with no palpable mass in the abdomen and no changes in laboratory tests. A thoracoabdominal computed tomography scan was performed, and in addition to many artifacts resulting from the bilateral hip arthroplasty, it revealed a collection in the right iliopsoas (abscess or hematoma) and a 24 cm homogeneous pedunculated mass in the liver's right lobe, elongated downward, ending inferiorly to the iliac crest; the Riedel's lobe was then diagnosed.

The study by Kurniawan et al.[1], on the other hand, reports the case of a 38-year-old patient who sought her gynecologist with a significant lower quadrant abdominal discomfort complaint. Physical examination showed stable vital signs and unchanged gynecological examinations. In the same exam, hepatomegaly was found by accident, later confirmed by hepatobiliary ultrasonography. The result showed an extension of the liver right lobe through the lower lobe of the right kidney, while the gallbladder, spleen, and pancreas appeared to be in healthy condition.

It is interesting to highlight a study of 58 liver specimens obtained from cadavers. Medical students from 2004 to 2012 at the Department of Anatomy of the MIMS medical school performed the study. Of the 58 specimens, 24 (41.37%) were standard, without fissures or accessory lobe and normal contour. Of the remaining 34 specimens, 31 (53.44%) specimens, despite appearing normal, had accessory fissures in the left lobe, right lobe, caudate lobe, and square lobe resulted in the formation of accessory lobes. Hypoplastic left lobes were observed in 2 (3.44%) specimens. The lingular process of the left lobe was present in only one specimen (1.72%). Observing the right lobe specifically, in only one specimen, two small accessory lobes were observed near the gallbladder base near the lower border[5].

One point to emphasize is that the accessory lobe can simulate a mass[12] in the right upper quadrant, with symptoms such as pain, vomiting, constipation, or local edema[2].

In this context, Riedel's lobe is a rare anomaly[13] found in the right hepatic lobe, characterized by an abnormal elongation that extends near the right iliac crest, usually producing pain, discomfort, or even the need for surgical intervention. Minor symptoms include acute or recurrent abdominal discomfort, nausea, constipation, or edema caused by extrinsic compression or an episode of torsion in this lobe with compression of adjacent tissues[2,9]. It should be evidenced that no pathognomonic sign for people with Riedel's lobe was found in any study addressing pathognomonic signs, making clinical diagnosis harder.

Such findings point out that the clinical picture usually shows discomfort in the right upper flank, without changes in vital signs and laboratory tests in most cases[1]. Imaging examinations or surgical findings made the discovery. In most cases, the treatment is conservative, consisting of rest, cold compresses, non-steroidal anti-inflammatory drugs, and medical attention in about three months for monitoring[11].

4. CONCLUSION

Riedel's lobe and other liver accessory lobes are anatomical variations with no particular consequences, except as a confounding source with tumors or the exceptional twisting of pedunculated shape. In the absence of underlying liver disease, cirrhosis, hepatomegaly, or known cancer, these morphological abnormalities' clinical impact is somewhat limited. In case of complications or after the diagnosis of pedunculated tumors in the liver, laparoscopy is well indicated for removing these lobules or tumors.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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Water quality and growth of juvenile specimens in giant freshwater prawn *Macrobrachium rosenbergii* (De Man, 1879) cultures applied in recirculation and biofloc systems

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Abstract

Biofloc research commenced in the late 1970s, with the white shrimp Litopenaeus vannamei and the Nile tilapia Oreochromis niloticus the most commonly studied species. The present study evaluated M. rosenbergii cultures in recirculation and biofloc systems by comparing the water quality and productive performance of juveniles in both systems. The study was based on a simple randomized experimental design with a recirculation and biofloc treatment, each conducted in triplicate. The initial length and weight of the organisms was 1.04 cm and 0.31 g (recirculation) and 1 cm and 0.30 g (biofloc), respectively, while the bioassay, which lasted nine weeks, was undertaken in a salinity of 5 ppm with a natural photoperiod (12:12). The present study monitored basic variables corresponding to the water, survival, growth (in weight), and the composition of the plankton.

The basic variables of the water (temperature, salinity, and pH) were kept within the recommended range for the culture. Of the plankton observed in the biofloc, nematodes, rotifers, cyanobacteria, ciliates, heliozoa, and dinoflagellates predominated. The organisms grown in the recirculation system reached 5.35 cm in length and 1.28 g in weight, while those grown in the biofloc reached 5.18 cm and 2 g, with significant differences in individual weight observed. Survival in the recirculation and biofloc systems was 73% and 60%, respectively, with significant differences observed. It is concluded that, although the survival rate was higher in the recirculation system, the weight of individual organisms was higher in the biofloc treatment.

Keywords: Biofloc, Macrobrachium rosenbergii, physicochemical parameters.

Introduction

Aquaculture has great economic potential in Mexico, bringing with it social benefits and providing an important source of food (Álvarez *et al*., 2012; Campos *et al*., 2016). In light of population growth, climate change, and globalization, the search for methods that promote the development of sustainable aquaculture is of the utmost importance (Campos *et al*., 2016).

Biofloc is an aggregate comprising bacteria, algae, and other microorganisms associated with particulate organic matter. In its initial stages, biofloc is formed by the colonization of heterotrophic bacteria, which secrete exopolysaccharides, which, in turn, facilitate the adhesion of microorganisms and organic matter (Crab *et al*., 2007; Ahmad *et al*., 2017; Venegas, 2019).

The microorganisms that develop in bioflocules play a key role in the nutrition of cultivated animals, as they are a rich natural source of proteins and lipids that is available *in situ* 24 hours a day. An interaction is produced in the water column among organic matter, the physical substrate, and a wide range of microorganisms, such as phytoplankton, free and attached bacteria, the aggregates of particulate organic matter, and herbivores, such as rotifers, ciliates, flagellates, protozoa, and copepods.

This natural productivity plays an important role in the recycling of nutrients and the maintenance of water quality (Emerenciano *et al*., 2013).

Among the main benefits of biofloc are water savings and the reduction of pelleted feed use (García-Ríos *et al*., 2019), with this system also increasing culture density and minimizing the use of space, thus guaranteeing a higher quality product than traditional systems (Mancipe *et al*., 2019).

In biofloc technology (BFT) systems, one of the most efficient methods for eliminating potentially toxic nitrogenated compounds occurs via the nitrification process, which consists in two phases: first, the bacteria of the genera *Nitrosomonas sp* and *Nitrosococcus sp* act on the ammonia generated by feces, urine, and food, oxidizing these residues into nitrite; and, second, the nitrite is converted into nitrate by bacteria of the genera *Nitrobacter sp* and *Nitrospira sp*, although, in some cases, the nitrate is reduced to nitrogen gas (via anoxic denitrification) by bacteria of the genera *Achromobacter sp* and *Pseudomonas sp*, thus completing the abovementioned cycle (Pérez-Rostro *et al*., 2014).

Among the most important parameters in biofloc cultures are dissolved oxygen, pH, temperature, ammonium levels, and salinity. While the optimal level of dissolved oxygen for shrimp is usually higher than 3 mg / l (D'abramo *et al*., 2003), it has recently been shown that shrimp can tolerate levels of 2 mg / l for short periods and survive. However, for farms that operate with BFT systems, it has been reported that the minimum dissolved oxygen levels must be higher than 4 mg / l (Miranda-Baeza *et al*., 2018).

The pH values in biofloc systems can vary from 6.8 to eight units, although values lower than seven are normal, and, if not properly controlled, could negatively impact the nitrification process (Emerenciano et al., 2017). Temperature is an important factor for the growth of organisms, which present better growth levels when the water temperature is within the optimal range, which, in the case of tropical species, varies from 28 to 30 ° C (Emerenciano *et al*., 2017).

Ammonium, in traditional cultures, should exceed 1.2 mg / l (Frías-Espericueta et al., 2000), although in BFT systems, this value should be lower than 20 mg / l (Emerenciano *et al*., 2017; Miranda-Baeza et al. 2018), while nitrites should not exceed 1 mg / l once the levels are considered stable, as high levels could be difficult to control (Emerenciano *et al*., 2017). Nitrates at concentrations lower than 100 mg / L do not present a high level of risk for organisms grown in biofloc (Miranda-Baeza *et al*., 2018).

As an alternative source of live food, flocs and their various benefits are of interest to aquaculture nutrition. Few studies have been conducted in Mexico on juvenile *M. rosenbergii*, despite it being a species with great commercial potential (Pérez-Fuentes *et al*., 2013). The present study aimed to evaluate *M. rosenbergii* cultures in recirculation and biofloc systems by comparing the water quality and the productive

performance of juveniles in both systems.

Materials and methods

The present study was carried out in the aquaculture bioassay laboratory of the Faculty of Biological and Agriculture and Livestock Sciences at the University of Veracruz, campus Tuxpan, in the state of Veracruz. The organisms were donated by the Postgraduate College, based at the Veracruz campus of the university, and acclimatized for 15 days on arrival at the laboratory.

Experimental design

The bioassay comprised two treatments (recirculation and traditional) conducted, in triplicate, using 300/L plastic tanks as the experimental units, into which 90 *M. rosenbergii* juveniles (the equivalent of 270 ind/m^3) were placed for each replica. The initial length and weight for the recirculation treatment was 1.04 cm and 0.31 g, respectively, and 1.01 cm and 0.30 g, respectively, for the biofloc treatment.

The water in the recirculation system was driven by an *airlift*-type system, while the experimental units were connected to a biological filter, with aeration provided by means of a ½ Hp electric blower. Prior to seeding, the system remained in operation for three weeks in order for the seedstock to mature, while, after seeding, a 50% water change was undertaken every week to guarantee optimal water quality conditions.

The experimental biofloc units were fitted with air diffusers on the tank floor to ensure that the matter remained suspended/keep the matter in suspension. Prior to seeding in the biofloc system, a three-week maturation period was applied, in which 5 g of unrefined sugar and 2 g of ground pelleted feed were added per m3 of water on a weekly basis. During the culture period, the carbon-nitrogen (C:N) ratio was 9: 1, while unrefined sugar was added as a complementary source of carbon, with the corresponding estimations made according to Avnimelech (2009). Both treatments used natural photoperiods of 12 h light and 12 h darkness.

Water quality monitoring

The water variables (salinity, temperature, and pH) were measured twice a day at 09:00 and 21:00, with the salinity measured using a Brixx refractometer, the pH measured using an API saline water kit, and the dissolved oxygen levels measured using a HANNA® model HI9747 oximeter.

The ammonium and nitrite levels in the biofloc system were monitored weekly for both treatments, while the nitrogen compounds were measured using a HANNA model HI83300 field photometer.

The amount of suspended solids was measured every week, using an Imhoff cone, with a 1L biofloc sample taken, for each measurement, and left to stand for 30 minutes prior to the reading.

Monitoring of microorganisms in the biofloc system

Every week, water samples (500 mL) were taken in the biofloc tanks and left to settle in the laboratory for a period of 60 min, fixed in 100 mL containers with 4% formalin, and then viewed under an optical microscope.

Feeding

In both treatments, the organisms were fed twice a day, at 09:00 and 19:00. The proportion of feed was calculated based on the estimated living biomass and adjusted weekly, from 10% at the beginning of the experiment to 5% by the end. Commercial feed, 0.5 mm in diameter and comprising 45% crude protein,

4% fiber, 9% fat, 13% ash, and 12% moisture (of the brand Pedregal®), was used.

Growth in length and weight was calculated biometrically. The length of the individuals was measured from rostrum to telson with a transparent ruler, while their weight was taken with a digital scale precise to a tenth of a gram. At the end of the bioassay, the organisms were counted to estimate the survival rate.

Data processing

The data obtained was subject to an analysis of the statistical assumptions of normality via the Shapiro Wilks test, while the homogeneity of variances was analyzed using Levene's test, with a significance level of $P < 0.05$. To ascertain the differences between both treatments, Student's t tests were performed, with data not complying with the assumptions analyzed via the nonparametric Mann-Whitney test. All statistical analyses were performed using the Minitab 10 software.

Results

The salinity levels in the biofloc treatment presented a minimum value of 4 psu and a maximum value of 6 psu, while minimum and maximum values of 5 psu and 7 psu, respectively, were observed for the recirculation treatment. In both treatments, the average salinity level observed throughout the experiment was 5 psu, with no statistically significant differences observed.

In the mornings, the dissolved oxygen level for the biofloc treatment was recorded, giving a minimum value of 6 mg / l and a maximum value of 9.6 mg / l, while, for the recirculation treatment, a minimum value of 5.3 mg / l and a maximum value of 7.5 mg / l were observed. During the night, the biofloc treatment presented a minimum value of 5.9 mg / l and a maximum value of 9.2 mg / l, while the recirculation treatment presented a minimum value of 5.1 mg / l and a maximum value of 7.7 mg / l. No statistically significant differences were observed for dissolved oxygen between the treatments.

The biofloc system presented a minimum and maximum morning temperature of 18 ° C and 28.2 ° C, respectively, while this was 22.2 ° C and 27 ° C, respectively, for the recirculation system. At night, the minimum temperature for the biofloc treatment was recorded at 19.5 ° C with a maximum temperature of 30.9 ° C, while, for the recirculation system, the minimum value was 23 ° C and the maximum was 28.7 ° C. The student's t test did not show statistically significant differences.

For both treatments, the minimum pH value in the morning was 8.2 units, while the maximum was 8.4 units. From Day 5 onwards, it was noted that a pH value of 8.2 became constant for both treatments, between which no significant differences were observed.

The ammonium levels in the biofloc treatment presented minimum and maximum levels of 0.25 mg / l and 0.36 mg / l, respectively, with stable concentrations close to 0.2 mg / L then obtained from Week 3 onwards. Minimum and maximum ammonia values of 0.25 mg / l and 0.55 mg / l, respectively, were obtained for the recirculation system. The student's t test did not show significant differences between the two treatments for this parameter.

A minimum nitrite level 1 mg / l was observed for the biofloc treatment, with a maximum peak of over 20 mg / l, while this variable remained at zero for the recirculation system due to the weekly water replacements carried out. The minimum and maximum nitrate levels observed for the biofloc treatment were 5 mg / l and 17.5 mg / l, respectively, with this variable beginning to increase once the nitrite levels

began to decrease. The nitrate level was 0 mg / l for the recirculation system.

The levels of suspended solids in the biofloc system ranged from 5 mg / L to a maximum of 8 mg / L and were found to be close to 1 mg / L for the recirculation system. The student's t test showed significant differences between treatments for this variable.

The microorganisms that presented during the first two weeks of the biofloc treatment were *Spirostomum sp*, *Epistylis sp*, and microalgae, with *Euplotes sp*, *Oscillatoria sp*, *Epistylis sp*, and *Paramecium sp.* appearing in weeks three and four. At the end of the culture, *Paramecium sp*, nematodes, *Aspidisca sp*, *Oscillatoria sp*, and rotifers were also observed (Figure 1).

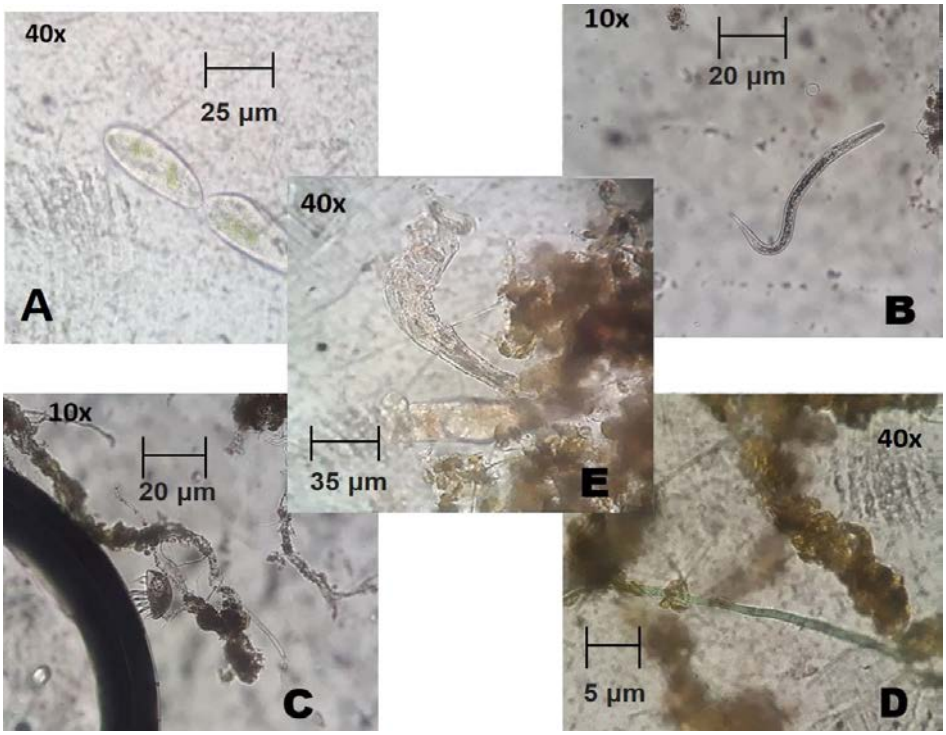
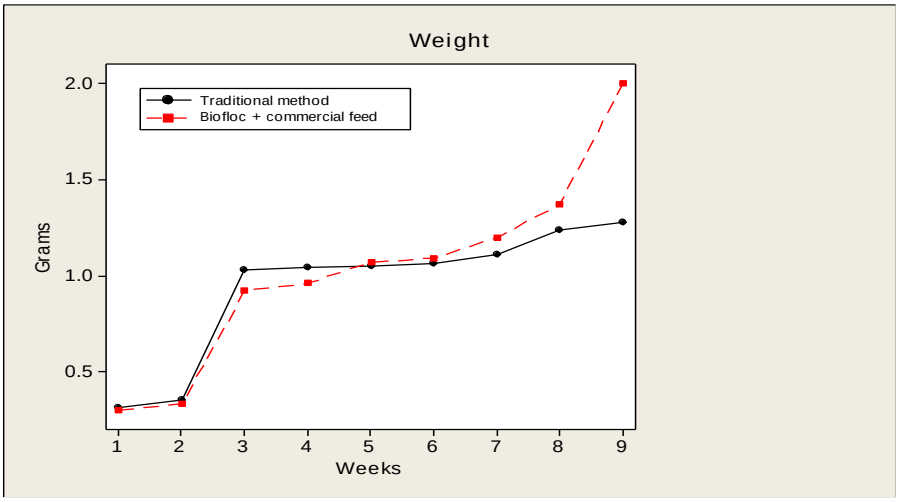


Figure 1. Some microorganisms present in the biofloc treatment at the end of the culture period: *Paramecium sp* (A); nematodes (B); *Aspidisca sp* (C); *Oscillatoria sp* (D); and, rotifers (E)

The daily weight gain observed for the recirculation treatment was 0.01 g, while this was 0.02 g for the biofloc treatment, with the student's t test showing significant differences. By the end of the experiment, a length of 5.35 cm and a weight of 1.28 g were observed for the recirculation treatment, while these variables were 5.18 cm and 2 gm, respectively, for the biofloc treatment. The student's t test showed significant differences (Figure 2).

Figure 2. Average individual weight of *M. rosenmebergii* grown in the recirculation and biofloc systems.

The survival rate was found to be 73% and 60% for the recirculation and biofloc treatments, respectively, with significant differences observed between the treatments (U <0.5).



Discussion

With dissolved oxygen being one of the most important parameters for shrimp culture, the average levels obtained by the present study for this parameter were 6.9 mg / l (recirculation) and 7.9 mg / l (biofloc). Miranda-Baeza *et al*. (2018) recommend minimum values of over 4 mg / l for biofloc culture systems. With D'abramo *et al*. (2003) suggesting that this parameter should remain above 3 mg / l, both treatments were found to be within the optimal range. With PH also an important variable, a study conducted on juvenile *M. rosenbergii* by Tidwell *et al*. (2003) found pH values of 9.0 units, a level considered critical. The average pH value observed in the present study was below 9.0 units for both treatments, which concurs with that recommended by D'abramo et al. (2003), who indicate optimal pH values of between 6.5 and 7.5 units. For biofloc systems, Emerenciano *et al*. (2017) recommend a pH of over 7.0 units in order to enable nitrifying bacteria to develop adequately in the flocs and carry out the nitrification process.

With regard to temperature, Singholka (1984) recommends an optimal temperature of between 18 and 34 ° C. As the bioassay conducted in the present study obtained an average temperature of 24.4 ° C for the recirculation treatment and 24.7 ° C for the biofloc treatment, these values were found to be within the optimal range for the development of the organisms.

While *M. rosenbergii* larvae require brackish water of 12 ups, when entering the near-juvenile stage, they need freshwater and can withstand a change in salinity of 12 to 0 ups. López (2004) recommends that this change in salinity be gradual, although this point does not appear in the literature cited. The present study maintained salinity at between 5 and 8 ups, thus staying within the recommended range.

Ammonium results from the metabolic waste produced by organisms (Emerenciano et al., 2017). Miranda-Baeza *et al*. (2018) indicate that, for commercial cultures produced via biofloc systems, ammonium levels should not exceed 20 mg / l; however, for traditional cultures, Frías-Espericueta *et al*. (2000) recommend levels of below 1.2 mg / l. As, in the present study, ammonium levels remained at an average of 0.26 mg / l (biofloc) and 0.28 (recirculation), they were within the optimal range.

Boyd (2001) suggests a nitrite concentration below 0.23 mg / l for traditional systems, while, for biofloc systems, Emerenciano *et al*. (2017) recommend that said concentration does not exceed 1 mg / l once the medium is stable, as it is normal for this parameter to be high while still in the maturation process. A peak of over 20 mg / l was recorded in the fourth week for the biofloc treatment, after which the levels dropped

to and remained at levels close to 0 mg / l until the end of the experiment, while, in the recirculation treatment, this variable remained at levels close to zero due to the water changes. The nitrate levels remained well below 100 mg / l, at which level and above the organisms may be damaged (Miranda-Baeza *et al*., 2018).

In BFT systems, floc levels tend to increase with the age of the culture and in accordance with the amount of feed added and the effect of adding external carbon sources (Emerenciano *et al*., 2011). Together, these factors increase the amount of particulate organic matter and microorganisms, which should be monitored in order that suspended solids remain at adequate levels for the species cultured. In this regard, Avnimelech and Suryakumar (2017) recommend concentrations of between 200 to 300 mg / l, concentrations which may vary depending on the species and the age of the organisms cultured. Emerenciano *et al*. (2017) recommend levels of sedimentable solids of 5 to 15 ml / l for shrimp grown in biofloc, a suggested range with which the present study complied, maintaining levels of 6 mg / l to 8 mg / l.

The diversity of microorganisms that develop naturally in the biofloc system tends to increase with the age of the culture. Various authors have monitored the succession of the main groups of microorganisms, among whom, Emerenciano *et al.* (2011) report four main groups, including protozoa (ciliates), rotifers, cyanobacteria (filamentous and unicellular), and pennate diatoms. Moreover, Monroy-Dosta et al. (2013) described five groups, comprising nematodes, microalgae, ciliates, rotifers, and bacteria. Jiménez et al. (2017) recorded seven phytoplankton genera, twelve ciliate genera, and one rotifer genus when molasses was used as a carbon source, while, when molasses and polished rice were used, three phytoplankton genera, five ciliate genera, and one group of rotifers were recorded. The present study registered six groups of microorganisms at the end of the culture period, including nematodes, rotifers, cyanobacteria, ciliates, heliozoa, and dinoflagellates, results which, in general, concur with previous studies and reinforce the importance of biofloc as a permanent source of live food.

Among the most important benefits of biofloc culture is its contribution to the nutrition of organisms. Studies conducted on stable isotopes indicate that biofloc contributes, by up to 18%, to tissue formation in shrimp (Ray *et al*., 2017). The foregoing concurs with the results obtained by the present study and may explain the difference found in final weight between the organisms grown in the recirculation and biofloc systems (1.28 g / ind and 2.0 g / ind, respectively).

Although biofloc provides live food of high nutritional quality via high-density systems, it is necessary to supplement the organisms' diet with pelleted food (Moreno-Arias *et al*, 2018). Emerenciano *et al*. (2011) found that postlarvae of the pink shrimp *Farfantepenaeus paulensis* fed with biofloc plus commercial feed presented a significantly higher weight (235 mg) than those cultured with biofloc without a feed supply (218 mg).

Previous studies conducted on shrimp and prawn have shown that organisms cultured in biofloc reach higher individual weights than those cultured in traditional systems. Among said studies, Pérez-Rostro et al. (2014) reported that *M. rosenbergii* adults reached a weight of 15.17 ± 8.2 g / ind in biofloc, while weights of 12.57 ± 7.89 g / ind were obtained by cultures using traditional methods. Furthermore, Kim et al. (2014) reported a final average weight of 13.298 g/ind for *Litopenaeus vannamei* cultured in biofloc and 7.767 g/ind for the control treatment.

Finally, Emerenciano et al. (2011) reported a higher survival rate (84.8%) for the postlarvae of the pink shrimp *Farfantepenaeus paulensis* in the control treatment than in biofloc treatments applied both with and without commercial feed (81.5% and 67.0%, respectively). Pérez-Rostro *et al*. (2014) recorded an 85% survival rate for *M. rosenbergii* via both traditional and biofloc culture methods. The present study obtained a lower survival rate for the biofloc treatment (60%) than for the recirculation system (73%), which could be due to the peak of nitrite levels registered during the fourth week of the culture. As research on *M. rosenbergii* cultures conducted in biofloc systems is incipient in Mexico, it is necessary to continue studying this species to obtain more information that would enable its exploitation in the medium term, due its high commercial potential for inland systems.

Conclusion

M. rosenbergii juveniles cultured in biofloc presented a higher individual weight than those cultured in the recirculation system, which can be attributed to the presence of permanently available live food.

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Research on Application of Teaching Informatization Construction Based on Cloud Computing

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Abstract

Cloud computing is the integration and storage of teaching resources in the cloud through modern network information technology, which can provide a convenient and fast platform for the construction and sharing of teaching resources informatization in colleges and universities. This paper first introduces teaching informatization and cloud computing, proposes that the main part of teaching informatization is teaching resources informatization, and the shortage of using information technology combined with it at present, and gives the advantages of cloud computing for teaching resources informatization application of high efficiency and sharing. Through the application of cloud computing, the teaching resources of colleges and universities are more perfect and sufficient, which is beneficial to assist the development of intelligent education and improve the education level, and promote the construction of teaching informatization.

Keywords: Teaching informatization; Teaching resource informatization; Cloud computing.

1. Introduction

1.1 Teaching informatization

Teaching informatization mainly refers to the whole process of using Internet technology to collect and obtain teaching information, adjust, improve and optimize teaching behavior.

It is an important part of education informatization. Guided by modern teaching concept and with modern information technology as the main instrument, teaching informatization serves teaching and learning, comprehensively improves teaching efficiency and quality and realizes modernization of college teaching. Its basic connotation includes five parts: infrastructure construction, teaching resources informatization, teaching process informatization, comprehensive service informatization and guarantee system construction. In recent years, the rapid development of mobile Internet, intelligent terminals, artificial intelligence and big data has had a significant impact on education and a great impact on the traditional manager-centered informatization construction. The teaching environment such as teaching means and

teaching space in the traditional sense has changed dramatically, and the time and space of teaching has been greatly expanded. Currently, teaching informatization construction is being explored and developed continuously, and it is expected that teaching informatization construction will promote the continuous development of education, innovate informatization teaching mode and cultivate high-quality talents to meet the needs of social development.

Cloud computing, virtual reality technology, mobile Internet, big data, etc. can boost the construction of college teaching informatization, and only when information technology is effectively applied, college teaching can cause a technological revolution. A lot of experiments have been made on the use of information technology: X. Liu and K. Li (2016) examine the impact of a teaching model that combines online learning and classroom flipping by building high-quality micro-course resources in a variety of ways on teaching and learning in higher education schools. Y. Li (2020) studies the application of information-based teaching methods in the English classroom. N. Li (2020) proposes the application of information technology in theoretical and practical teaching of college physical education elective courses. MH. S et al (2020), analyze the dilemma of computer education in information-based colleges and universities, and then proposes scientific countermeasures. M. Qin (2020) proposes to integrate information technology and give full play to the advantages of information technology in education, making the teaching of microcontrollers interesting and understandable. J. Zhu (2019), advocates the combination of multimedia network technology and the application of modern educational techniques and methods to reform and transform the teaching mode, teaching content and teaching methods of art education. F. Gao (2020) proposes a new way of thinking to build an information management teaching model. J. Chen and H. Dou (2021), analyzes the strategy of informatization of university education and teaching management in the era of cloud computing and big data, and designs a set of informatization management system. R. Wang (2020), proposes the model of cloud classroom teaching activities based on xAPI and PHP web development technology, which can record and analyze the whole process of cloud classroom teaching activities in detail. L. Yan and W. Yue (2020), grasp the three aspects of the connotation of information technology in education from three aspects: information infrastructure, education, research and human quality, and advocates the concept of information-based education.

The construction of teaching informatization still has the problem that information technology and education teaching have not achieved deep integration. At present, the application of information technology in all aspects of teaching is still only at the primary stage, the interoperability and sharing of data and resources between different information systems needs to be strengthened, and the integration ability of data and resources needs to be improved.

1.2 Cloud computing

"Cloud computing" has gradually become an important term in the information industry, and has gradually moved from a concept to a focus on implementation. Cloud computing is an evolution of information technology and a major business model for delivering IT resources. With cloud computing, individuals and organizations can gain on-demand network access to a shared pool of managed and scalable IT resources, such as servers, storage and applications (A. Sunyaev, 2020).

Cloud computing is a program that uses huge databases for data processing and file handling offering a

better approach to storage, application and computing performance in today's world (Tadapaneni, 2018). Generally, resources and data are integrated into small programs, which are then analyzed and processed by multiple servers so that these small programs can serve the users. In simple terms, cloud computing is a kind of distributed computing, which uses simple distributed computing to allocate and distribute tasks, and finally merges the obtained calculation results to ensure that mobile terminals can complete a large amount of data processing and data operations in a short period of time. This is the most common form of data computing and processing in information computing, and is the embodiment of the advanced science that network technology has evolved today. Compared with the traditional network model, cloud computing data is more thoroughly virtualized, making the stored data highly flexible, scalable, and cost-effective.

As far as the current application status is concerned, cloud computing is a collection of multiple services in a three-tier structure. First, the underlying structure of infrastructure services (IaaS), which mainly includes computing and storage, is equivalent to renting computers and data center storage space to customers, and can be reduced and increased at any time. Second is the mid-tier application platform service (PaaS), which mainly refers to the running environment of actual applications, equivalent to providing customers with a specific operating system VM, custom software stack and application set. The third is the top-level software program service (SaaS), which is mainly a runtime model for a large number of application programs and is equivalent to renting a software application program according to the actual needs of the user . Cloud service providers charge according to the hardware environment, system platform, type of software program and time used by the user.

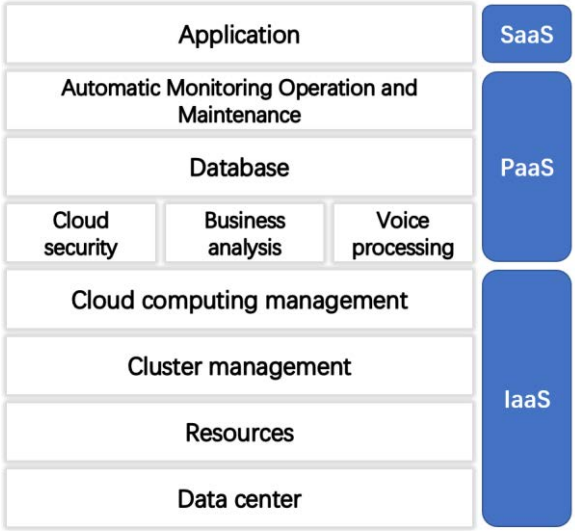

Figure 1. Simple construction of cloud computing.

The information construction of teaching resources is an important work for universities to promote information construction, which is a long-term and constantly updated process. And an advanced and stable network resource sharing platform is a guarantee for the construction and application of high-quality teaching resources. Cloud computing-based informatization teaching resource library can effectively improve the stability, scalability, sharing and security of the resource platform, which is not only conducive to the effective use of platform resources by users, but also improves the efficiency of platform resource management and maintenance. Therefore, cloud computing has a very important practical value in the

construction of teaching information technology.

2. Model Design

2.1 Infrastructure model

The rapid development of information technology and its wide application in education determines that the construction of modern teaching resources will be the eternal theme of teaching informatization in colleges and universities. The core problem facing the development of modern education technology today is how to use network multimedia technology to build teaching resources and how to effectively use these resources for teaching services. Therefore, this paper focuses on the application of cloud computing to the informatization of teaching resources. At present, the campus network construction of most domestic universities can meet the basic requirements and can build a cloud-based infrastructure model.

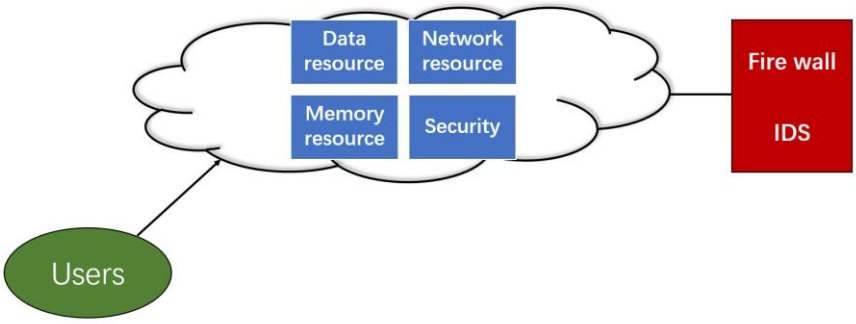

Figure 2. Infrastructure model of teaching informatization based cloud computing

The model is able to meet the needs of all parties in the university, such as students, teachers, researchers, administrators, and developers of information-based teaching and learning resources. The cloud-based infrastructure can provide computing and storage services to teachers and students, providing processing power, storage, networking and other basic computing resources that developers of teaching resources can use to deploy and run any software, including operating systems and applications, for network design and collaborative work to optimize all their needs.

2.2 Application model

The application model of cloud-based information technology teaching resources in universities is shown in Figure 2. The model is a powerful cloud network that connects a large number of concurrent network computing and services, which can use virtualization technology to extend the capability of each service and combine their respective resources through the cloud computing platform to provide super computing and storage capabilities.

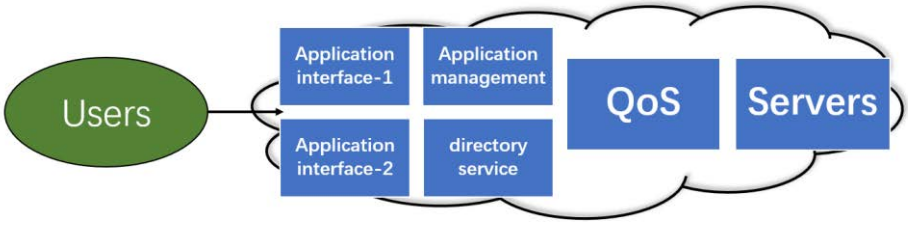

Figure 3. Application model of teaching informatization based cloud computing

Application interface. Provides an interactive interface for teachers and students to request services, and is also the entrance for users to use the cloud. Through a Web browser, you can register, log in and customize services, configure and manage users, and open application instances the same as a locally operated desktop system.

Directory services. Students and teachers can select or customize the list of services after obtaining the corresponding permission, or unsubscribe from existing services, and generate corresponding icons or lists to display the related services in the cloud subscriber side.

Application management. Used to manage cloud subscribers with computing resources and services available at the time of management, manage authorization, authentication and login for users, accept requests sent by users, and forward them to the appropriate applications based on their requests.

QoS. Autonomously deploys resources and applications intelligently based on user requests, dynamically provisioning and reclaiming resources.

Servers. Virtual or physical servers, managed by management systems, responsible for high concurrency user request processing, large computing volume processing and user web application services. The cloud data storage uses appropriate data cutting algorithms to upload and download high-capacity data in a parallel manner.

The most important features offered by cloud computing are availability and scalability. Application-based, user-friendly interfaces enable teachers and students to successfully scale their computing environments and quickly build personalized solutions based on content needs. Improved data mining techniques filter and find the content helping students. Students' goals are not limited to the curriculum or on-campus, so existing content is dynamically changing and requires customized services combined with third-party commercial services to build new applications. Informational teaching resources are stored on a cloud with space sizes allocated on demand and flexible scaling, forming a teaching resource storage cloud.

According to the previous discussion and application practice of cloud computing in the field of education informatization, it can be proved that cloud computing has a broad development prospect in the field of education informatization in higher education with its unique functions, features and operation mode. Using cloud computing for the construction of informatization teaching resources in colleges and universities, it is only necessary to connect the management terminal to the running equipment to transmit and process the informatization teaching resources. The requirements of cloud computing for the terminal are not high, and different computer devices and terminal devices are able to access the teaching resources used smoothly, simply and quickly. Universities can allow different students to use their personal computers to connect directly to the cloud for teaching resources inquiry and learning when teaching activities are carried out,

reducing the school's capital expenditure on resources for purchasing equipment. There is no need to develop a separate information technology teaching resource system, which makes the operation of teaching activities easier and faster.

3. Conclusion

The establishment and processing of college teaching informatization under cloud computing is the demand of the development of the times, which can indeed be close to the informatization of college management, make the integration and closeness of college teaching resources informatization faster, facilitate teachers and students to break through the limitation of time and space, inquire the knowledge they want to learn under different spaces, bring great convenience to learning activities and teaching activities, and provide effective conditions. The infrastructure model and application model of teaching resource informatization proposed in this paper provide certain guidance for teaching informatization, which can improve the stability, scalability, sharing and security of the resource platform more effectively. It not only facilitates users to use the platform resources effectively, but also improves the efficiency of platform resource management and maintenance. However, there are certain drawbacks in the internalization of teaching resources in colleges and universities supported by cloud computing, which need to be studied by relevant educational researchers in order to promote the benign development of informatization teaching resources construction work.

Acknowledgments

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COMPLIANCE APPLICATION PROCESS AS A STRATEGIC TOOL IN THE MANAGEMENT OF A THIRD SECTOR ORGANIZATION

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Abstract

Adapting to integrity models that respect the current legislation has become fundamental in the management of organizations as a strategic form, mainly in entities with public and non-profit purposes, in a non-governmental scope. Therefore, the objective is to implement a model for the application of the compliance program in a Third Sector institution. In this way, the present article can be considered in an exploratory, applied and qualitative way, in two aspects, bibliographic research and case study, the data collection was through a meeting and interview with the company's professionals, reporting the importance of the theme. The results showed the main tools and compliance mechanism, proposing actions that can be used in practice with the purpose of providing a broad view of the functioning of the proposed model, with transparency and ethics, thus increasing the competitiveness of the business.

Key words: Compliance, Ethics, Integrity.

I. Introduction

With globalization and technological advances in the corporate environment, interest in the compliance mechanism has increased, based on ethical and transparency principles, through guidelines developed according to the nature and resources of each company, in the search for reliability in the execution of its activities.

It is adapted to integrity models that respect current legislation, it has become fundamental in management as a strategic form, due to the increase in market competitiveness and the ease in obtaining information about organizations.

Compliance with the established rules pertaining to the business is essential, not only for tax and tax issues, but also for labor and environmental issues that must be properly addressed [1][2].

Thus, it is believed that there is a need for an analysis of the problem of organizations' difficulties in complying with standards, where it is necessary to know and measure the conducts that facilitate irregularities and acts of corruption, allowing the relevance of technical preventive procedures and a

punitive control, in order to exercise its role in society, managing resources in a transparent manner.

In view of this, it is of utmost importance to use compliance in the management of organizations, especially in Third Sector institutions, which are entities with public and non-profit purposes, in a non-governmental scope, in order to implement a set of adequate policy controls, organizational structure and software as strategic tools for good management and overcoming corruption.

According to [3] [4], the implementation of a protection and integrity mechanism is considered compliance, as it intends to improve the organization's relationship with society, with the public authorities and other interested parties.

Compliance alters the corporate climate in order to avoid risks, creating a more ethical environment, avoiding the practice of serious acts to the public administration, stipulating a code of ethics according to the nature of each company, being in compliance with the laws and acting with honesty [5].

Depending on the corporate doctrine, compliance can be understood as procedures adopted by a certain society, aiming to optimize the compliance with rules and policies established by the organization, with the intention of reducing risks and responsibilities [6].

With efficient compliance programs, companies create and maintain more quality in their operations and are able to attract more investors, having more credibility, obtaining better financing rates, growing more and better, in a sustainable manner [7].

However, compliance activity in the company is essential for a good impression of morals, aiming to improve its elements, also contributing with the instruments to control regularity and ethical behaviors [8].

In this context, the main objective of the work is to analyze a model of the application process of the compliance program in a Third Sector organization, reflecting on the importance of the theme in the institutions, identifying the main tools necessary for the procedure of these practices in these companies, showing the efficiency of their compliance mechanisms and their strategies for organizational management [9].

From an institutional and scientific point of view, this work is justified by the interest in the researched topic on the application of the compliance program in companies, through a literature review, private analysis and information collected in the studied institution, whose activities support development projects academic, scientific and technological, but that can be introduced in any institution that views organizational innovation, where results make it easier to understand the need to comply with rules and conduct so that their processes are successful.

II. Literature review

Due to the more competitive corporate scenario and with advanced technology, the dynamism in organizations has increased in the environment of major changes in business models. Thus, the need for a complete and responsible conduct grows even more in companies, and it is important to adopt compliance measures, which according to [10], the term of this word comes from English, from the verb to comply, which means to conform, to comply, obey some rule.

Compliance is understood as the following of rules, procedures, acting in conformity, in an ethical

manner in all activities, that is, compliance with laws and regulations, several actions that have positive impacts on any institution [11] [12].

According to [13], when an organization is in compliance, it is subject to ethical principles and observes its code of conduct, strictly following the current legislation, ensuring that the integrity of its management and its employees is preserved. Where their control systems, policies, structures, auditing, monitoring, in addition to the communication, training, and other processes are considered [14][15].

II.1 Compliance in the Third Sector

The performance of the Third Sector is obtained for several reasons, such as the growing economic and financial importance of organizations and the visibility of social movements supported by a vision of a more fair world [16-19].

According to [18], it defines the Third Sector in a more simplistic way, like all those non-profit institutions, in a private sphere, with purposes of public interest, in defense of rights, without obtaining individual profits or economic gains.

Its activities are considered as the institutional space that houses associative, private and voluntary actions, aimed at goods of collective consumption, without economic surpluses of particular appropriation generated in the process [16-17].

For [20], he says that the Third Sector has great power and by adopting socially committed management, in a serious and consistent way, these companies can obtain strong partners in the construction of a more responsible, prosperous and fair society. Figure 1 shows the partnership between the Third Sector and other sectors.

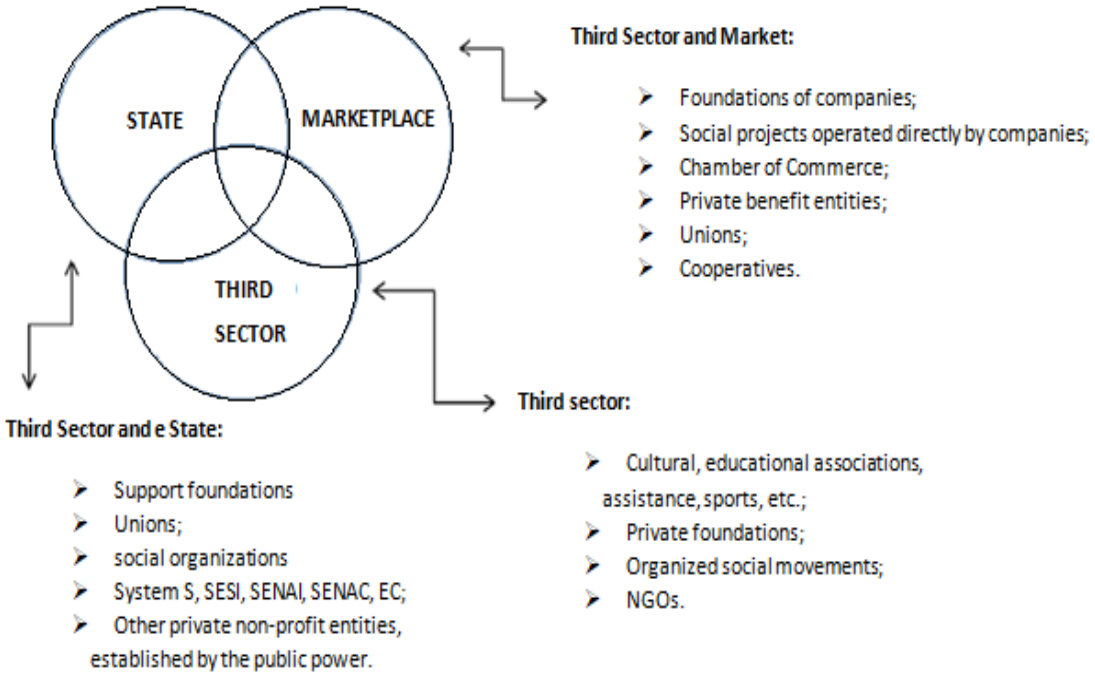

Figure 1: Partnership Third Sector with the other sectors.

Source: Adapted from [20].

In Brazil, the Third Sector contains a great diversity of non-profit organizations that operate in different areas, such as: health, education, culture, social assistance, human rights, environment, science and technology, among others [21] [22].

In Figure 2, it is possible to see the map of Civil Society Organizations - CSOs existing in Brazil, as social entities, cooperatives, foundations and political parties.

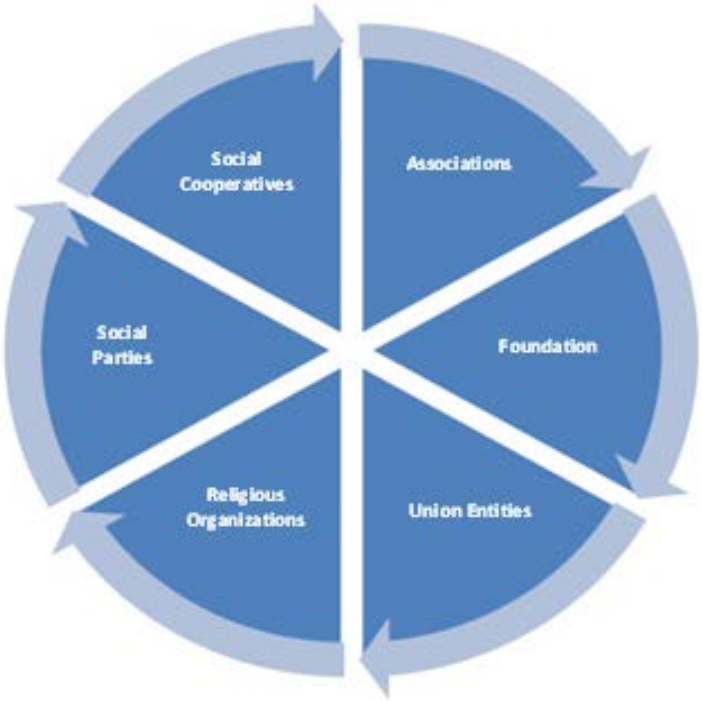

Figure 2: Map of Civil Society Organizations - OSC.
Source: Adapted from [21].

II.2 Necessary tools for compliance in the third sector

The incorporation of compliance as a tool in the search for legality, security and the standardization of processes, was carried out in an evolutionary way in Third Sector organizations, acquiring a scientific and technical basis for the foundation of changes that would go beyond theory, in order to guarantee training, control and adequacy of legal and institutional procedures [23].

The tools of an integrity program help to strengthen the institution's credibility in a solid manner, optimizing the quality and efficiency of its actions, improving levels of corporate governance, focusing on prevention practices and reducing all types of exposure to risks [24].

The authors [25], highlight some essential tools of the compliance program:

- Formation of the organization's code of ethics;
- Support in the development of professionals in their ability to deal with ethical situations;
- Creation of means for the recognition of unethical actions, with a debate on the subject being allowed [25].

However, it is indicated that there is a responsible manager in the organizations for this, being in charge of developing and structuring the compliance system throughout the institution [25].

The role of compliance is consultancy in the organization, where the paths effectively lead the institution and its employees to practice and respect good governance on a daily basis, tracing strategies

aligned with variable and dynamic programs [26].

The tools offered by compliance are quite efficient in the organizational environment, which include the opportunity to reverse the destroyed image faced in the market, its application makes it possible to impose a significant level of the solidarity and social function of the institution [28].

In order to include corporate integrity in the organizational environment, the integrity of the people involved should not be expected to come in an instinctive manner, and it is necessary to establish a set of values and principles, following internal procedures and rules that can serve as a guide to guide the performance of everyone's conduct [29].

According to [30], he says that one of the most important tools to establish a corporate culture model of compliance is the formalization of guidelines and standards of behavior, monitoring and continuous improvement.

For [31], he stresses that the compliance tools in the institutions, must act in compliance with internal and external rules, laws and policies, with participation in the approval of new processes, disseminating high ethical standards and strengthening the culture of internal controls.

For [31], he also mentions the tools for monitoring and controlling compliance that can be implemented within the organization:

- Compliance Tools: Regulations and Policies;
- Compliance Tools: Culture and Code of Ethics;
- Compliance Tools: Internal Controls and Risk Management [31].

II.3 - Compliance mechanisms and their application in organizations

With compliance being considered a set of measures internal to companies, the procedures for auditing legal compliance in the organizational environment have become more acceptable, reinforcing ethical commitments, aiming to prevent or reduce risks of violation of legislation [32].

It is important to highlight that innovation in management through compliance mechanisms is not normally used preventively, but due to some imminent internal or external event, as well as, in the need to raise funds, in preparation for obtaining funds. good measures or when a penalty is imposed [33].

For [32], he points out that the application of compliance mechanisms reinforces the use of the instrument aimed at combating corruption and, they implement cautious procedures that make it possible to minimize this vulnerability and, monitoring must be implemented in organizations, checking if ethical standards are in accordance and in accordance with the legislation in force.

A Third Sector organization that values good governance practices and transparent management can achieve its strategic objectives more firmly [29].

II.3.1 Benefits of compliance mechanisms

For [32], compliance is very important for organizations, being essential to the company's image and, mainly, to ensure competitiveness, meeting legal requirements through compliance procedures.

The authors [34], highlight the main compliance benefits for companies that adopt compliance:

−Civil and Criminal Integrity Preservation Program, which allows the prevention and reduction of the risks of non-compliant conduct, with the Organization's Senior Management (AAO) responsible for the potential illegal or irregular behavior of its employees, providing a reduction in the degree of exposure;

- Reduction of the incidence of fraud and non-conformities that generates diversion of resources, increasing performance and efficiency;
- Prevents risks of legal sanctions, financial loss and impact on the organization's image;
- Puts the quality of decisions within the company, reducing operating costs;
- Increased efficiency in management and better performance of the company;
- Competitive advantage vis-à-vis other companies, in relation to transparency and ethics;
- Gains in productivity, due to an ethical organizational culture, influencing the integrity of employees;
- Transmission of good practices, expanding the harmonization of the internal public and generating continuous improvement in activities [34].

II.3.2 Structure of the compliance program

The structure of the The compliance program must be well planned and according to the reality of each organization, its particularities, such as: culture, size and sector, need to be balanced and must require a focus on its performance [35].

According to [36], the first steps involve knowledge of the objectives, principles, goals and vision of the company, and it is essential to know and understand well the business and the area of operation.

It is essential for the compliance program to define the processes that involve the identification, measurement and prioritization of the organization, taking into account the risks and the line of defense, as well as the integrated management, in addition to other issues that are related to these aspects [37].

According to [36], after the program is described, it needs to be structured. Figure 3 shows one of the several structure models of the compliance program.

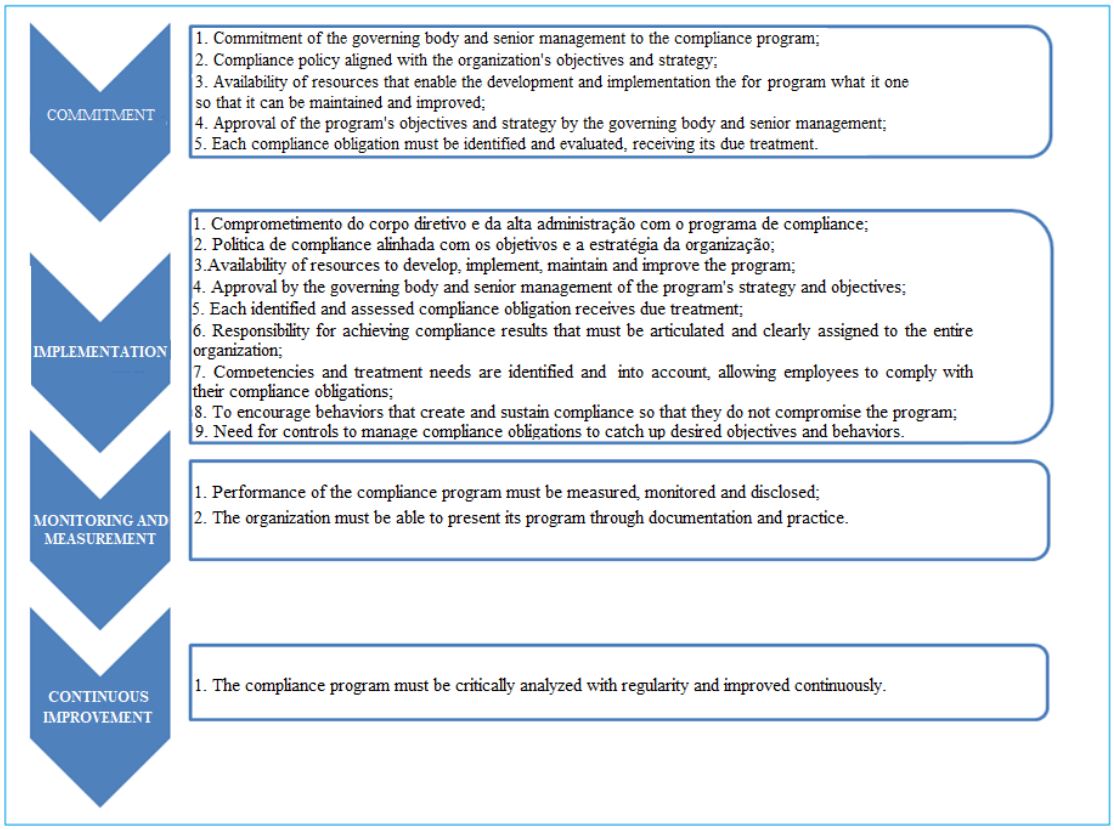

Figure 3: Structuring model for the compliance program.
Source: Adapted from [36].

With the program structure defined, it is essential to establish initiatives that collaborate with business strategies, such as the pillars of compliance, to make the fight against corruption an effective practice in organizations [38].

2.3.3 The pillars of the compliance program

Conforming [23], compliance is a program seen as an organized and complex system that interacts with other business processes of the company, composed of several components and depends on a multiple structure that includes procedures, systems, people, documents, ideas and actions. These components are considered pillars, defined in Table 1.

Table 1: Pillars of the compliance program.

Pillars of the Compliance Program	
1st Pillar - Top Management Support	It must receive unconditional support and endorsement from the company's top executives.
2nd Pillar - Risk Assessment	These are events with negative impacts in reaching a goal. It is seen as one of the bases of success of the program, due to the policies, the code of conduct and the monitoring efforts that must be built from the

	risks identified as relevant during the analyzes.
3rd Pillar - Code of Conduct and Compliance Policies	Documentation that serves as an initial formalization of what the company's posture is in relation to the various subjects on its business practices, serving as a guide in conjunction with the actions and examples of senior management, where it shows the company's commitment to the compliance program.
4th Pillar - Internal Controls	They are generally formalized mechanisms in writing in the company's policies and procedures and minimize operational and compliance risks, ensuring that the accounting and financial books and records accurately reflect the company's business and operations.
5th Pillar - Training and Communication	Each employee of the company, from all sectors and management must understand the objectives of compliance, the rules and most importantly, their role in ensuring the success of the program.
6th Pillar - Reporting Channels	Communication channels such as "whistleblowing channels" provide employees and business partners with a means of alerting them to potential violations of the code of conduct, other policies or regarding inappropriate actions that are taken on behalf of the company.
7th Pillar - Internal Investigations	Companies need to have internal processes that allow investigations to promptly respond to reports of illicit or unethical behavior, ensure that facts are verified and responsibilities identified.
8th Pillar - Due Diligence	It is the assessment prior to contracting to comprehensively understand the corporate structure and financial situation of third parties, surveying the history of potential commercial agents, checking whether they have a history of unethical practices or in any way, may expose the company to a business that involves risks cool.
9th Pillar - Auditing and Monitoring	The compliance program activity is measured by its effectiveness, therefore, to know if it is moving in the right direction, it is necessary to implement a constant evaluation process, called monitoring, which are regular audits aimed at identifying whether the other pillars of the program are working as planned.

Source: Adapted from [23].

For [36], he says that forto facilitate the understanding of the structure of a compliance program inserted in the company, there are the pillars with all parts of the audit process, shown in Figure 4.

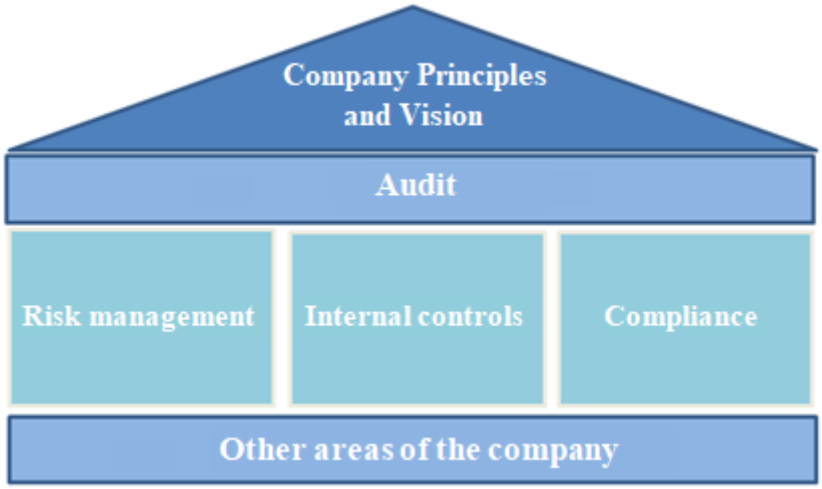

Figure 4: Pillars of the audit process.
Source: Adapted from [36].

It was possible to observe in Figure 4 the pillars that stand out the most in companies, which are part of the audit process, as well as, risk management, internal controls and compliance, for performing their activities on a routine and permanent basis, being responsible for monitoring and ensure the various areas and units of the organization so that they are in compliance with the regulations applicable to the business, that is, they act according to procedures, standards and rules developed by business management [36].

It is also recommended that the organization define a professional to act as an ethics officer, reporting directly to the management, exercising full or part time, the management of the compliance program, coordinating the committee on an ongoing basis [39].

2.3.4 Profile of the compliance professional

After defining the focus for structuring, its pillars, the knowledge of the company's business, the goals, the challenges and what it does, we must then seek the qualified professional to lead the project to develop good people management, management support is essential for the success of the program [36].

According [37], no there is a specific training to act in the compliance function, but it is necessary that the professional has experience, knowledge, personal and professional qualities to enable the conduction of activities in an appropriate way, such as:

- Solid ethical and integrity values, shown through their conduct and attitudes;
- Ability to understand the culture of the organization and the nature of the activities;
- Ability to communicate and argue with all levels of the organization and regulatory bodies, supervisors, audits and representative entities;
- Ability to say "no" in situations that constitute risk;
- Independence to show your technical opinion without fear of retaliation and exemption so that your decisions are not influenced by relationships of affinity;
- Empathy and accessibility to clarify doubts and address issues at various levels of the organization;

- Ability to handle pressure;
- Attention to opportunities for improvement in internal processes;
- Ability to keep up to date and to the needs caused by market changes, new technologies and business models [37].

Thus, the profile of the professional for the implementation of compliance in the company has as a key point the duty to manage risks, have a good system of controls and carry out the governance of this culture [36].

II.3.5 - Implementation of the compliance program

It is important for the company to present the principles for the development, implementation and maintenance of the compliance program, which according to [39], some steps must be observed for its implementation and consolidation, highlighted as:

- **Awareness:** the organization needs to reflect on the importance of ethics in the daily lives of its stakeholders;
- **Awareness:** it is relevant at this moment to advance in reflecting on the importance of the theme for an understanding of the advantages and disadvantages of aligning organizational ethical concepts;
- **Motivation:** the organization promotes the right environment for stakeholders to be interested in adopting ethical guidelines;
- **Training:** instruments such as code of ethics, whistleblowing channel that enable stakeholders to develop the ability to deal with ethical issues in a way that is more adherent to the organization's principles;
- **Side dish:** assistance in the practice of the actions of all those involved, promoting a synergy of ethical precepts in the organization;
- **Adequacy:** the organization needs to consider the continuous changes that have occurred in the business, which may reflect on the way of living the principles adopted, this does not mean that the premises and values are changeable in essence, but the occurrence of accidents requires revision and adaptation of the way the organization applies its principles [39].

Finally, there is the stage of designing processes and controls, which is also essential, being absolutely clear to everyone involved in the program. In this phase, procedures, forms, standardization of controls, team structure and approvals with those responsible are defined, in accordance with the entire procedure [36].

III. Materials and methods

III.1 -Experimental Methodology

In order to demonstrate the understanding of the integrity program in the Third Sector, in order to provide greater knowledge on the subject, there was a need to present a model of application of compliance in a support foundation, based on the studies of [40] [41], ensuring that the interests of the organization are met with regard to political and procedural issues related to ethics inserted by the institution.

The present study can be considered in an exploratory way for providing greater knowledge on the

topic, of an applied nature, establishing the practice of specific problems of the organization with the intention of solving them and qualitative seeking to understand its concepts, in two aspects, bibliographic research with the purpose to identify the approaches of the authors through books, theses, articles, electronic sites, company documents and, case study, with the objective of analyzing a model of application of the compliance program in an institution, being evaluated by professionals of the area .

The data collection was carried out through a meeting and interview with the organization's professionals, analysis of company documents and through the bibliographic references researched, in order to consolidate the theoretical and practical foundation on the importance of compliance in organizations, identifying its main tools, showing its compliance mechanism, describing and proposing actions of strategies that can be used in the practice of organizational management.

For the analysis of the application of the compliance program in the researched institution, several management tools were used in order to provide a broad view of the functioning of the proposed model.

III.1.1 - Characterization of the organization

In view of the need to address the difficulties of companies in complying with and knowledge of standards and conduct, and the irregularities that facilitate acts of corruption, meeting the main objective of the work, which is to analyze a model of compliance enforcement process in an organization of the Third Sector, the study sought to research data from the Muraki Institutional Support Foundation, as it does not have an integrity program in its management, and it is important to implement technical preventive procedures and punitive control, in order to exercise its role in the society, managing resources in a transparent manner.

Created on July 13, 1999, the Muraki Foundation is a private non-profit institution, with the objective of supporting the Institute of Technology of the Amazon (UTAM), having its registration with the Foundations Ombudsman of the Public Ministry of the State of Amazonas [42].

After the extinction of UTAM and the creation of the State University of Amazonas (UEA) in 2001, Muraki also started to support the entire state university, being an institution established with the purpose of carrying out the administrative and financial management of teaching projects, research and extension, working towards its mission and statutory objectives, in support and academic, scientific and technological development with future professionalization [42].

Driven by the demand of the Industrial Pole of Manaus - PIM, in 2006 the foundation created the Competitive Intelligence Nucleus - NIC, being a sector of the institution responsible for the development and implementation of research, innovation and development of R&D projects, with the beneficiaries being the following: scientific, industrial communities and Amazonian society [42].

Located in the Center-South Zone of Manaus, in Amazonas, the Muraki Foundation is an institution capable of developing and managing projects and activities aimed at scientific and technological, artistic and cultural development, as well as the preservation of the environment, always focusing on the customer satisfaction, legal parameters and society's interests, with a collection produced by its employees and partners. He currently has the executive board, the legal sector, the R&D sector, project management, IT, people management, the accounting, financial sector, purchasing and accountability sectors.

After meeting with the professionals responsible for the foundation, it was observed that, for the

compliance program application process model to meet the company's internal procedures, it is important to define the interactions of the management system considering the strategic objectives for implementation. The interactions of the management system are shown in Figure 5.

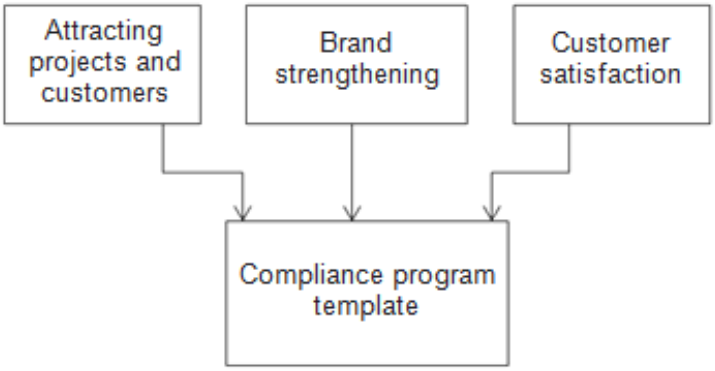

Figure 5: Interactions of the management system.
Source: Authors, (2020).

According to Figure 5, it is possible to verify that the model of the compliance program offers effective conditions for the perspective and satisfaction of customers and the ability to improve the image of the institution through the management system implemented.

III.1.2 - Proposed model

For the proposed model, a meeting and interview was held with Muraki professionals, with a view to the compliance program model for the practice of good governance with a new form of management, ensuring the fulfillment of the institution's needs with regard to political issues and procedures related to ethics and integrity inserted by the foundation. Through a meeting and interview with Muraki professionals, the application model of the compliance program was analyzed, establishing its evaluation parameters divided into eight stages. Table 2 shows the eight stages of the evaluation parameters for the application model of the compliance program.

Table 2: Parameter for evaluating the compliance program.

Stage	Evaluation parameter
1st Stage	Top Management Commitment.
2nd Stage	Risk assessment.
3rd Stage	Propose Compliance Policies.
4th Stage	Internal and External Controls.
5th Stage	Communication and Training.
6th Stage	Reporting Channels.
7th Stage	Auditing and Monitoring.
8th Stage	Compliance Management System.

Source: Authors, (2020).

Table 2 describes the stages of the compliance program evaluation parameters established to meet

the objective of this study.

Step 1 - Top Management Commitment: to meet this stage, a meeting was held with professionals with high strategic training in the environment in which they operate at the foundation, in order to gather data on the interest and motivation for implementing a model of compliance program in the institution .

Step 02 - Risk Assessment: this step assumes the identification of compliance risks, measured through the risk matrix through an alignment meeting with professionals at the institution, members of the human resources team, where the assessment is a suggestion for dealing with the consequences if the risks are accomplished.

Step 03 - Propose Compliance Policy: after meeting and interviewing the company's professionals, a compliance policy was proposed for this stage to assist the Muraki Foundation.

Step 04 - Internal and External Controls: After holding a meeting with professionals in the area, several internal and external issues were raised at this stage, which should be considered by the Muraki Foundation for the implementation model of the compliance program, based on the company's information regarding the forces, weaknesses, opportunities and threats.

Step 05 - Communication and Training: for this stage, the communication criteria on the integrity program and the periodic training and transparency of the company were analyzed.

Step 06 - Reporting Channels: this step consists of providing access to the internal and external public, however, with rules and procedures aimed at the discretion of those who report and who demonstrate great learning in relation to the existing channels.

Step 07 - Audit and Monitoring: this step seeks to improve the prevention and fight against the occurrence of serious acts, with procedures that guarantee the interruption of irregularities or violations detected of the damage generated, in addition to application in cases of violation of the compliance program, disciplinary measures and channels for reporting complaints. irregularities, widely disclosed to employees.

Step 08 - Compliance Management System: this step constitutes the approximation of the information collected in the previous phases in order to build the model of compliance program to be proposed for the management system of the Muraki Foundation.

IV. Results and discussions

IV.1 - Applying theresults

The study sought to propose a model of compliance program, aiming at the practice of good governance in the company. After presenting the data, the model proved to be satisfactory for the institution's professionals, as it allows amanagement that ensure that the organization's needs are met with respect to policy and procedure issues related to ethics and integrity inserted by the foundation to support decision making.

To analyze the application model of the compliance program at Muraki, several management tools were used, in order to provide a broad view of its operation.

The program model was analyzed by professionals in the foundation area, and its evaluation parameters were established in order to present the results obtained in the construction of the method applied in this work, divided into eight stages.

IV.1.1 - Analysis of the application model of the compliance program

The application model of the proposed compliance program was based on the requirements defined by the professionals of the studied company, taking into account the internal and external issues that are fundamental to its processes, using the brainstorming technique for this purpose, in order to clarify the critical points in the institution.

After obtaining the information, eight stages of evaluation were described, established as parameters for achieving the research objective.

1st Stage - Top management commitment

In this stage, meetings and interviews were held with professionals with high strategic training in the environment in which they work at the Muraki Foundation to analyze the commitment of top management to the compliance program in relation to the preservation and correction of acts of corruption. For this, the professionals presented their procedures in order to show the interest of the organization's top management on the attitudes of good governance in the actions carried out at the foundation.

It is possible to observe in Table 2 the requirements obtained regarding the commitment of Muraki's top management in relation to good governance actions and the strategic issues of its management for the application of the compliance program model.

Table 3: Senior management requirements for applying the compliance program.

Muraki Foundation senior management requirements for the compliance program application model
Professionals with high strategic training in the environment in which they work at the institution.
Integrity requirements.
Propose compliance policies.
Good image.
Transparency.
Periodic accountability.
Compliance with legal requirements.

Source: Authors, (2020).

It can be said that although the Muraki Foundation does not yet have a compliance program, it has a set of regulations and policies related to integrity issues, according to the requirements highlighted in Table 4.1 that is directly linked to the company's strategic direction. Supervision by top management ensures that effective actions are applied to an incentive measure that promotes ways of improving the company's control environment.

2nd Stage - Risk assessment

This step provides for the identification of compliance risks that takes into account the policy of

integrity programs and the definition of strategic values of the institution. During a meeting at the company with professionals in the area, some fundamental obligations related to compliance were proposed, which need to be fulfilled by the foundation in the application of the program, as shown in Table 4.

Table 4: Fundamental obligations of the institution for the compliance program.

Fundamental compliance obligations
Promote ethics in your relationships.
Valuing employees.
Meet legal requirements as a support foundation and project manager
Focus on results.

Source: Authors, (2020).

It was possible to identify the risks incorporated in the institution's procedures, after the delimitation of obligations, during the meeting with the company's professionals. Table 5 describes the risks included in the institution's procedures.

Table 5: Risks inserted in the institution's procedures.

	Risks inserted in the institution's procedures
1	Delay or breach of obligations (Accounting).
2	Failure to prepare and evaluate the legal instrument.
3	Incompatible ethical conduct.
4	Labor issues regarding the hiring of individuals and legal entities (supplier).
5	Wrong payment process.
6	Failure in greeting at the obligations of funding agencies.
7	Lack of a system for meeting R&D projects.
8	Absence of control of information available on the transparency portal.

Source: Authors, (2020).

Each risk presented was numbered and measured using the risk matrix assessment technique, by multiplying its consequence by its probability. The values attributed to each category take into account the studies by PINTO (2012). Table 6 shows the levels assigned to each risk.

Table 6: Levels assigned to each institution's risk.

No.	Risk	Probability	Consequence	R = P x C
1	Delay or non-compliance with obligations (Accounting).	2	3	6
2	Failure to prepare and evaluate the legal instrument.	2	4	8
3	Incompatible ethical conduct.	2	4	8
4	Labor issues regarding the hiring of individuals and legal entities (Supplier).	3	3	9
5	Wrong payment process.	3	3	9
6	Failure to comply with the obligations of the Financing Bodies.	3	4	12
7	Lack of a system for meeting R&D projects.	4	4	16
8	Lack of control over the information available on the Transparency Portal.	4	4	16

Source: Authors, (2020).

According to Table 6, the multiplication of probability and consequence provides the severity of the risk according to the resulting value, assigning the level of each one. It is possible to observe in Figure 6 the evaluation of the classification of the foundation's risk matrix, after presenting the result.

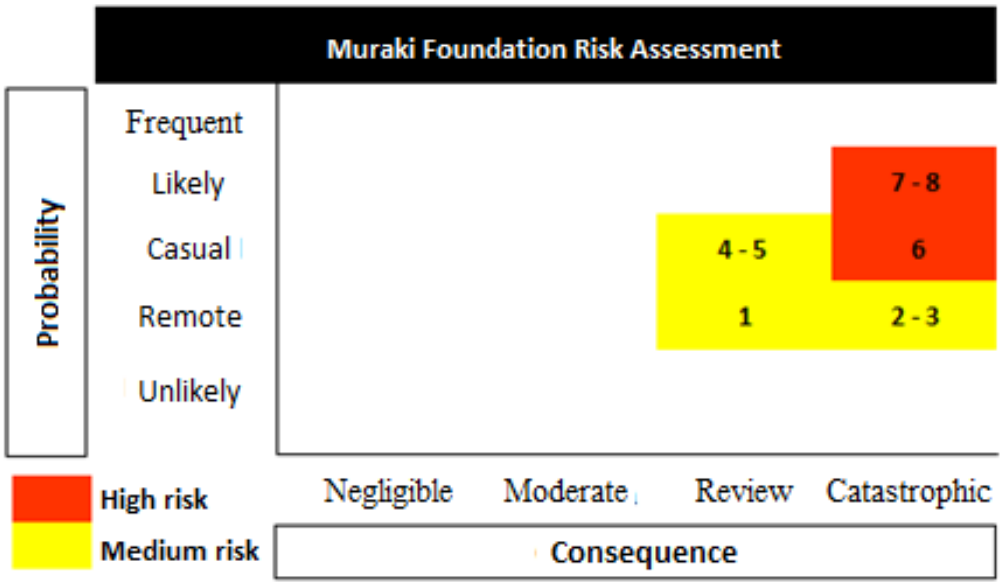

Figure 6: Aassessment of the foundation's risk matrix.

Source: Authors, (2020).

Considering the risks defined with the institution's professionals, as shown in Figure 4.2, the results presented in the matrix were: medium and high risk, probability: probable, occasional and remote,

consequence: catastrophic and critical, seen as damage to the foundation. The classification took into account the studies by [43].

Therefore, after the result of the multiplication of probability and consequence, the risks considered as medium and high are shown in Table 7.

Table 7: Risks considered medium and high of the institution.

No.	Risk	Classification	Probability
1	Delay or non-compliance with obligations (Accounting).	Average	Remote
2	Failure to prepare and evaluate the legal instrument.	Average	Remote
3	Incompatible ethical conduct.	Average	Remote
4	Labor issues regarding the hiring of individuals and legal entities (Supplier).	Average	Casual
5	Wrong payment process.	Average	Casual
6	Failure to comply with the obligations of the Financing Bodies.	High	Casual
7	Lack of a system for meeting R&D projects.	High	Likely
8	Lack of control over the information available on the Transparency Portal.	High	Likely

Source: Authors, (2020).

During a meeting with the professionals of the Muraki Foundation, all the consequences of the risks were recognized and recommendations were made to prevent the impacts, through planning and good organizational management, such as the application of the compliance program. Table 8 shows the consequences and recommendations of the risks encountered.

Table 8: Cconsequences and risk recommendations of the institution.

No.	Risk	Consequences	Recommendations
1	Delay or non-compliance with obligations (Accounting).	Fine, audit, rework and return of resources.	Plan and control the obligations and deadlines to be met.
2	Failure to prepare and evaluate the legal instrument.	Return of resources, administrative penalties, rework and negative image.	All legal instruments must pass through Legal.
3	Incompatible ethical conduct.	Audit, loss of projects and negative image.	Elaboration and command of a code of ethical conduct,

			defining the procedure and monitoring of the processes.
4	Labor issues regarding the hiring of individuals and legal entities (Supplier).	Financial losses, negative image, charge, breach of contract and delay in the process.	Improvement of process controls, paying attention to labor legislation, observing contracts.
5	Wrong payment process.	Rework and customer dissatisfaction.	Provide detailed payment obligations procedure.
6	Failure to comply with the obligations of the Financing Bodies.	Return of resources, negative image, rework and loss of accreditation.	Improve the monitoring of funders' requirements.
7	Lack of a system for meeting R&D projects.	Rework, lengthy procedures, lack of process control and Delays.	Create an integrated system ensuring the monitoring of R&D processes.
8	Lack of control over the information available on the Transparency Portal.	Audit, negative image and administrative penalties.	Define procedures for the management of the Transparency Portal.

Source: Authors, (2020).

During the meeting with Muraki professionals, it was recommended to carry out an action plan to reduce risks and their impacts, seeking to establish new processes through the elaboration of procedures and control through application of the compliance program.

3rd Stage - Propose compliance policy

Top management must build an integrity policy with the provision of information and guidelines from the Muraki Foundation, related to the planning of the management of its activities, and must be followed by all employees. Through a meeting with the professionals in charge of the area, a model of integrity policy was defined for the application of the compliance program, which is described in Table 9 based on the guidelines of the foundation.

Table 9: F integrity policyMuraki undation.

Integrity policy
Make a commitment to effectively meet the requirements of interested parties.
Ensure transparency in its processes, especially in the management of resources transferred by financiers.
Provide a working relationship environment.
Accounting controls that can ensure reporting and reliability.
Decision-making process.

Source: Authors, (2020).

4th Stage - Internal and external controls

At this stage, several internal and external issues were raised through the SWOT matrix, which should be taken into account by the institution for the application model of the compliance program. The situations described were taken from the information provided by Muraki professionals through the meeting and analysis of company documents. Figure 10 shows the internal and external issues to be considered for the construction of the compliance program at Muraki.

Table 10: Qinternal and external suggestions from the Muraki Foundation.

Foundation internal and external issues	
External	**Internal**
Bargaining power of the purchasing sector.	Internal communication and with project coordinators.
Assistance to bureaucracy and legislation of the control bodies.	Mapping of process.
Oversight of the control bodies.	Captura de projeto.
Good relationship with the control bodies.	Employee well-being.

Source: Authors, (2020).

Table 10 presented the internal and external issues of the Muraki Foundation, related to the application model of the compliance program, seen as positive and negative, related to the pertinent legislation for company evaluation.

5th Stage - Communication and Training

In this stage, the criteria related to training and communication for the application of the compliance program in the institution were analyzed through a meeting with the responsible professionals. Table 11 shows the communication and training suggestions made with Muraki professionals.

Table 11: Communication and training suggestions for the compliance model.

Communication and training for the compliance program
Electronic messages or other means with information on health policies to enhance the effects of communication.
Campaigns to better understand the importance of integrity and ethics policies.
Courses related to the topics of integrity and code of ethics.
Measurement plan of the perception of content on the part of each individual for a dynamic measurement in the improvement of processes.
Creation of criteria based on the principles of morality and administrative adequacy, to avoid subjective decision making.

Source: Authors, (2020).

For the suggestions presented, it is relevant to create criteria actions based on the principles of correct and dignified management, to avoid subjective decision making.

6th Stage - Reporting Channels

During a meeting held with the institution's professionals, it was reported on the importance of reporting channels for the application of the compliance program, as they provide good access to both the internal and external audiences. Suggestions for accessing the reporting channels can be seen in Table 12.

Table 12: Access to reporting channels.

Reporting channels
Standards and procedures what aim protection whistleblowers.
Knowledge of the channels and a use quite.
Ease of access to the reporting channel by all employees.

Source: Authors, (2020).

It is important to highlight that the actions of the channels that propose to reasonably examine the complaints and forward them, are not done properly, being considered an operational deficiency for the responsible area. It is recommended to specialize a channel to deal with integrity issues, improve internal regulations by defining the amount that will be seen by the area, and it is important to adopt a disciplinary audit of operational capacity that acts in the appropriate investigation of complaints.

7th Stage - Audit and monitoring

This step aims to improve the prevention and fight against the occurrence of bad acts, with procedures that guarantee the interruption of irregularities found and damages generated, in cases of violations of the compliance program, disciplinary measures, place of communication of irregularities and complaints must be applied. and be widely disseminated to employees. Table 13 shows the audit and monitoring actions for the application model of the compliance program at the Muraki Foundation.

Table 13: Auditing and monitoring for the compliance program model.

Auditing and monitoring for the compliance program model	
1	Actions under the responsibility of the risk management and internal audit and committee environments.
2	Senior management exempt from measures.
3	Assessment of current legislation.

4	Application of disciplinary measures to employees in case of violation of the integrity program.

Source: Authors, (2020).

The importance of preventing and combating the occurrences of bad acts is essential, that is why the procedures highlighted in Table 13 guarantee the interruption of irregularities to be found, protecting the company's image.

8th Stage - Compliance management system

For this stage, the information from the previous phases was taken into account, in addition to the discussions held at the meetings with the foundation's responsible team, covering the entire process carried out by the institution. At this stage, the commitment of top management to the structure of the compliance and inspection program for the management system was evaluated, as shown in Figure 7.

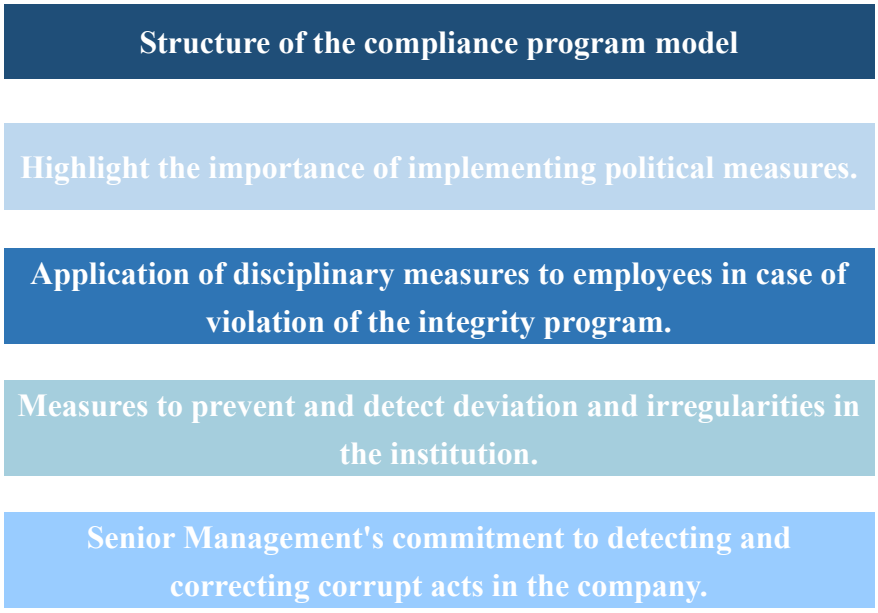

Figure 7: Compliance program structure.

Source: Authors, (2020).

Although the Muraki Foundation has a set of regulations and policies related to ethics and irregularities, a model for applying the compliance program in its procedures was suggested, as it is important to have an integrity plan approved by the responsible sector, ensuring that the resources essential for the actions to be properly implemented in a correct and effective manner, in addition to adopting an incentive measure that consistently promotes an improvement in the control environment in the institution's management system, with more transparency in its activities, further protecting the image from the company.

V. Conclusion

In this dynamic and globalized scenario, the use of management tools and the creation of new

strategies that contribute to the improvement of organizational and professional measures in support of decision making, in a transparent manner, have been increasing more and more, significantly in companies. As the implementation of integrity program systems grows, the institutions create mechanisms and methods that clearly and integratedly display the processes of the activities of each sector and, consequently, the positive results of the organization. Thus, companies and especially Third Sector institutions have undergone a series of adaptations, as society has begun to see and demand more from organizations the development of measures that improve economic and social activities, with more transparency. Yet, meeting the main objective of the work, we sought to list the critical factors for the success of the analysis of a model of application of the compliance program, through the use of methodology based on ethical standards and procedures, for the realization of good management practices in the organization, considering the context in which the company is inserted, which is the Third Sector, since the Muraki Foundation is a non-profit institution that supports Research, Extension and R&D projects, managing government and private funds. Compliance is seen as a mechanism to ensure good governance and transparency for the company, supporting effective actions to preserve ethical values and comply with obligations.

Therefore, aiming to increase the power of competitiveness in the market with a good image, the integrity of organizational activities and the search for improvement in administrative procedures have been growing more and more, regardless of the branch of the company. Thus, the study sought to propose a model for the application of the compliance program in a Third Sector institution, as the use of this tool has been shown to be fundamental for organizations, guaranteeing their competitiveness, considering practices of transparent actions for society and control bodies. To achieve this goal, it was necessary to identify all stages of the compliance program process, serving as parameters for creating a model, evaluating the procedures and behavior of the institution's employees. The use of the information gathered with the support of the professionals of the studied company was of paramount importance for the performance of comparisons and simulations made in the proposed model, using several management tools so that it was possible to obtain good results. Information collected by the institution's professionals was submitted and, after data obtained in the analysis, it was observed that thealthough the Muraki Foundation has a set of regulations and policies related to ethics and irregularities, it is necessary to have an integrity plan approved by the sector responsible for the compliance program, ensuring that the essential resources for actions are properly implemented in an effective manner, in addition to applying an incentive measure that consistently promotes an improvement in the control environment in the company's management system. Based on this information, it is valid to develop techniques for analyzing critical activities to be used when evaluating each procedure performed by the foundation, the use of management tools should also be adopted for the knowledge of the organization's internal and external environment. , looking at their strengths, weaknesses, threats and opportunities, in addition to the identification and measurement of risks to improve the practice of its actions, in a transparent manner complying with the rules and legislation of the control bodies. It is essential for Muraki management to address integrity programs, identifying the main tools necessary for compliance in Third Sector institutions, the application of the compliance mechanism, so that their proposals for good governance action strategies can be used in practice.

Therefore, this research can serve as a consultation for new studies on the topic presented, that regardless of the branch of the company, the compliance program model can be considered a great tool for

organizational management, with transparency and ethics, thus increasing competitiveness of business.

VI. Thanks

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PERCEPTION INDEX OF ENVIRONMENTAL EDUCATION IN FUNDAMENTAL EDUCATION SCHOOLS IN A CITY ON THE BRAZIL / BOLIVIA FRONTIER

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ABSTRACT

Objective: *to analyze the Environmental Education Perception Index in the light of national curricular parameters (PCN's) within the scope of elementary education in state schools in the city of Guajará-Mirim, Rondônia, on the Brazil / Bolivia border.* ***Method:*** *for this study, factor analysis was used as a mechanism for building performance indices for each parameter studied. The Statistical Package for the Social Sciences - SPSS [30] tool was used to determine the proposed indexes that followed the scale advocated by Hair et al [21].* ***Results:*** *the results presented by the teachers of the 4 schools correspond to the perception index considered "good" with an average index of 0.699. The average perception index of school technicians and managers was 0.591, considered a "regular" index. The students had an average performance of 0.537, considered a "regular" performance index. The general IPEA among all schools surveyed was considered "regular" with a performance index of 0.597.* ***Conclusion****: the fact that Guajará-Mirim has 92% of its territory occupied by Conservation Units and Indigenous Lands and a strong environmental policy does not correspond to the level of abstraction applied by formal Environmental Education. Environmental Education given in Guajará-Mirim elementary schools imposes considerable risks on the environmental conscience of future generations, as it presents certain deficiencies in fulfilling its institutional role as a social transformer, configuring itself as a limiter of sustainable development and awareness environmental.*

Keywords: Perception Index. Environmental education. Factor analysis. Elementary School.

1 INTRODUCTION

Environmental problems are the responsibility of individual and collective [1]. According to Oliveira et al [2], contemporary society faces numerous problems of an environmental nature, considering a number of factors, some of a natural nature, and others not. However, most of the difficulties experienced in this aspect have as a main cause human action, directly or indirectly, either as a result of the attitude itself, or as a result of its omission. Exacerbated consumerism and the considerable increase in the use of disposable materials are evidence that, despite much talk, there is still little reflection and what has been done is insufficient to change this reality.

For Oliveira et al [2] education, in the sense of acquiring knowledge that enables the understanding of the cause and effect of the facts, as well as the reflection of practices adopted, can be configured as a mechanism for changing the attitude towards the care that one must have with the environment in which we live. In this regard, it is essential to educate people about the scarcity and limitations of natural resources, as well as to make them aware that it is the responsibility of each one to maintain a balanced environment for this and future generations [2].

The Federal Constitution of Brazil of 1988, in its article 225, determines that "everyone has the right to an ecologically balanced environment, a good for the common use of the people and essential to a healthy quality of life, imposing on the public power and the community the duty to defend and preserve it for the present and future generations "[3]. The Federal Constitution also determines that the public power must promote Environmental Education at all levels of education and public awareness for the preservation of the environment in order to spread the idea that everyone has the right to a healthy environment and that

this condition it must endure for future generations [3]. Under this prism, Environmental Education contributes to the fulfillment of this responsibility of the public power, as it is configured as a way of sensitizing people to the need for a balanced and healthy environment for all [2].

Pacheco [4] reminds us of Resolution No. 2/2012 of the Ministry of Education (MEC), which establishes national curriculum guidelines for Environmental Education. According to MEC Resolution No. 2/2012, the term "environmental" does not just exemplify just one type of education, but constitutes a structuring element of society, for which it is necessary to mobilize social actors committed to transforming political and pedagogical practices and educating environmentally ethical citizens.

Among other legal instruments, Law No. 9,795 / 1999 stands out, which institutes the National Environmental Education Policy. According to this Law, Environmental Education is an essential and permanent component of national education, and must be present, in an articulated manner, at all levels and modalities of the educational process, in a formal and non-formal character. According to Brazil [5], Decree No. 4,281 / 2002, which regulated Law No. 9,795 /, establishes that the National Environmental Education Policy will be carried out by the bodies and entities that are part of the National Environment System (SISNAMA), by public and private institutions of the education systems of the education networks, by public agencies of the Union, States, Federal District and Municipalities, involving non-governmental entities, class entities, means of communication and other segments of society. And that in the inclusion of Environmental Education at all levels and teaching modalities, the National Curriculum Parameters and Guidelines are recommended as a reference, observing the integration of Environmental Education to the disciplines in a transversal, continuous and permanent way and the adequacy existing programs for the continuing education of educators.

This work seeks to understand how the perception of Environmental Education is understood from the National Curriculum Parameters (PCN's), based on formal Brazilian education. The PCN's are a set of documents that since 1997 has been implemented throughout the national territory as a reference for the renewal and re-elaboration of the curricular proposal [6]. It addresses the contents of the different areas of knowledge, that is, from elementary school to high school where one must study Portuguese language, mathematics, the physical and natural world, the social and political reality, emphasizing the Brazilian situation [6].

According to Brazil [7], the Ministry of Education's Proposed National Curriculum Guidelines for Environmental Education postulates that in its pedagogical praxis, Environmental Education involves the understanding of a responsible, critical, participatory citizen education, where each subject learns from scientific knowledge and the recognition of traditional knowledge, making it possible to make transformative decisions based on the natural or built environment in which people are inserted. Environmental Education advances in the construction of responsible citizenship, stimulating fairer interactions between human beings and other beings that inhabit the planet, in order to build a sustainable, healthy and socially just present and future.

According to BRASIL / MEC / SECAD [8], the PCN's are a subsidy to support the school in the elaboration of its educational project, inserting procedures, attitudes and values in the school life, as well as the need to contemplate some social aspects, urgent issues of scope national, called transversal themes: environment, ethics, cultural plurality, sexual orientation, work and consumption, with schools and / or

communities and other themes relevant to their reality. For Tomazello [9] in the PCN's, education is seen as an indispensable element for the transformation of environmental awareness, where new behaviors and new attitudes must be adopted.

At school, environmental content must be integrated into the curriculum through transversality, as they are treated in different areas of knowledge, in order to permeate the entire educational practice and, at the same time, create a global and comprehensive view of the environmental issue. The inclusion of Environmental Education in the school curriculum, proposed by the PCN's through the theme of the environment, implies a process of educational innovation [10]. For Moraes [11] Environmental Education is a coherent and methodologically acceptable alternative for institutional action to seek the balance of the environment. There is a consensus in the educational community that environmental education is essential to achieve the ideal of a sustainable society.

Environmental Education has an important role in promoting the perception of the necessary integration of human beings with the environment [12]. A harmonious relationship, aware of the dynamic balance in nature, enabling, through new knowledge, values and attitudes, the insertion of the student and the educator as citizens in the process of transforming the current environmental framework of our planet [13]. According to Wesceslau and Nogueira [12] Environmental Education, guides in the construction of new paths, new relationships between society and the nature in which they live, assisting in the process of training more critical human beings and concerned with preservation issues. The school environment is not only the school physical space. The educational environment is constituted in the relationships established in the school routine, between the school and the community, between the community and society, between its actors, in the ideological clashes due to hegemony, therefore it is a complex movement of relations [14].

According to Loureiro [15] Environmental Education, understood as "educational and social praxis" and can be worked out both formally and informally. In the formal aspect, we have the school, a place par excellence for experiencing this practice, because, in addition to being an environment conducive to teaching and learning, it already has a public that can act as a multiplier of ecologically correct ideas and actions. Environmental Education as an educational and social praxis aims to build values, concepts, skills and attitudes that enable the understanding of the reality of life and the lucid and responsible performance of individual and collective social actors in the environment [16].

Laurel; Layarques and Castro [16] advise that the social relations that are established at school, in the family, at work or in the community allow the individual to have a critical perception of themselves and society, thus being able to understand their position and social interaction, building the basis of respectability towards others. Wenceslau and Nogueira [12] teach that this interaction between individuals plays an important role in the construction of the human being, and from this social interaction, the individual will internalize the elements of his culture, building his inner or intrapsychological universe from the middle external.

This research defines the approach to the perception of Environmental Education based on a proposal of an analytical model. Being that the parameters used in the research corresponded to the evaluation of the perception of the environmental attitudes of the teachers of the researched schools; the practices and experiences developed by teachers in the classroom with regard to environmental education; and the perception of elementary school students of how they see such environmental education practices

being carried out in their respective schools, capable of generating the perception index of environmental education. Some school information was used, such as: school creation law; school management competence; number of students enrolled; number of students enrolled in elementary school; number of teachers; number of teachers linked to elementary education.

According to Brandalise et al [17] perception is a person's interpretation of a message and it can be different depending on who receives it, which leads one to believe that the level of education and experience influences the way a stimulus is perceived and, consequently, in the individual's attitudes and behavior. Each individual perceives, reacts and responds differently to the environment in which he lives and that the responses or manifestations that result from it are the result of perceptions (individual and collective), cognitive processes, judgments and expectations of each person.

It is even hypothetically believed that these statements are confirmed in the context of the Amazonian reality, such as the municipality of Guajará-Mirim, which has approximately 92% of its protected territory, which are distributed by Nature Conservation Units (UC's) and Indigenous Lands (TI's) that deserve to highlight the following questions: how is the practice of environmental education perceived in state elementary schools? What is your relationship with the formation of the sustainable development paradigm, from the perspective observed by students, teachers and technical-administrative staff in public elementary schools?

The study consisted of 4 state public schools in the city of Guajará-Mirim, with a universe of 2,205 students, 1,799 students enrolled in elementary school, 83 teachers, 77 teachers linked to elementary school. What was established as the objective of this research was to analyze the Environmental Education Perception Index in the light of national curricular parameters (PCN's) within the scope of elementary education in state schools in the city of Guajará-Mirim, Rondônia, on the Brazil / Bolivia border.

2 METHOD

2.1 Type of research

The research method adopted was the hypothetical-deductive one originally formulated by Karl Popper. Such a method starts from a conjecture that is tried at all costs to be refuted. If such a conjecture remains valid, then the hypothesis is accepted as true.

2.2 Research location and sample

The field research was carried out in 4 elementary schools in a Brazilian city, on the border with the Republic of Bolivia. Data collection was carried out with 1,799 students from a universe of 2,205 students enrolled in the 4th and 5th year of study and with 77 teachers from a universe of 83 elementary school teachers, in addition to 25 participants including technicians and educational managers.

2.3 Indicators for index construction

The Environmental Education Perception index was built from the indicators: types of pollution; greenhouse effect; loss of biodiversity; desertification; climate changes; soil degradation; water pollution; depletion of the ozone layer; destruction of forests; too much population growth; water shortage; poverty; burned; socio-environmental inequality; quality of life; conscious consumption; collection and disposal of solid waste; reuse of recyclable materials; waterborne diseases; sanitation; cares with the body;

conservation units; indigenous lands; forest reserves; practices of preservationist and conservationist actions, ethics; cultural plurality; job; environmental preservation; sustainable development; ecological awareness, environmental education, public policies, environmental legislation.

2.4 Data collection instrument and ethical aspects

The interview form was previously prepared and discussed with the management of each school involved. Data collection took place after the signing of the Free and Informed Consent Form by parents or guardians of the students and after authorization from the direction of each school. There was no situation of embarrassment or exposure of the research subjects. Therefore, it complied with the provision provided for in resolution 196/96 of the National Health Council of Brazil.

2.5 Index construction method

For this study, factor analysis was used as a mechanism for building performance indices for each parameter studied. Factor analysis is a generic name given to a class of multivariate statistical methods whose main purpose is to define the underlying structure in a data matrix. In general terms, factor analysis addresses the problem of analyzing the structure of the interrelations (correlations) between a large number of variables, defining a set of common latent dimensions, called factors. With factor analysis, the researcher can first identify the separate dimensions of the structure and then determine the degree to which each variable is explained by each dimension. Once these dimensions and the explanation of each variable are determined, the two main uses of factor analysis - summary and data reduction - can be achieved, according to Paraguassu-Chaves et al [18] in your study "Environmental Education Perception Index (IPEA) headed for sustainable development: A study in Elementary Schools in the city of Guajará-Mirim, Rondônia (Brazil)" and corroborated by Carvalho et al [19] and Carvalho et al [20]. According to Hair et al [21] when summarizing the data, factor analysis obtains latent dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. Data reduction can be achieved by calculating scores for each latent dimension and replacing the original variables with the same ones. Consecrated authors such as Santana [22]; [23]; [24]; [25] and Cavalcante [26] confirm the efficiency of the factor analysis for the construction of perception indexes.

As a method of construction of the Environmental Education Perception Index, the logic of factor analysis was adopted, which can be presented in the matrix form as in Dillon; Goldstein [27]**:**

$$X=\alpha F+\varepsilon \qquad (1)$$

Being, X = is p-dimensional vector transpose of the observable variables, denoted by $x = (x 1 , x 2 , ..., x p)$; F = is the q-dimensional vector transposed unobservable variables or latent variables called common factors, denoted by $F = (f 1 , f 2 , ..., f q)$, where $q < p$; ε = is the transpose vector p-dimensional random variables or unique factors, denoted by $\varepsilon = (e 1 , and 2 , ...,e p)$; α = is the matrix (p, q) of unknown constants, called factor loads. Well-known authors like Johnson; Wichern [28] and Mingoti [29] corroborate the factor analysis applied in the construction of indexes.

2.6 Scale adopted in the research

The Statistical Package for the Social Sciences - SPSS [30], version 17 tool was used to determine the proposed indexes that followed the scale advocated by Hair et al [21].

Table 1: Scale adopted by the research adapted from Hair et al [21].

Scale	Description
0,801 – 1,000	Excellent
0,601 – 0,800	Good
0,401 – 0,600	Regular
0,201 – 0,400	Bad
0,000 – 0,200	Terrible

3 RESULTS AND DISCUSSION

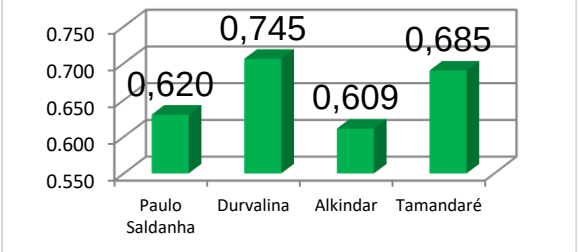
The results presented by the teachers of the 4 schools correspond to the perception index considered "good" by the scale adopted, with an average index of 0.699. The indices occurred, in descending order, at the Durvalina Estilben de Oliveira State School (0.765), followed by the Almirante Tamandaré State School (0.685), Paulo Saldanha State School (0.620) and 0.609 index at the Alkindar Brasil State School in Arouca (Graph 1).

From the School's point of view, through its technicians (administrative and managerial part), the Durvalina Estilben de Oliveira (0.630), Paulo Saldanha (0.620) and Almirante Tamandaré (0.620) State Schools presented a "good" performance index, while the Alkindar Brasil de Arouca State School had a "regular" performance index (0.495). The average perception index was 0.591, considered a regular index (Graph 2).

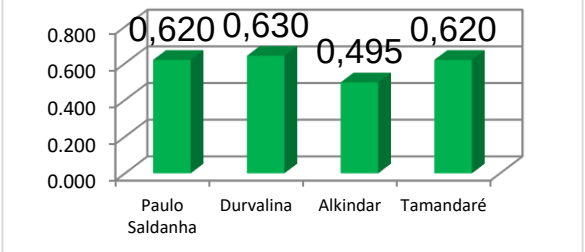
The results presented by the students were the following performances: Almirante Tamandaré State School (0.620) considered "good" performance index, Paulo Saldanha State School (0.540), Durvalina Estilben de Oliveira State School (0.530) and Alkindar Brasil de Arouca State School (0.460) considered "regular" performance indexes, with an average of 0.537 considered regular performance index (Graph 3).

The average of the results found for the analyzed parameters of teachers, school (technicians) and students, reaches the perception index of environmental education in elementary school for each of the schools surveyed. The Almirante Tamandaré State School obtained the best index of perception of environmental education with IPEA (0.641) considered "good" performance, followed by Durvalina Estilben de Oliveira State School with IPEA (0.635) considered "good" performance index. The State Schools Paulo Saldanha with IPEA (0.593) and Alkindar Brasil de Arouca with IPEA (0.522) obtained indexes considered "regular" (Graph 4).

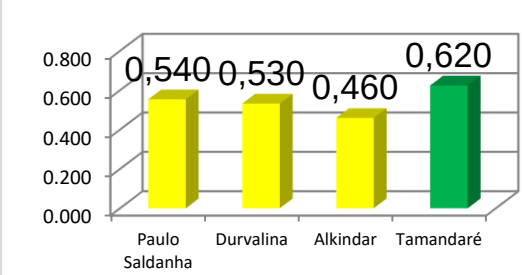
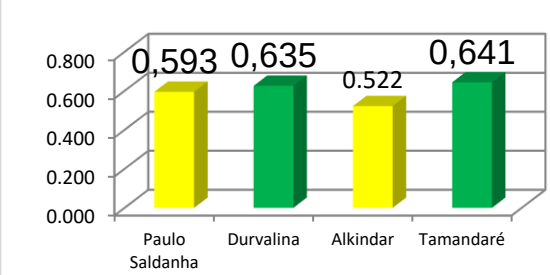
The general IPEA among all schools surveyed was considered "regular" when reaching the IPEA of 0.597.



Graph 1: IPEA - parameter: Teachers



Graph 2: IPEA - parameter: School

Source: Own elaboration	Source: Own elaboration
	
Graph 3: IPEA - parameter: Students Source: Own elaboration	**Graph 4: IPEA - Elementary Education of the surveyed schools** Source: Own elaboration

It is possible to perceive the distorted vision in which students, teachers and managers (technical and administrative education) find themselves in relation to the perception of the local reality, where a large part of the municipality is in the form of Legally Protected Areas - ALP's (92.06% of its territory). There is a gap between the reality of a region with 92.06% of its territory consisting of conservation units and indigenous lands and educational practice within this focus. According to Paraguassu-Chaves et al [18] the municipality of Guajará-Mirim has one of the highest rates in the world in terms of legally protected areas and even so educational practices do not go beyond what is usually done in any other region from Brazil, that is, it is clear that the perception of elementary school students about the practice of environmental education in state public schools existing in the region presented, with the exception of one School, present a performance considered only “regular”. This fact is noticeable when one observes the answers obtained when asked “do you know what Nature Conservation Units and Indigenous Lands are?” where 42.9% of the Almirante Tamandaré school, 18.2% of the Durvalina Estilben de Oliveira School and 15.4% of the Paulo Saldanha School chose the criterion “knows little” and / or “knows completely”, a fact not observed for the School Alkindar Brasil de Arouca [19]; [20].

On the other hand, those who said “they don't know” and / or “they know very little” reached the highest percentage at Escola Alkindar Brasil de Arouca with 80% followed by Schools Paulo Saldanha (79.9%), Durvalina Estilben de Oliveira (72.7%) and Almirante Tamandaré (28.6%). For those who said “more or less” the result pointed 28.6% to Escola Almirante Tamandaré, 20% to Escola Alkindar Brasil de Arouca, 9.1% to Escola Durvalina Estilben de Oliveira and 7.7% to Escola Paulo Saldanha [19]; [20]. Results that corroborate with this research. When asked “do you know that the municipality of Guajará-Mirim is almost entirely made up of Nature Conservation Units and Indigenous Lands?” the result showed that 40% of respondents from the Alkindar Brasil de Arouca School stated that they “do not know” and / or “know very little” about it, followed by the schools Durvalina Estilben de Oliveira (27.3%) and Paulo Saldanha (23.1%). For this criterion, data for the Almirante Tamandaré School were not observed. However, for those who claimed to "know completely" and / or "know little" the highest percentages found were in schools, in descending order, Escola Almirante Tamandaré (85.7%), Durvalina Estilben de Oliveira (45.4%) , Paulo Saldanha (38.5%) and 20% Alkindar Brasil de Arouca School [18]; [19] and [20]. Environmental Education is important, as it helps students to develop an idea about the factors of their

environment to establish a connection between what he has learned and his daily life. Environmental knowledge helps the student to understand reality and act on it, as well as participating in school activities and actions in the community is what Lemos and David [31] discuss in the research "Reflections on the transversal theme of the environment in teaching fundamental "and by Lemos [32] in his master's dissertation on environment and regional development with the title "The Foundation for the Conservation of Nature of Mato Grosso do Sul and the origins of the environmental movement in the State: 1979 to 1989".

According to Brazil [33] the general objectives on the environment for elementary education, proposed by the PCN's, are basically: the knowledge and the integrated and systemic understanding of the environment; the adoption of postures at home, at school and in the community; adoption of attitudes of respect for cultural, ethnic and cultural heritage; the perception of personal processes as a fundamental element for acting in the environment; among others. For Environmental Education, it is important to work with the local reality without losing sight of the planet's perspective in its environmental, social and cultural aspects [31]. Elementary school should offer knowledge of society and nature so that students can develop their potential and adopt social attitudes and social behaviors that allow them to live in a constructive relationship with themselves and their environment [33]. As the student gets to know the natural environment and the social environment, he / she appropriates knowledge that will be added in the articulation of actions for environmental conservation.

According to Guimarães [14], the educator is not only responsible for showing the conflicts and contradictions of this society, but helping students, in schools, to understand social and environmental relations, reflecting, even, on the meaning of their own contradictions. and conflicts in their midst. The educator then behaves as a mediator for the development of these relations of socioenvironmental conflicts in the school environment and emerges as a collaborator in supporting Environmental Education, in a transformative educational process, aimed at the construction of a new paradigm that contributes to the aspirations of a better socio-environmental quality of life and for a healthy planet. However, according to Branco; Royer; Branco [34] many challenges and demands in the educational field need to be overcome, such as, for example, the adequate training of teachers, (re) defining the role of the school in today's society and a better approach to environmental issues within the scope of Environmental Education in school context in Brazil. For these same authors, in this sense, Environmental Education has a preponderant role of leading to new initiatives, of developing new thoughts and practices, of promoting the breaking of society's paradigms, forming conscious and participative citizens in collective decisions. In addition, its role is not limited to the environment, but its range expands to the economy, justice, quality of life, citizenship and equality.

By Branco's analysis; Royer; Branco [34] While emphasizing the relevance and emergence of Environmental Education, there is still a need to overcome and improve without, however, denying advances in the area of education. It is important to highlight that, if on the one hand Environmental Education has been the subject of political discussions at national and international events in the last decades and these events have contributed considerably to the elaboration of relevant documents, laws, studies and treaties in favor of the environment and of humanity, thus building its bases, on the other hand, in school units, Environmental Education is still far from developing an effective work and with expressive

results. The authors conclude that it is common in the school context, teachers carry out Environmental Education practices as isolated actions and disconnected from scientific meanings, such as, for example, the selective collection of waste, joint efforts against dengue, the transformation of solid waste into utensils, among others, represent, in many cases, such teaching in the school environment. Despite the importance of these actions, the first aspect to be considered is that Environmental Education is not limited to this, but it needs further investigation and scientific deepening of the contents, reflection on the ideological, political and social issues that are directly or indirectly interconnected.

In this sense Tozoni-Reis [35], thinks that when reflecting on Environmental Education, the need to think and do Environmental Education is pointed out by overcoming the disciplinary barriers, by overcoming the traditional forms of education and teaching, and in the search for epistemological alternatives and pedagogical. For this author, only the relationship between knowledge and social relationships is built by the new paradigm of responsibility for human action in nature and in society. It is an approach in which the human being promotes the recovery of his relationship with nature, that is, the social characteristic of the human being who, when interacting with nature, transforms it and is also transforming it through a historical process enabling the human being, finding balance with other living beings through autonomy, social equality and emancipation [36]. And so, only then can a critical theory of Education be enough to support more conscious environmental education actions and consequent emancipatory educational actions.

From all conceptual argumentation, definition, the legal framework and the practical application of Environmental Education, it can be seen that the perceptions are different. This is because it must be considered that each individual perceives, reacts and responds differently to actions on the environment in which he lives, and the responses or manifestations that result from it are the result of perceptions (individual and collective), cognitive processes, judgments and expectations of each person [4]. For this author, environmental perception is the process of obtaining information on the part of an individual belonging to the environment in question and, from this point, this individual becomes aware of this environment and elaborates the forms of interaction and preservation of this environment.

Environmental perception is information in the same way that information generates information: uses and habits are signs of the informed place that only reveals itself to the extent that it is subjected to an operation that exposes the logic of its language [37]; [38]. These same authors defend that the perception is the mental and conscious elaboration about a determined object or fact, either clarifying, distinguishing or privileging some of these aspects, or when associating it with other objects or context.

Environmental perception provides a great service to environmental education, which in turn should promote consistent, non-contradictory results for society, which differs from the current scenario, which is more a training process than an education process itself, where Brugger [39] and Cunha; Leite [40], teach us how environmental problems end up being reduced to mere problems such as pollution, scarcity of natural resources, decreased biodiversity, recycling, among others.

According to Paraguassu-Chaves et al [18] when analyzing the perception of Environmental Education in the context of elementary education in the state schools of Guajará-Mirim, one can perceive that the level by the abstraction of society, students, teachers and technicians and school managers. What seems to live in a moment of institutional crisis, values, ethics and behavior. On the one hand, there is a

legal condition that corresponds to a strong environmental policy represented by 92% of its preserved territory. On the other hand, the garbage is thrown on the streets, the bones of slaughtered animals can be seen in the urban perimeter of the city, the domestic garbage of the city can be deposited in open dumps without any criteria, exposed wasteland, the streets without conditions access, people depositing their debris in the middle of the street and on sidewalks, deforestation without technical criteria, burning without authorization from environmental agencies. And, still through the third bias, it is evidenced the low transversal power among all the subjects of school formation of the students in the researched schools, besides the need for a better formation of contents and pedagogical actions for the teachers, facts these also found by Carvalho et al 19]; [20]. In view of the arguments presented, it is understood that there is a consensus on the need to problematize the environmental issue at all levels of education, on the other hand, doubts arise regarding the valuation and effectiveness of the environmental issue as an educational action at all levels and in a way interdisciplinary, mainly due to the lack of qualified managers and teachers to articulate this set of knowledge, attitudes and environmental sensitivities in the existing disciplines, which can negatively reflect the perception of Environmental Education in students.

4 CONCLUSION

By the level of abstraction, it was possible to observe that elementary school students from state public schools, teachers and school technicians and managers live a moment of institutional crisis, of values, ethics and behavior, so that the citizens' attitudes, with regard to environmental practice, which does not, therefore, correspond to the legal condition of a region with a strong environmental policy, mainly because it has 92% of its territory occupied by Conservation Units and Indigenous Lands.

The results presented by the teachers correspond to the perception index considered “good” by the scale adopted, with an average index of 0.699. From the School's point of view, through its technicians (administrative and managerial part) the perception index was 0.591 considered a “regular” index. The results presented by the students 0.537 considered a “regular” performance index. The general IPEA among all schools surveyed was considered “regular” when reaching the IPEA of 0.597. With the results found, it is understood that there is a reasonable expressiveness of connection between the real world and what happens in society and what involves the academic community with the practice of environmental education in the school environment. Environmental Education is necessary to corroborate the breaking of paradigms in society, capable of contributing to the formation of critical citizens, concerned with the environmental issue, capable of deciding, acting and combating the demands that deal with environmental problems from the perspective of the process educational. It is necessary to rethink the educational content as a cross-cutting theme, to raise the discourse of instigating to rethink new practices, to value the relationship between man and nature and to discuss sustainability. In spite of the well-considered “good” index, the need for better teacher training is evident in order to guarantee, in fact, the teaching of Environmental Education. A curricular restructuring is necessary to support Environmental Education, avoiding reductionist, fragmented educational practices and an ineffective approach.

It is necessary to articulate Environmental Education, strengthening and providing training with a more critical bias and guiding it to what is provided for in the PCN’s and DCN’s.

Finally, it can be seen that the Guajará-Mirim elementary schools impose considerable risks to the environmental awareness of future generations, as they present certain deficiencies to fulfill their institutional role as a social transformer, configuring themselves as a limiter of sustainable development and environmental awareness.

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Structured Assessment on Learning Progress

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Abstract

This paper presented a novel technique and practice of the assessment of learning progress of university students in an engineering discipline. Instead of measuring the effectiveness of accumulation of specific knowledge, the newly developed assessment technique evaluates the development of the intelligence of the students. The key components of the proposed technique are a performance-based method for the estimation of the intelligence level and a cognitive mental faculty-oriented decomposition method to determine the intelligence contribution factors for learning subjects and exam questions. The proposed technique was applied to assess the learning progress of a group of university students in the field of automation, and the results from test agreed with the expectation well.

Keywords: contribution factors; learning progress; mental faculties; structured assessment

1. Introduction

As we are in the process of building an innovation-oriented country, there is ever increasing huge demand for better students from various of social sectors. The effectiveness of teaching in higher education is critical to meet the demand. The conventional higher education system, especially in China, assess the quality of the teaching in universities based on the effectiveness of accumulation of the knowledge. The amount of knowledge that students obtained is obviously important, but is certainly not all that the students should gain in their university study.

1.1 The necessity of assessment

In many previously reported researches, it has been generally agreed that the criteria of the assessment of transfer of learning should be determined by the characteristics of different types of social sectors, more precisely the end users of university graduates. The criteria for being a good student could be very different from place to place, however, among various criteria the intelligence is always included.

The critical development of the students in university, except for the accumulation of knowledge in a specific area, should be the development of their intelligence. Since the intelligence level of the university graduates determines the innovation capability of our society to a large extend, the critical assessment criteria for the university education should emphasize on the intelligence to reflect the needs of current social development.

1.2 The objective

The objective of the research reported in this paper is to investigate how the students' intelligence are

developed as the learning subjects are arranged through the course of their university study in a specific discipline.

This paper is not attempting to cover all the disciplines in university education but a typical one, namely automation, as an example in the field of engineering. There are some typical characteristics of the student group in this research. Some engineering students are trained to be engineers in automation-related area. However, a large proportion of the students are willing to pursue further education at post-graduate level. The particular interests in our research are to investigate how the intelligence of the students has been developed with respect to the subjects learned during the university study. We proposed in this paper that the intelligence of the students should be measured using a performance-based technique to reflect the real effect of the intelligence in its application, and as the principal type of tasks of university students, to learn a specific subject was chosen as the task to reflect the nature of university study.

2. Theory and technique applied

The meaning of intelligence may be defined in many ways, however this paper takes the definition as "the ability to acquire and apply knowledge and skills" to specifically fit to the purpose of the research.

2.1 Designated definition of intelligence

Although there are no universally agreed assessment techniques for intelligence that should be used, it is generally accepted that the four important basic ideas about the assessment of intelligence should be embedded in any of the techniques [1][2]. Intelligence, if it is defined as mental ability, could be measured by objective tests, in which each question has only one "correct" answer. Differences in intelligence are quantifiable in terms of degree of intelligence. In this sense, numerical values could be assigned to distinguish levels of intelligence of people. Differences among people form a bell-shaped curve, or normal distribution. In a bell-shaped curve, a majority of scores cluster in the middle, and fewer are found reaching the two extremes of genius and mental deficiency. The precise extent to which two sets of test scores were related could be determined by a statistical procedure (correlation).

As the defined intelligence shall consist of various of abilities to achieve the objective, we propose in this paper that the intelligence could be decomposed according to the modules in the mental faculty. In general, the mental faculty has been regarded as the inherent cognitive powers of human mind, which could be grouped into modules [2][4], and through which the mind performs various functions and tasks [3]. However, there has been no globally agreed model to define the modules that describe the mental faculty comprehensively, or in other words, researchers intended to choose or to place their particular interests in certain modules of the mental faculty to suit their specific areas of researches [5][6].

Taking into account the particular interests in this research, we define the following modules of mental faculty for the measure of intelligence.

Table 1. Modules of mental faculty

Perception	The faculty of apprehending the external world through different sense channels.
Reason	The faculty of forming conclusions, judgments, or inferences from facts or premises through rational thought.
Volition	The faculty of making conscious choice, decision, and intention, and keeping them as a particular mental image "fixed" in the mind.
Memory	The faculty of retaining and reviving facts, events, impressions, etc., for recalling and recognizing previous experiences.

Imagination	The faculty of forming mental images to match up a particular thought or idea.
Attention	The faculty of distributing mental resource.

2.2 Technique of assessment

The intelligence, as defined in this paper, cannot be measured directly. This paper proposed to measure the performance of the students as the estimation of intelligence level. Since the quality of the performance is very much task-related measurement, the absolute measurement of the performance will not lead to any certain information. The proposed technique uses a relative comparison of the performance measurement between two groups of students who have taken different number of subjects to reveal how the intelligence development is related to the subjects learned.

Apart from of pure accumulation of knowledge in the discipline, we believe that all the subjects will contribute to the development of the intelligence of the students. More specifically, the contribution will be made according to the contents of the course to the modules of the mental faculty. According to the nature of knowledge, each learned subject will make different impact on different module of mental faculty, and all the subjects that students learned will make a general impact on the development of the students' intelligence. The impact on each module of the mental faculty will be valued as contribution factors (CF) respectively.

Due to the fact that there is no unified measure for intelligence, the absolute intelligence values of the students are not associated with any particular meaning. However, the comparisons between the scores of different groups from the same task would be a clear indication of the differences in the intelligence between the students of comparing groups.

3. The case study

The typical task of university students is to learn a subject, and the performance of learning can be measured by a well-structured examination which is accepted in general. The well-structured examination covers the knowledge of the subject comprehensively and has a clear indication on how the teaching materials and exam questions are related to the mental faculty modules respectively.

3.1 Participants

The chosen subject for performance measurement should not be sensitive to the difference in the learned subjects of compared student groups in terms of the knowledge contained in those subjects.

All the subjects were decomposed into the possible contribution factors (CF) to each mental faculty modules according to the nature of the subjects. The accumulation of the contribution factors of the total subjects learned provide an estimation of the development of the student's mental faculty which was considered as the estimation of the intelligence level of the student.

The 180 participants are divided into two groups, with each group 90 students. The first group are senior students in the major of automation, while the second group are junior students from the same department. The students from both groups took exactly the same subjects in their early two years' study. The subject for the performance measurement is Engineering Psychology, and it has no specific relationship with the subjects that Group No.2 missed. Both groups were combined into a joint class in order to eliminate the influencing aspects from teaching task. Four examinations were given during the course.

3.2 Data Process and Analysis

All the courses learned are decomposed according to the cognitive facilities, and the accumulated

contribution of two groups of students are shown in Table 2. Where group one, the senior students are better in the six factors.

Table 2. The contribution factors (CF) from learned subjects

C F	Perception	Reason	Volition	Memory	Imagination	Attention
Group 1	24	36	32	26	28	26
Group 2	22	26	28	21	19	20

All these six contribution factors are based on the courses that the students have attended. Where the contribution factor is assigned to **Perception** if the knowledge learned related to information resources, data acquisition; and to **Reason** if the knowledge learned helps form conclusions, judgments, or inferences from facts or premises through rational thoughts. The knowledge is likely related to signal/information processing and analysis. The data to **Volition** if the learned knowledge supports to make conscious choice, decision, and intention, and keep them as a particular mental image "fixed" in the mind. The knowledge was normally associated with fundamental theory. The contribution factor is assigned to **Memory** according to the size of the learned knowledge that required to remember; to **Imagination** if the knowledge learned helps to form students' mental images to match up a particular thought or idea. The knowledge was normally associated with advanced technologies; to **Attention** if the learned knowledge that requires interdisciplinary information to understand.

3.2.1 The performance measurement

During the semester, there are four tests that are carried out without advance notification to students. It means that the tests show the actual status of the students' level of understanding the contents. There are 3 major questions in each exam. Question one (Q1) is to fill three blankets a, b, and c. Question 2 is an explanation of some concept, and Question 3 is about the application, which needs to analyze and solve practical problems with the knowledge. The score of each exam was carefully recorded and evaluated.
In the first exam, the questions are designed including the six contribution factors. The contribution factors are calculated as Table 3.

Table 3. The contribution factors of the questions in exam I

C F	Perception	Reason	Volition	Memory	Imagination	Attention
Q1(a)				●		
Q1(b)				●		
Q1(c)			●	●		
Q2		●	●		●	●
Q3	●	●	●			●
Ratio	1/30	2/30	3/30	3/30	1/30	2/30

The scores of all the students in the two groups were analyzed, and the results show the mean scores of Group 1 senior students in the factors of Reason, Attention and Imagination are higher than group 2 junior students.

Table 4. Results of the first exam:

Mean scores	Perception	Reason	Volition	Memory	Imagination	Attention
Group 1	1.82	3.91	5.92	5.43	0.94	3.85
Group 2	1.84	3.65	5.91	5.44	0.82	3.24
G1 vs. G2		0.26			0.12	0.61

The questions in the second exam link the contribution factors as Table 5. And the results are shown in Table 6.

Table 5. The contribution factors in exam II

C F	Perception	Reason	Volition	Memory	Imagination	Attention
Q1(a)				●		
Q1(b)				●	●	
Q1(c)		●	●	●		
Q2	●	●	●		●	●
Q3	●	●	●	●		●
Ratio	2/30	2/30	3/30	4/30	2/30	2/30

Table 6. Results of the second exam:

Mean scores	Perception	Reason	Volition	Memory	Imagination	Attention
Group 1	3.72	5.81	7.42	7.25	1.85	3.75
Group 2	3.74	5.29	7.41	7.32	1.66	3.54
G1 vs. G2		0.52			0.19	0.21

From the above data, it shows that Group 1 performs better in the factors of Reason, Attention and Imagination.

In the third exam, the contribution factors are shown as Table 7. And the comparison of the results is shown in Table 8. Group one has better scores in the aspects of Reason and Attention, especially.

Table 7. The contribution factors in exam III

C F	Perception	Reason	Volition	Memory	Imagination	Attention
Q1(a)						●
Q1(b)	●				●	
Q1(c)		●	●	●		
Q2	●	●	●		●	●
Q3	●	●	●	●		●
	3/30	3/30	3/30	2/30	2/30	3/30

Table 8. Results of the 3rd exam:

Mean scores	Perception	Reason	Volition	Memory	Imagination	Attention
Group 1	5.61	5.71	7.42	7.25	3.87	5.40
Group 2	5.71	5.39	7.41	7.32	3.70	5.11
G1 vs. G2	0.1	0.32			0.17	0.29

In the fourth exam, the contribution factors are indicated in Table 9, afterwards, the scores are calculated and the results are shown in Table 10. Group 1 students are better in the aspects of Reason and Imagination.

Table 9. The contribution factors of exam IV

C F	Perception	Reason	Volition	Memory	Imagination	Attention
Q1(a)			●			●
Q1(b)		●			●	
Q1(c)		●	●	●		
Q2	●	●			●	●
Q3	●	●	●	●		●
	2/30	4/30	3/30	2/30	2/30	3/30

Table 10. Results of the 4th exam:

Mean scores	Perception	Reason	Volition	Memory	Imagination	Attention
Group 1	3.82	7.25	5.40	3.25	1.82	5.45
Group 2	3.79	7.11	5.32	3.32	1.67	5.51
G1 vs. G2		0.14			0.15	

4 Conclusion

From the results obtained, we could reach the following conclusions. The proposed performance measurement produces basic sensitivity to distinguish the intelligence level between two groups of students with essential salience. And the development of intelligence appears to have salient positive correlation with the subjects learned.

The basic features of proposed assessment could be checked from the aspect of reliability and validity. The assessment produced consistent outcomes from the four exams and proved to be reliable. The validity of assessment was demonstrated by the analysis results matching with the theoretical expectation. The assessment could cover all modules of the mental faculty.

5 Acknowledgement

My sincere gratitude shall be extended to all the students who attended the course Psychology Engineering, and the members of my teaching team as well.

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Reflection on the Influence of the Artistic Atmosphere on the University Organization Development

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Abstract

This article reflects on the influence of the artistic atmosphere on the university organization development, emphasizing that the artistic atmosphere should be regarded as the strategic objective. Universities must use technology and aesthetics to build an artistic campus environment, influence the values of its organization members through an artistic atmosphere, and then integrate the humanistic factors of artistic aesthetics and creative awareness in the university culture, awaken more humanized communication and interaction, and shape the behavior of organization members, ultimately make the members of the organization have a strong sense of collective creativity, finally improve the effectiveness of organization management to promote the development of the organization.

Keywords: *Reflection, Artistic Atmosphere, Organizational Development in University*

Introduction

Art and aesthetics are expressed by human instincts. When people step into a university campus, they first observe and feel the presence of the buildings, decorations, slogans, the overall environment, and the behaviors of people related to the university within the visual range. These factors constitute the university atmosphere and have an impact on the university (Ali & Demiray, 2019).

Universities have been paying attention to a rigorous academic atmosphere and beautiful campus environment, hoping that students, teachers, and administrators can work, study, and interrelate in a comfortable environment. The campus of a university covers an area is expanding, green area, where all kinds of educational and community activities are developed and done and the university culture is maintained on campus. Well-known foreign and local professors were invited to give lectures in the campus.

Through my experience in visiting some universities, most of them have realized the importance of the organizational atmosphere and emphasized its impacts on organizational development. The following atmospheres communication are as important also to promote organizational progress: academic, moral, environmental, and regional. Especially during the pandemic, when virtual classrooms became the educational trend, build the university's organizational atmosphere has also been moved online. However, each university has its own set of organizational development strategies and unique factors that affect the

organizational atmosphere. All of these are the behaviors of the organization to optimize the management through external physical environment and internal behavioral motivations.

Some art universities have realized the influence of the artistic atmosphere on the organization development, and are trying to improve the organizational governance, the teaching and operation modes through artistic creativity practices, and then develop the capability of the organization. However, awareness of the importance of the artistic atmosphere on the university organization development still needs to be improved.

Organizational Development

Organizational cognition is a complete system that includes interdisciplinary fields, in which culture is an artificial component of organizational cognition. Through perception and thinking, it makes assumptions about organizational policies, governs the values and beliefs of organizational members, and makes direct or indirect contributions to the innovation of organizational development (Turi et al.,2019).

The foundation of implementing the various procedures of organizational development is the consistency and commitment of the organization members to the university culture. If the ideology of the organization members is consistent with the development objectives of the organization, the members can easily cooperate with the organization's reform and sustainable development. Hence, this requires the organization not only to do better in governance system and management, but also to encourage members to have a strong sense of belonging in the organization, in order to achieve the organizational goals successfully.

Application of Kurt Lewin's Model of Change

A university must create an artistic creative atmosphere so that everyone who enters will have cultural experiences of visual, auditory, psychological, emotional and experiential learning that are different from those of other institutions.

According to Kurt Lewin's three-step Model of Change, Unfreeze, Change and Freeze Stages serves as a guide for organizational reform. First stage, the university organization needs to unfreeze by rebuilding the physical campus environment with artistic aesthetics, which include the use of technology and art to beautify the building; and the campus guidance system, teaching space and exhibition area. Renovations of sculptures in front of the teaching building, mural in the architecture, guide systems, artworks in public areas, digital teaching equipment in classrooms, and the virtual immersive experiences of the library references.

By constructing a strong artistic atmosphere in the physical environment, on the one hand, it can promote members' positive attitudes and emotions towards the campus environment, and affect the visual aesthetics and values of the organization members. On the other hand, the practical behavior can be maintained in line with the up-to-date trend in science, technology and arts in society, and thereby, it can promote the diversified cooperation between the university and the art institutions and science and technology institutions in society.

Second stage, change is needed on the university organization, by integrating artistic aesthetics and

creative consciousness into the university organization. It includes an open attitude towards educational innovation, popularizing aesthetic education in teaching, and stimulating the interactive and communication behavior with humanistic attitude. These artistic and humanistic factors create a new psychological atmosphere for the organization members. On one hand, this in-depth experience constructs a diversified and unique personality value for the organization members, making the members of the organization acquire a strong collective creativity, and influence their behavior. On the other hand, it can create common beliefs, influencing the collective attitude of members towards the organization, and improving the effectiveness of organization management.

The third stage of freeze, applying the general trend of global education shifting to digital mode, the building of an artistic atmosphere must extend to online education. This includes the use of Augmented Reality digital technology in the virtual classroom, virtual library orientation and virtual meeting, while using digital art to create a virtual artistic atmosphere on the university website and classroom interactive platforms.

This stage enhances members' perception of behavior and reality through the digital experience platforms that combine art and technology. On one hand, it reflects the creative working and communicating ways of the organization under the new trend of digital education, encouraging members to create and share new knowledge and to have a sense of identity from members. On the other hand, it reflects the maximum variability and tolerance of an organization under the various environments, whether face-to-face or virtual.

Finally, after reshaping the physical art atmosphere of a university, reshaping the cognition of its members towards art atmosphere, and reshaping the art atmosphere of digital education, a complete set of organizational system with artistic creativity will be formed and rooted deeply in the consciousness of the organization members, to improve the overall structure of the organization and its effectiveness, and ultimately promote the continuous development of the organization.

Conclusion

With the trend of digital teaching becoming the mainstream, organization development also needs to change accordingly. The artistic atmosphere can not only build consensus in the real physical space, but also enhance the innovative experience in the virtual space. Nowadays, information and knowledge are transferred rapidly through the virtual space. An open, artistic, university space that is conducive to the development of creative consciousness, provides highly innovative opportunities for organization members, and also enables them to have a strong common perspective, which in turn promotes the need for organizational change. It is by recognizing the potential value of the artistic atmosphere, incorporating these common visions into organizational development through explicit or implicit factors, and enhancing the organization through a more innovative artistic atmosphere, that the university will be able to keep pace with social and educational development trends and improve educational competitiveness during the pandemic.

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Analysis of the practical reform of engineering thermal physics teaching based on FLUENT

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Abstract

Engineering thermophysics is a technical science which studies the law of energy transformation in the form of heat and its application.It studies the internal laws of various thermal phenomena and thermal processes, and can be used to guide engineering practice. FLUENT is a tool course that plays a great role in assisting with the simulation of some devices in engineering thermophysics and fluids. However, in the process of learning simulation, students have had difficulty in mastering the FLUENT software and this paper proposes some constructive suggestions for measures to increase students' mastery of this software.

Keywords: *engineering thermophysics; FLUENT; microchannel heat sink; practice*

1 Introduction

[1] FLUENT can be used for anything related to fluids, heat transfer and chemical reactions, etc. FLUENT software is very powerful and has a wide range of applications in aerospace, automotive design, oil and gas and turbine design with its rich physical models, advanced numerical methods and powerful pre-processing and post-processing capabilities. Proficient use of FLUENT allows researchers to reduce the repetitive and inefficient effort invested in computational methods, programming, pre-processing and post-processing, and to devote their main effort and intelligence to the exploration of the physics problem itself. However, problems with FLUENT's own operating language and method of application, coupled with a single PowerPoint teaching, make it difficult for students to become proficient in this vital software. Therefore FLUENT needs to be taught in conjunction with practice and theory for better teaching results. In this paper, we will discuss the teaching model of FLUENT and make suggestions to improve the current situation of FLUENT teaching.

2 Example of a microchannel radiator

As described above, FLUENT can be used for anything related to fluids, heat transfer and chemical reactions, etc. In this paper, we will take The microchannel heat sink as the entry point to explain the importance of FLUENT. There are various categories of microchannel heat sinks and since Tuckerman's introduction of the microchannel heat sink, many research institutes have developed various heat transfer techniques to further improve the heat transfer performance of microchannels. The main heat transfer techniques currently available are: nanofluid, porous material filling, addition of ribbed/notched

microstructures, etc. [4] Xia et al. from Beijing University of Technology proposed the use of Al2O3 and TiO2 nanoparticles with high thermal conductivity to improve thermal conductivity of cooling medium, reduce the conduction thermal resistance and enhance the heat dissipation effect of the microchannel. [2] Deng et al. from Xiamen University and [5] Shen et al. from Northwestern Polytechnical University filled the microchannels with porous metal materials of different shapes, not only to improve the convective heat transfer area, but also to promote fluid mixing and enhance the heat dissipation effect. [3] Liu et al. of Huazhong University of Science and Technology proposed a microchannel heat sink radiator. In terms of microchannel heat sink, it is impossible to use macroscopic theory to measure it, and it involves fluid mechanics, so the skillful use of FLUENT is an effective method to simulate this kind of heat sink efficiently, which makes the research in microchannel heat sink fast and convenient. Thus, when it comes to simulation of fluids, heat transfer and chemical reactions, we can use FLUENT to carry out simulations to get twice the result with half the effort. This is why FLUENT is a core tool for engineering students. The main focus of this paper is on how to get students up to speed with the software and how to become proficient in its application.

3 Common problems in teaching

3.1 Shallow and boring teaching methods

In normal teaching activities, the teaching of FLUENT is only superficial, lacking the corresponding theoretical knowledge teaching, students' repeatedly boring practice of a single case caused a fatal problem: in the case of theoretical knowledge is not solid enough, they can not really understand the operation of the FLUENT software.In that case, it caused the students only proficient in the simulation of what they always practice, and can not simulate other module, which is turning students into kind of bookworm, and make them not being able to do other example, resulting in a fake mastery of the FLUENT software.

3.2 The FLUENT software system language is English

FLUENT is currently a popular international software, so the language of the system itself is English, and for most students, the vocabulary of professional system terms in the FLUENT system is not built up enough to understand the entire operating interface, which leads to a half-understanding of the system and makes it difficult to even maintain normal operation on a regular basis, which causes them great difficulties in mastering FLUENT.

4 Proposed solutions

4.1 Enrichment of teaching methods

In the usual teaching activities, students always operate FLUENT directly, without the corresponding theoretical support, which makes it difficult for them to master the FLUENT system systematically. So, in that case Fluent teaching should set up corresponding theoretical courses in advance. Teachers should teach some relevant knowledge of engineering thermophysics and fluidology, and then carry out actual computer operation simulation, so that students can apply the theory to practice.This will enable them to understand the specific meaning behind each step of the operation, so that they can master FLUENT systematically

and get rid of the simulation of a single model, and then they can really do whatever they want by FLUENT.

4.2 Supplementary teaching of professional English words

During the course of their studies, students are rarely exposed to the unusual words that will make them difficult to understand the whole FLUENT system. Therefore, during lessons, teachers should explain the terminology, not only its meaning, but also the knowledge behind it, so that students can really understand the FLUENT system and master its operation.

Conclusion

In the field of fluids, heat transfer and chemical reactions, etc., FLUENT is a very important simulation tool that allows efficient simulation. There are currently problems with the teaching of FLUENT, such as the shallow and boring teaching methods and the large number of hard English words in the operating system. In order to solve these problems, this paper proposes a series of specific measures to ensure that students are proficient in FLUENT system and to strengthen their ability to do by themselves.

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Risk Assessment Proposal in Hydraulic Presses with Fuzzy Logic

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Abstract

The aim of this study was to evaluate the safety level of industrial machines, in particular hydraulic press. The dissertation used hydraulic presses as the object of study. The research instruments used were machine safety analyzes based on normative items pre-established in ABNT NBR: 12100, possible accidents that these machineries can cause. The results show that hydraulic presses cause many accidents, in some situations dying. Through Annex B of ABNT NBR 14153: 2013, there are 4 risk categories for machinery, the greater the degree of risk, the more unsafe the machine is. The appraiser's experience is very important to analyze the machine and reach the level of risk level before and after the adjustment. Finally, it appears that the machine analyzed in this study was at risk level 3, after analysis and adaptations the same machine was at risk level 1, totally acceptable to maintain the operator's safety level.

Keywords: *industrial machines; hydraulic press; risk level; accidents; safety; ABNT NBR 14153: 2013.*

1. Introduction

Intense discussions about the health of the worker have been focused on Medicine and Safety at work, due to the significant increase in accidents mainly with industrial machinery and equipment. Amputations, lacerations and even death, have left workers insecure and psychologically shaken[25].

Inadequate work environment, unsafe act, lack of knowledge of the worker in relation to the activity to be performed, can contribute to accidents occurring. The situations can be isolated or together and in all cases the employer is directly related, since the machinery should have been adequate since 1978 when Ordinance MTb nº 3,214 was enacted, the parameters were established by Regulatory Norm NR12 - Safety in Machines and Equipment of the Ministry of Labor and Employment and has undergone several changes since then, by Ministry of Labor and Employment (2020).

Notably, accidents have a direct influence on the worker's life, and may reduce work capacity, in the event of loss of limbs or incapacitating accidents, subjecting their dependents to losing perhaps the only source of family income, and bringing social costs, mainly in Health and Social Security (JUNIOR,2009).

According to the Ministry of Social Security (2001, p. 01), the damages caused by accidents at work are of a direct, immediate order, either due to the health or physical integrity of the employee and the health of his dependents, perhaps losing the mainstay of the family. It is still necessary to comment on the costs that are generated for the state with Health and Social Security. The losses are numerous and go beyond the physical level, often emotionally affecting employees not only directly involved in the accident but their co-workers who may be shaken by the event.

In 2019, there were some changes in the parameters of verification and adequacy of machines and

equipment. SEPTR Ordinance No. 916 of 07/30/19, excluded several items contained in the NR-12 - Safety at Work in Machinery and Equipment, as for example: import of machinery, in the previous wording it was necessary to adapt as soon as they were installed in the industries, significantly increasing the costs with machinery and labor to perform the service. With the modification, businessmen are released from this suitability if the machinery is already adequate with safety measures even if they are international and have a compliance report. This change brought relief to employers who can invest this amount that they would spend on adapting to other security measures within the company, or even training their technical personnel.

Despite the modifications in the NR-12 - Safety in Machinery and Equipment norms, the origin, degree of risk and severity of the damage observed in NBR 14153: 2013 are still in force (MTE, 2020).

According to the regulatory standard NR-12 - Safety in Machinery and Equipment, all equipment must be adequate so as not to cause any injury, whether temporary or permanent to the operator. This standard has an annex (ANNEX - VIII PRESSES AND SIMILAR) dedicated to this type of equipment identifying the points of attention and how to carry out the adaptation in order to satisfy the precepts of the regulatory standard and other Brazilian standards (MTE, 2020)

According to Annex VIII - Presses and Similars - NR12 (MTE, 2020), the presses are machines that have the capacity to conform, cut materials of different compositions. They consist of tools that move the "hammer" (punch) that can be driven by a hydraulic or pneumatic system, hydraulic or pneumatic cylinder, or a mechanical system. They are heavy and very powerful machinery, where their failure can cause lacerations, amputations and, in more drastic scenarios, death.

Hydraulic presses are undoubtedly one of the machines that cause the most accidents in the industries, and with the economic opening, many of these machinery coming from Asian countries or the Middle East, arrive in the country without the proper protections or safety adjustments exposing workers to the serious risks to physical and psychological integrity (JUNIOR, 2009).

An important part of these accidents is caused by obsolete, unprotected and unsafe machines, being verified by the government through inspections (STUMPF, 2005).

Injection and mechanical presses have been the biggest cause of accidents in Brazil. Within this problem, the government has concentrated efforts to understand why. In investigations, there are several reasons, such as: lack of knowledge and preparedness of entrepreneurs to apply the normative requirements in their companies, lack of awareness of people, both employees and employers, about the importance of safety with this type of machinery for the preservation of physical integrity. and psychological of its collaborators, thus making it difficult to reduce expenses with early retirements and costs in general with treatment for the injured (STUMPF, 2005).

According to Vilela (2000), several initiatives were taken to establish appropriate safety measures for workers who operate presses, due to the high risk of crushing, amputation and death.

In 2002, the "Collective Convention for the Improvement of Working Conditions in Presses and Similar Equipment, Plastic Injectors and Galvanic Treatment of Surfaces in the Metallurgical Industries in the State of São Paulo" was signed, with union leaders and workers representatives in front of them class, in order to establish minimum conditions and safety criteria for press workers. This convention had 62 workers 'unions, 11 employers' unions and as a mediator the Regional Labor Office of the State of São Paulo (DRT / SP) (MTE, 2002).

From this convention, several operations of inspection of presses and the like started through the Ministry of Labor and Employment, culminating in the elaboration of Technical Note nº 16 - DSST / MTE, serving as a reference and technical support (MTE, 2005) .

Industrial machines have been the focus of regulatory bodies for safety adequacy, as they signal high numbers of accidents as evidenced by SISLAB (2020), only the northern region holds 15% of accidents in industrial machines, and in presses this percentage represents in around 7%, a very high number considering the number of inhabitants of the region. These figures did not include death, which would significantly increase this percentage.

For the adequacy of machines, the NBR's (Brazilian Norms) have a large list of information that helps in the analysis and guides to the correct form of adequacy with safety. The use of the methodology covered in NRB 14153: 2013, for example, helps to make an analysis of the risks and dangers of the machine under study and the use of the most plausible resources for the adequacy of the machinery being studied.

The relevant factor of the presses contributing to a significant participation of accidents, motivated the question of obtaining an inference model that could more quickly and accurately diagnose, through something already defined in ABNT NBR 14153/2013, the category of the degree of risk of machine, giving a more precise direction to the technical analyst when making a decision to propose an efficient adaptation that is able to meet the pre-established normative requirements.

In this approach, the present work intends, based on the tool presented in NBR 14153: 2013, to propose a Fuzzy inference model to assist in the categorization of the degree of risk of industrial machines, seeking to subsidize improvements in safety at work with this equipment, as well as to propose suggestions that aim to improve the adaptations of machines and equipment and the analysis of accidents faster and more efficient.

2. Methodology

2.1 Fuzzification

Presses have been configured over the years; an extremely important machinery due to the types of accidents they can cause to the worker. The difficulty in making the correct adaptation, often comes from the lack of knowledge of the injuries that they can cause and in which part of the machine they can occur.

With this theme, the present work uses an inference model, based on Fuzzy Logic, to measure the degree of risk of machines and equipment from variables predisposed in ANBNT: NBR 14153: 2013. Relevant Severity (S), Frequency and / or time of exposure to danger (F), Possibility of avoiding danger (P) were used as relevant variables.

The model is based on the category table in ANNEX B of ABNT NBR14153 / 2013.

The fuzzification variables and their linguistic values are shown in Table 2.1.

Table 2.1

System Relevance Functions

INPUT VARIABLES	POSSIBILITIES	**CAT** - Risk Category **Language Value** (OUTPUT)
Severity of Injury (S)	S1	
	S2	
Frequency exposure to danger (F)	F1	B CAT1 CAT2 CAT3 CAT4
	F2	
Possibility to avoid the damage (P)	P1	
	P2	

Note: CAT is the output linguistic variable, it is the degree of risk.

Source: Author (2020)

The Figure 1, illustrates the implementation of the risk degree simulation model according to ABNT NBR14153/2013 in its ANNEX B.

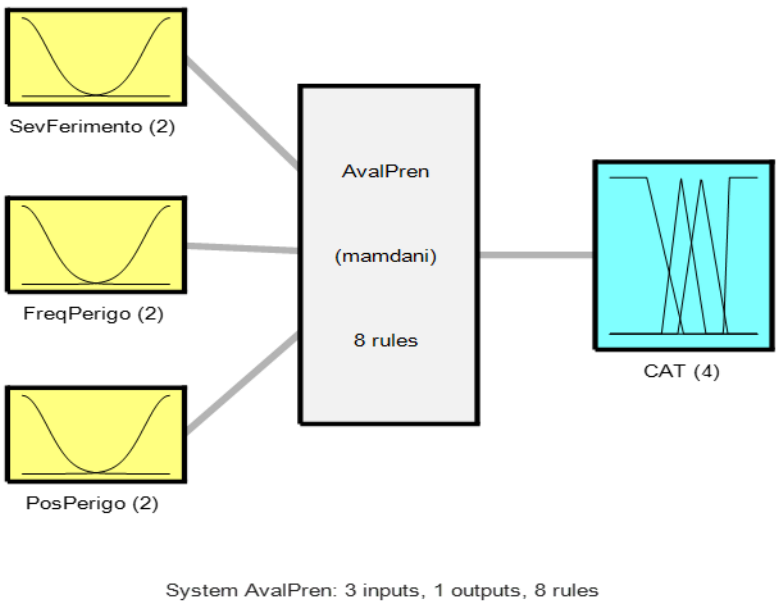

Figure 1 - Input and output variables of the proposed model

Source: Author (2020)

The variables of entry and exit of the system are previously defined by ABNT NBR14153 / 2013 in its ANNEX B, the definition of the category will be given by the set of entries according to previous

knowledge of the machine and its possible accidents. Therefore, the system variables can be described as follows:

a) Severity of injury S - (SevFerimento): this variable analyzes the injuries caused to the employee in case of any type of failure in the machine's control system. This categorization must take into account the severity of the accident: bruises and / or lacerations without complications should be classified as S1, in situations of amputation and even death, they should be classified as S2. Usually S1 involves reversible injuries, which cause temporary work incapacities, while S2 is considered serious, with no possibility of reversal of the injury, permanently curtailing work capacity or even resulting in death.

Figure 2 illustrates that the fuzzification of this variable is the bell function.

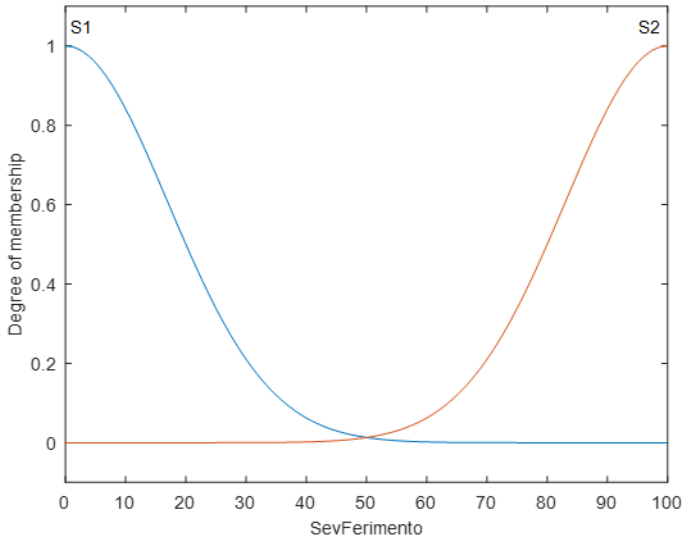

Figure 2 - SevFerimento Variables (Severity of Injury)
Source: Author (2020)

b) Frequency and / or time of exposure to danger F - (FreqPerigo):there is usually no time specification, the analysis continues taking into account whether the worker is frequently or continuously exposed to danger, F2 must be chosen. Machine operators who must place and remove parts from inside the machine, for example, are constantly exposed to danger, so the choice would be variable S2. Figure 3 shows the fuzzification of this variable.

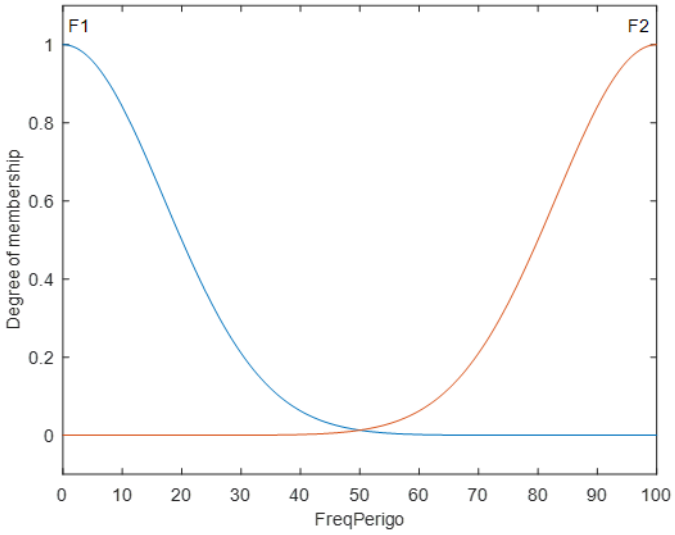

Figure 3 - FreqPerigo variables (frequency and / or time of exposure to danger)
Source: Author (2020)

c) Possibility to avoid danger P - (PosPerigo): this parameter takes into account the possibility of avoiding the danger when it appears, before the actual accident occurs. Some aspects must be taken into account, for example:

- **Is the operation carried out with or without supervision?**
- **Is the operation performed by specialists or non-professionals?**
- **How fast does the danger appear - quickly or slowly?**
- **Could the possibility of avoiding the danger be by escape or by the intervention of third parties?**
- **What are the practical safety experiences related to the process?**

The subcategory P1 should only be chosen in real cases in which the accident can be avoided or its effect significantly reduced, whereas P2 must be used when there is no chance of avoiding the accident.

Figure 4 illustrates the fuzzification of this variable, and like the previous ones, it follows the bell function.

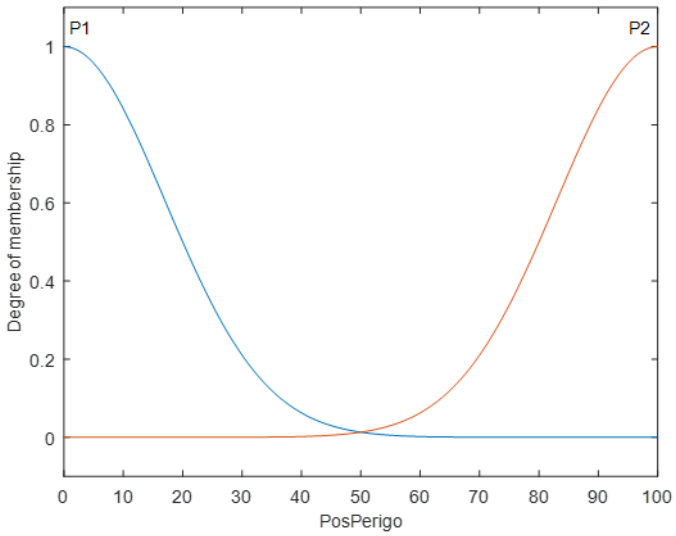

Figure 4 - PosPerigo variables (Possibility to avoid the danger)
Source: Author (2020)

d) Risk Category - CAT: This variable results in the degree of risk of the machine being analyzed. The result of this interaction is triangular, as illustrated by the fuzzification in figure 5.

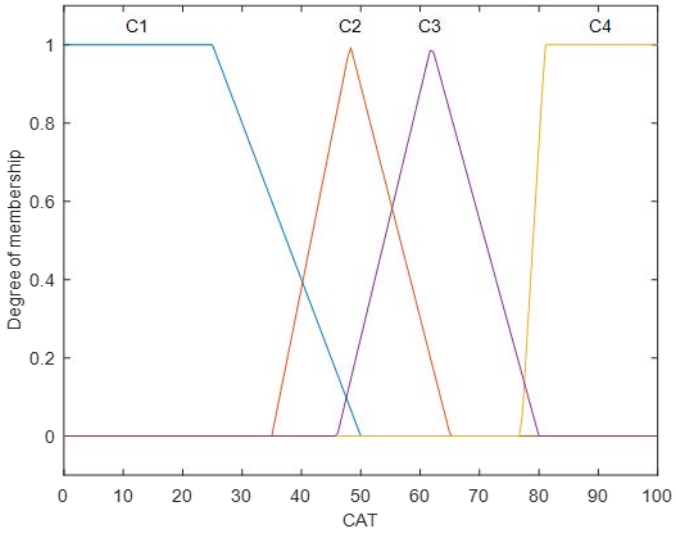

Figure 5 - Output variables - CAT (machine risk category)
Source: Author (2020)

The set of inference rules of this application, resulted in 8 combinations that can be seen in the illustration of table 2.1.

Table 2.1

Rules of the proposed model

1.If (SevFerimento is S1) and (FreqPerigo is F1) and (PosPerigo is P1) then (CAT is C1) (1);
2.If (SevFerimento is S1) and (FreqPerigo is F1) and (PosPerigo is P2) then (CAT is C1) (1);
3.If (SevFerimento is S1) and (FreqPerigo is F2) and (PosPerigo is P1) then (CAT is C1) (1);
4.If (SevFerimento is S1) and (FreqPerigo is F2) and (PosPerigo is P2) then (CAT is C1) (1);
5.If (SevFerimento is S2) and (FreqPerigo is F1) and (PosPerigo is P1) then (CAT is C2) (1);
6.If (SevFerimento is S2) and (FreqPerigo is F1) and (PosPerigo is P2) then (CAT is C3) (1);
7.If (SevFerimento is S2) and (FreqPerigo is F2) and (PosPerigo is P1) then (CAT is C3) (1);
8.If (SevFerimento is S2) and (FreqPerigo is F2) and (PosPerigo is P2) then (CAT is C4) (1);

Source: Author (2020)

2.2 Fuzzy Inference for the proposed model

The degree of risk of a press can vary from 1 to 4 and depends on the analysis performed, conditions of the machinery and experience of the operator. These factors influence the final result, and can hide serious safety problems if the study is not done in detail.

In order to help in the more accurate judgment of the degree of risk, the 3 characteristics were used to judge the degree of risk in machines, using as a basis Annex B of ABNT NBR14153 / 2013, and from these, pertinence functions were created.

The range used was from 0 to 100, corresponding to each of the two possibilities 50% chance of being selected during the analysis.

The combination of these membership functions will result in degrees of risk that can be seen in Table 3.1.

Table 3.1

Result of combinations of membership functions

Grade From Risk	Combination of Possible membership functions
B	S1
1	S1
2	S2-F1-P1
3	S2-F1-P2
	S2-F2-P2
4	S2-F2-P2

Source: Author (2020)

It is noted that the degree of risk has two distinct combinations, being defined only by the type of injury that the employee may suffer during his working period.

2.3 Rules applied

As shown in table 3.3, each combination results in a degree of machine risk. For the proposed analysis of this study, the choice was the hydraulic press where its operation, as explained previously, serves for cycles, that is, each cycle is completed after started, thus making the machinery of high degree of risk, as it is impossible to avoid the accident when the machinery is not properly fitted with the normative safety items. The degree of risk for this machinery is the highest in the normative risk category, 4, analysis for this machinery is serious injury, which can even be death, the operator's frequency in the machinery is considered constant because in its a large majority the operator stays throughout his shift in the equipment, placing and removing performed parts, needing to insert hands and arms into the machinery where he presses, making it impossible to rescue the person alive or intact, because after pressing this machinery does not disarm if the equipment is turned off, responding for cycles it continues the work until its final position. Accidents in these cases are always, amputation, tearing, and in more extreme cases, death.

2.4 Case study

The data for implementing this was obtained in a company in the thermoplastic branch of the Industrial Pole of Manaus.

A small press (a baler) was used to carry out this analysis, the data were tested using the inference model comparing before and after adaptation, thus showing the effectiveness of the proposed model.

A first analysis was carried out with the machinery before adaptation, without the safety devices installed, verifying points of attention and risk / danger. From these data, the proposed inference model was used and the degree of risk in which the machinery is found was verified.

After this first approach, we proceed to the second simulation, right after the suitability of the press. The safety items installed were mentioned and again their data were inserted in the proposed inference model to verify the new degree of risk of the machine.

Within these analyzes it was possible to verify whether or not the machinery had a considerable reduction in the degree of risk, migrating from step 3 to degree 1 of risk, the lowest in the table in ANNEX B of ABNT. According to Annex B - ABNT NBR 14153: 2013, the lower the CAT, the greater the safety of the machine, and it is at this stage that it is intended to reach, so that there are no accidents that incapacitate or even culminate in the death of employees.

When analyzing the baler press illustrated in Figure 6, it appears that it in its initial state had few safety items, thus not guaranteeing the safety of the company's employees.

Figure 6 illustrates the machinery that is the object of this study and some safety problems detected according to normative items. The items in disagreement with ABNT NBR 14153 follow:

Figure 6 - Baling press without visible procedure.
Source: Author (2020)

- The operating procedure is not visible on the machine.
- Condition the corrective and preventive maintenance procedure of the machines;

Figure 7 - Floor demarcation.
Source: Author (2020)

- Lack of proper demarcation of the floor.

Figure 8 - Fixing the machinery.
Source: Author (2020)

- Machinery is not attached to the floor.

Figure 9 - Signaling.
Source: Author (2020)

- Missing sign indicating PPE's to be used

Figure 10 - Sensing.
Source: Author (2020)

- C heck the sensing that is in doubtful condition. Apparently, it is inoperative due to some impact suffered.

Figure 11 - Electrical panel and electrical controls
Source: Author (2020)

- Perform proper grounding on the machine followed by a report, according to NBR-5419, NBR-5410 and NR-10.
- Inadequate electrical control box according to regulatory standard NR10

Applying these security flaws found in the equipment, in the proposed fuzzy inference model, we have the following result:

Table 5.1

System Relevance Functions before adjustment

Accidents possible	Severity Of Injury (S)	Frequency exposure to danger (F)	Possibility to avoid the damage (P)	Value linguistic (Exit)
Sprain	S1	F1	P1	CAT 1
Amputation	S2	F2	P1	CAT 3
Shock	S2	F2	P1	CAT 3
Sis. Fuzzy%	74%	81.3%	35.5%	63%

Source: Author (2020)

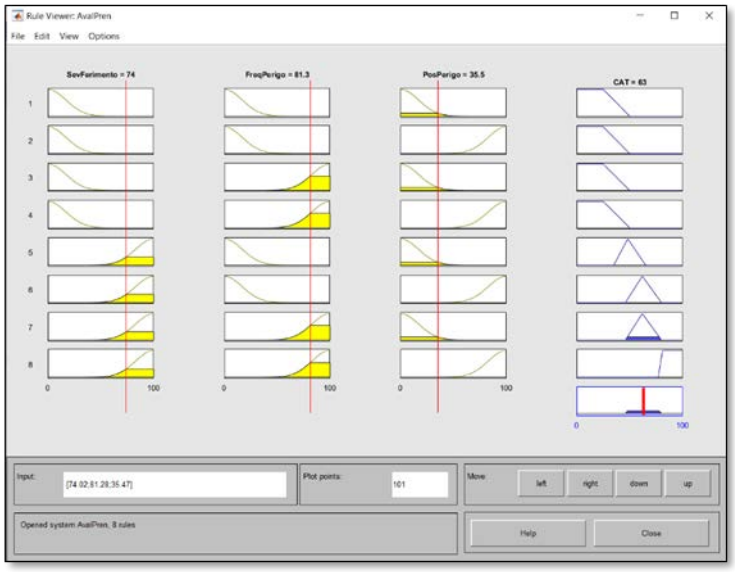

Figure 12– Rules viewer

Source: Author (2020)

The rules viewer illustrated in figure 12 shows that CAT is 63%, that is, CAT 3. In the conditions found in the machinery, there are two types of accidents that require changes in the safety of the equipment, amputation and shock as they give the machinery a degree of risk 3 (CAT 3).

Amputation for access to the pressing area of the press, in the removal of the burden from the machinery, which can be avoided.

The model fuzzy for the data obtained in the initial stage of the hydraulic press, it is illustrated in figure 13.

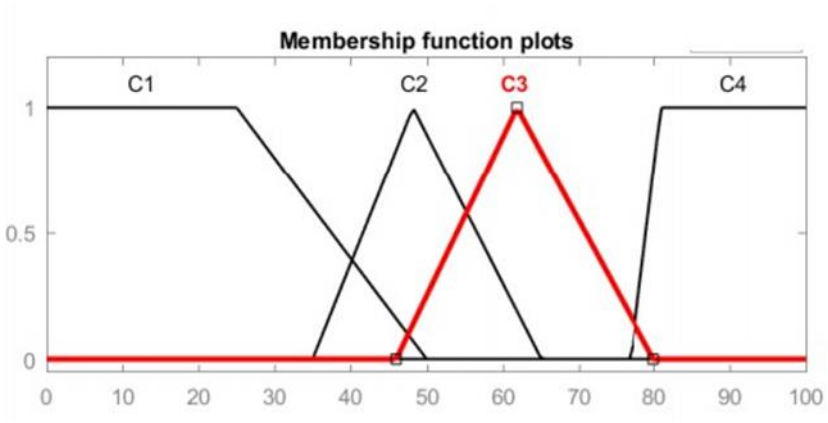

Figure 13 - Press risk category before adjustment.
Source: Author (2020)

As part of the suitability, an electromagnetic interlock sensor was placed on the material input door of the press, so it can only be operated with the door closed, the electrical frame reformulated, resized, the wiring changed and the control buttons changed. Press feet fixed to the floor without risk of the machinery tipping during operation.

After adapting the machinery, eliminating the unsafe conditions found initially, the modification illustrated below is verified and again the mathematical model is used to evaluate the new category of safety of the machinery.

Figure 14 - Machining fixation.
Source: Author (2020)

Figure 15 – Sensing
Source: Author (2020)

Figure 16 – Electrical
Source: Author (2010)

After adaptation, the concepts of the model were again applied to find the new risk category (CAT) of the machinery according to table 5.2;

Table 5.2

System Relevance Functions after adjustment

Accidents possible	Severity of Injury (S)	Frequency exposure to danger (F)	Possibility to avoid the damage (P)	Value linguistic (Exit)
Sprain	S1	F1	P1	CAT 1
Amputation	S1	F2	P1	CAT 1
Shock	S1	F2	P1	CAT 1
Sis.Fuzzy%	22.6%	22.1%	35.5%	24.1%

Source: Author (2020)

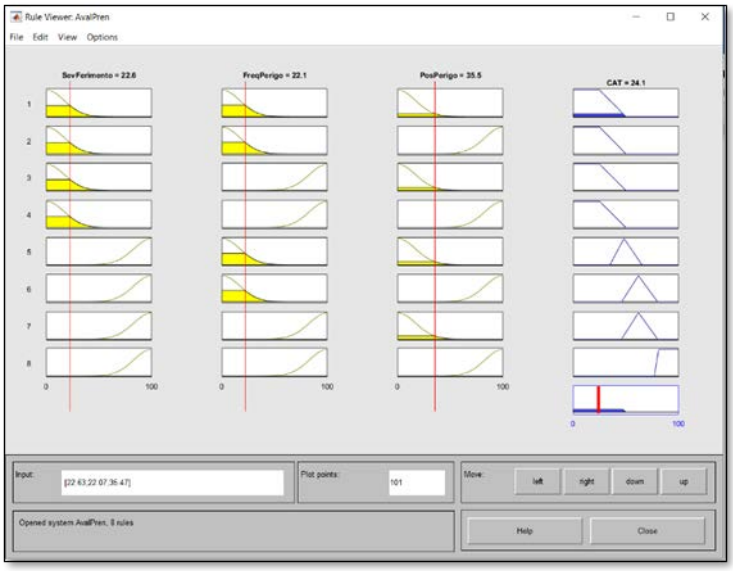

Figure 17– Rules viewer

Source: Author (2020)

The new risk category is CAT 1, making the equipment suitable for handling. The rules viewer shown in figure 17 shows that CAT is 24.1%, that is, CAT 1.

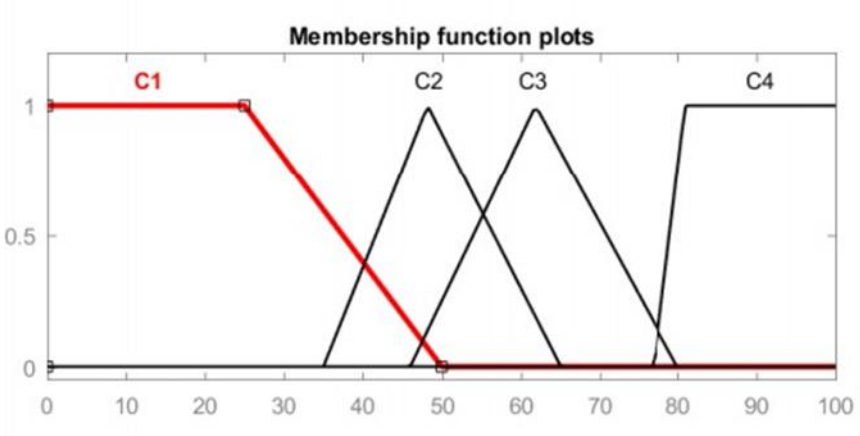

Figure 18 - Press risk category after adjustment.

Source: Author (2020)

The more severe the analysis reference used (S2, F2, P2), the greater the degree of risk of the machine.

When analyzing Figure 18, it appears that when the frequency of exposure to danger and the severity of the injury are low, the CAT (risk category) will also be low, the same occurs if it represents the frequency of exposure to danger and the severity of the injury is high, CAT tends to be a high degree.

In figure 19, there is a surface window generated by the matlab of the study model proposed, where it can be observed that the greater the severity of the injury, the longer the employee's exposure to the equipment during their workday, the greater the degree of risk of this machinery and the greater the need to adapt this equipment.

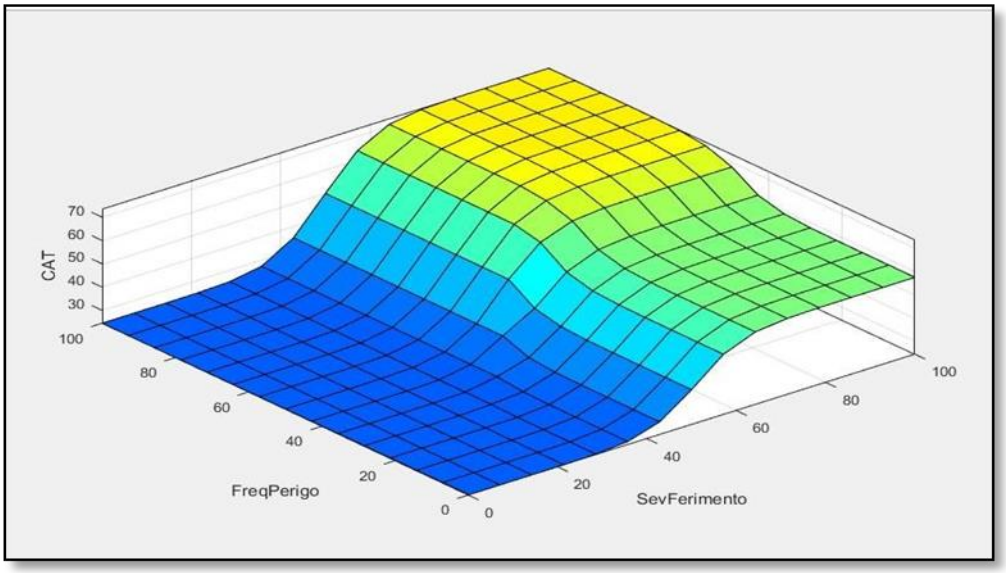

Figure 19 - Surface Analysis of the Degree of Risk.
Source: Author (2020)

3. Conclusion

Applying the model in logic Fuzzy, the true degree of risk of the machine is verified, before and after the adaptation, in the case in question the degree of risk has reduced from risk level 3 (CAT3) to risk level 1 (CAT1), this means that the machinery is if suitable for handling, accidents that could occur before adaptation will not happen because the safety devices attached to the machinery guarantee the operator's safety.

The reduction of two degrees of risk in machinery implies a lot of changes in the structure and concept of safety, training of personnel in the use and safe handling, coupling of sensors and safety rails, preventive and predictive maintenance scheduled and fulfilled, all of these and others concepts were applied so that the machinery could reach an acceptable level of safety, thus preserving the physical and mental integrity of the employees.

With the use of this tool, it is possible to analyze with greater speed and precision to what degree the machinery is found and to what degree of risk the same machinery is found after adaptation, regardless

of the experience and technical knowledge that the analyzer may have.

The knowledge of the entire work process, of the dynamics of the employee's job on the machine to be analyzed brings a lot of contribution to the final result of the analysis, as it delivers to the analysis tool concrete and realistic data with the final result the degree of real risk. of the machine, however the tool allows any lay person to perform analysis on the same machinery and find the same result, since the window of possibilities for analysis is beyond the simple “yes” or “no” of the usual logic.

The ideal is that a first analysis is carried out before adapting the machinery, and another analysis after analyzing the results obtained and the adequacy carried out.

A proposal for the evolution of this tool is to create a chatbot system in the form of a questionnaire for the operator to carry out these analyzes during his working day, to integrate the results to a database in order to have a real-time notion of all the machines in the factory parking, thus streamlining decision making by those responsible for maintaining the safety level of their employees.

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Smart City and Smart Tourist Destinations: Learning from New Experiences in the 21st century

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Abstract

Digital transformation has been a worldwide reality since the late 1990s. However, the 21st century has promoted its acceleration and scope for its use. Tourism professionals have sought the benefits that digital connections via smartphones bring to the diffusion and negotiation of services and products. However, young people from the internet age seek autonomy in the elaboration of their own travel itineraries, contributing to the emergence of intelligent tourist destinations. Based on the correlation with the principles of smart cities that increasingly become the goal of global managers, this study seeks to demonstrate the potential of the insertion of the tourist segment in this new perspective of social behavior. The results show that the co-creation by the travelers in search of experiences of impact in their lives is here to stay with QR Codes and Apps of cell phones. Information and digital communication technologies bring greater autonomy and creativity to the universe of tourists.

Keywords: Smart City; Young Travelers; Intelligent Destinations; News Social Behaviors.

1. Introduction

Since the early 2000s, authors dedicated to research on the relationship between Tourism and the use of digital technologies such as Gretzel (2006, 2011), Sigala et al (2015), Huang et al (2017), Li et. al (2017, 2018), Xiang et al (2017) and Shu-Tai Wang & Ping-Ho Ting (2020) highlighted the emergence of Intelligent Tourism as a vector that approaches Big Data, technological innovations, digital marketing, online market research and social networks to support managers and tourism agents in optimizing their resources and attractions for the connected population.

However, in addition to the traditional suppliers of products and services, tourists themselves have also

sought to develop greater autonomy in planning trips. They are increasingly using smartphone apps to develop personalized itineraries, seek more competitive prices and alternative places where they can experience different experiences. In this regard, smart cities favor this approximation between individual and collective expectations for resources including Internet of Things (IoT) devices, computing platforms, and data storage media (SINAEEPOURFARD; KROGSTIE; SENGUPTA, 2020) geared to tourism. Smart cities are categorized based on a set of improvements for digital access to citizens in various segments such as: smart economy (ECO), intelligent population (PEO), smart management (GOV), intelligent mobility (MOB), intelligent environment (ENV), intelligent living conditions (LIV) (SOJDA, 2020).

Thus, the objectives of this research are to relate the potential offered by smart cities to tourism, as well as to understand how the new generations take ownership of technological mobile devices contributing to the development of smart tourist destinations. The present study is purely based on secondary data. Therefore, for this purpose the bibliographic, analytical, and descriptive method was used.

2. Smart City and Smart Tourism: context and research

The increase in the urban population, the complexity and competitiveness of cities pointed to the role of Information and Communication Technologies (ICTs) in the coordination of activities and services, involving connected, better informed and engaged citizens (BUHALIS; AMARANGGANA, 2014).

Between the end of the 1990s and the almost twenty years of the early 2000s, debates around smart city projects expanded around the world. Tests have been carried out in Europe, the Americas and Asia, from London to Boston and Hong Kong, from Barcelona to Amsterdam and São Paulo in Brazil, as citizens around the world demand that their local governments offer urban spaces designed to improve their quality of life (DAMERI; ROSENTHAL-SABROUX, 2014).

At the end of the 1990s, the publication Intelligent Environments - Spatial Aspect of the Information Revolution already relied on virtual technologies to define a smart city as: “a virtual reconstruction of a city, or as a virtual city” (DROEGE, 1997).

The adhesion of several countries of the European and Asian continents to the proposal of smart cities made each research group in academic institutions or municipal urban planning, seeking to define the concept according to their possibilities of understanding and adaptation to their realities. In this way, five definitions summarized the ideal of implementing multiple ideas (table 1).

Table 1. Smart City concepts in use in Western, Eastern and European research Asia (Mkrtychev et al., 2018)

Origins	Definitions
Standardization Administration of China - the smart cities standardization working group. Chinese nationals - SAC	Smart City is a new concept and a new model, which applies the new generation of IT to facilitate the planning, construction, management and intelligent services of cities.
British Standards Institution - BSI/PAS 180	Smart City is a term that denotes the effective integration of physical, digital and human systems in

	the environment built to provide a sustainable, prosperous and inclusive future. for its citizens.
Smart Sustainable Cities Focus Group - ITU / T FG	A smart and sustainable city is an innovative city that uses ICTs (information and communication technologies) and other means to improve the quality of life and the efficiency of urban operation, services, and competitiveness, while ensuring that it meets the needs of generations present and future in relation to economic, social and environmental aspects.
Technical Board of Directors / Smart Cities Strategic Advisory Group - ISO TMB	A smart city is one that dramatically increases the pace at which it improves its socio-economic and environmental results (sustainability), responding to the challenges of improving the way it involves society, how it applies collaborative leadership methods, how it works in city disciplines and systems and how it uses information from data and modern technologies to offer better services and quality of life to those involved with the city, now and for the foreseeable future, without unfair disadvantage to others or degradation of the natural environment.
European Smart Cities - Vienna University of Technology.	A Smart City is a city that performs well in six key areas of urban development, built on the "smart" combination of endowments and self-determined, independent and conscious citizens

The table above shows the smart city concepts used in this study.

According to Komninos (2002), all smart cities are also digital cities, but not all digital cities are smart. Hence the need to distinguish the basic concepts in theoretical reflection and constitutive practice. While the digital city uses online services adapting to technology what it already offered personally to the community regarding administration (web portal), the smart city creates services for citizens with digital spaces for consultation and online collaborative tools, where there is participation, interaction, and intervention by the population in improving the continuity of products in order to solve everyday problems. The first is based on receiving services from public agencies, the second is based on innovation, being a co-creator of services.

The concept of smart city originates from California (USA), where smart communities are structured, as geographic areas of different sizes, where residents, organizations and government institutions use ICTs to transform territories, promoting cooperation between government, companies, educators, and citizens. Thus, technological improvements encourage the exchange of knowledge between different groups (INVAT.TUR, 2015).

This "Intelligent Community" approach began at San Diego State University (SDSU) to transform the

community, of various sizes and significantly, using Information Technology (IT) (CALIFORNIA INSTITUTE FOR SMART COMMUNITIES, 2001).

According to the California Institute for Smart Communities, there are ten steps to start the process of building an intelligent community, as follows: 1. Better understanding of the concept of "smart community", considering not only technology, but also the economic structure and social; 2. Broad communication of the concept of smart community, decentralizing power to favor its collective appropriation; 3. Creation of a new decision-making mechanism with an emphasis on collaboration between all parties; 4. Assessment of the needs of the community and their definition, based on the reconfiguration of geographical limits, communication technologies, their demands and sense of priority; 5. Vision and mission statement for the smart community, described in up to one page and certified by all its civil and government members; 6. Establishment of goals and priorities, elaborated by collaborative commissions among all interested parties, adopting schedules and assisting in the development of tasks that can be distributed around areas (health, education, transportation, legislation, government services, economics, etc.); 7. Strategic plan for the concept of smart community to become a reality, guiding the development of broadband infrastructure connecting the entire community, of systems and services that benefit the community and an agenda with regulations for the new infrastructure and information services, always updated; 8. Definition of responsibilities and schedules, making the expectations of those involved clear, determining the sources of financing, public / private partnerships and outsourcing; 9. Community interactions, based on zoning, land use, development and control of information systems, using culture as a magnet in the remodeling of space and its social relations; 10. Monitoring, keeping energy, focus and commitment alive in the continuity of the development processes of a new Information Management System (GIS) for the collective construction of a smart community (CALIFORNIA INSTITUTE FOR SMART COMMUNITIES, 2001).

Steventon and Wright (2006) define Intelligent Community as: "an intelligent environment, which incorporates information and communication technologies (ICT) that create interactive environments, which bring communication to the physical world". From this perspective, an intelligent city (in more general terms, an intelligent space) refers to a physical environment in which communication and information technologies, in addition to sensor systems, disappear as they become embedded in physical objects. and in the environments in which we live, travel and work. In other words, technological informational integration becomes part of human life to have its effects naturalized.

Komninos (2006; 2008) draws attention to the fact that smart cities evolve towards a strong integration of all dimensions of intelligence: human, collective, and artificial, available in a City. They are built as multidimensional clusters, combining the three main dimensions.

The innovation that underpins the smart city proposals emerged as a great response to the main challenges facing cities and their residents. In the past, much of the focus of debates gave rise to technological interventions, but the awareness that technology alone will not be enough to achieve the objectives of the smart city has made the centrality of propositions shifted to the human factor. Local communities are the main stakeholders in providing products and services from smart cities around the world and therefore cannot be ignored. Community involvement (or citizen involvement) becomes an essential part of the organizational processes of local authorities to offer innovation in smart cities (MAZHAR et al., 2017).

Although this discussion has already leveraged smart city projects in many states in Brazil, there are still

many spaces missing from this notion as an important factor in urban development via technological communication, since until 2016, they were only inserted in this context: São Paulo, Rio de Janeiro, Curitiba, Brasília, Belo Horizonte, Vitória, Florianopolis, Barueri, Recife and Campinas (SEBRAE, 2016). Most Brazilian cities listed as smart cities have turned their development towards technologies applied to urban mobility systems with the adoption of Light Rail Vehicles (VLTs) or Bus Rapid Transit (BRTs), "citizen service" information systems in sites of city halls (varied documents, property records, processes), garbage collection and recycling, monitoring of pollution levels, intelligent use of energy matrixes, among others.

ICTs have supported cities in addressing their social challenges, increasing the development of Smart City in facilitating continuous access to value-added services, both for their citizens and for tourists and city visitors who now have real-time information about the public transport network, in addition to promoting interconnectivity between the city's stakeholders through the "Internet of Things" (Internet of Things - IoT), allowing cities to dynamically engage with their stakeholders (BUHALIS; AMARANGGANA, 2014).

In his research, Yongda (2017) starts from two initial concepts: first, "smartness" to describe innovation and transformation linked to new technologies, which can integrate and share data in real time for communication and collaboration in decision-making processes. The second term, "smart technology" was thought of as a technology with a degree of intelligence that supports new forms of collaboration and value creation, leading to innovation, entrepreneurship, and competitiveness.

In 2012, the city of Palma de Mallorca (Spain) approved its "National Comprehensive Tourism Plan" bringing together the concepts of sustainability, knowledge, innovation, and technology aimed at tourist destinations. From this proposition, the definition of "smart tourist destinations" was arrived at as:

"An innovative space, accessible to all, consolidated on cutting-edge technology, which guarantees the sustainable development of the territory, facilitates the visitor's interaction and integration with the environment, and increases the quality of their visit to the destination" (SECRETARIAT OF STATE OF TOURISM, 2018).

We sought to develop comprehensive intelligent systems capable of facilitating the integration and interaction of the tourist with the interpretation of the destination on a chronological basis (before, during and after the trip), contributing with elements that guide the interpretation of the surroundings, speeding up the decision-making process. decisions and increase the quality of your vacation, leisure, and leisure experience (MUÑOZ; SÁNCHEZ, 2015).

In 2015, the "Libro Blanco de los Destinos Turísticos Inteligentes" by Francisco Javier Blanco Herranz, brings the concept of intelligence (smart) is presented, in a multivariate way, as: expression of digital exchange, projection of the future, collaborative experience, focus of DTIs in Public Policies, city as a technological platform for innovation, competitive factors, articulation of knowledge via systems, integration with sustainability, among other topics.

A more organizational view of the assumptions is interwoven with Intelligent Tourist Destinations. The requirements are sustainability, financial viability, and public / private collaboration. Its mission is to convert a tourist destination into a DTI, using innovation (processes or tools) and technologies (information, communication, efficiency). The results are demonstrated in the increase of business competitiveness and public initiative, in the improvement of the quality of the visit and the quality of life of the residents. There

will also be the generation of efficiency, employability, income (tax, wages, business) and satisfaction with the enterprise. Thus, agents - public administration, private companies, and training entities - will be working in the same territory in a collaborative way (MUÑOZ; SÁNCHEZ, 2015).

Therefore, smart tourism encompasses a new generation of ICTs that are made available through a platform - using IoT, cloud computing, mobile technology, and AI - reports of tourist attractions, consumption of tourist products, in addition to the results of research in the tourist area which can be made available in a language intelligible to companies and organizations (YONGDA, 2017).

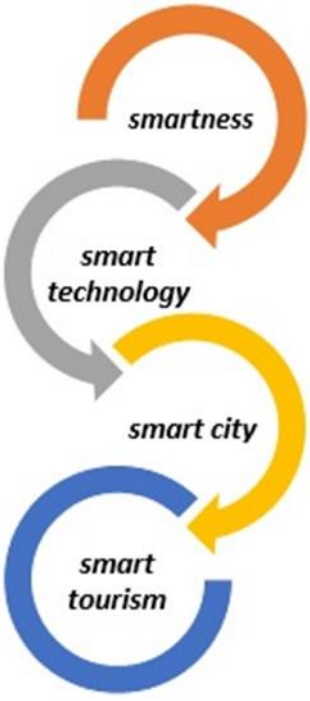


Figure 1. Diagram of smartness influence.

The figure above shows the smartness cycles adopted by service and product segments.

More assertive and intelligent technologies seek to respond to the requests of tourists and stakeholders, focusing on facilitating consumer decision-making processes (Figure 1). They do not aim at the universality of social groups, in view of their heterogeneities, mainly in relation to the way they handle digital resources (greater proximity or resistance). Its focus is on those who have adopted smartphones as more efficient, fast and hyperconnected solutions.

3. DICTs and new consumer trends in smart tourism.

Digital Information and Communication Technologies (DICTs) contribute to the generation of experiences with added value for tourists, in addition to improving efficiency and supporting the automation of processes for organizations related to tourism and hospitality. Thus, the development of smart cities can incorporate the formation of "smart tourism destinations", since the use of technology in the environment of the destinations enables the enrichment of tourist experiences and increase the competitiveness of destinations (BUHALIS; AMARANGGANA, 2014).

That said, “[...] Tourism and ICT can be considered two sides of the same coin. If a historical analysis of

the evolution of tourism is carried out, it is easy to see that it is intricately linked to technological evolution" (MENDONÇA, 2002), aiming at making the offer of services more rational to obtain an advantage over the competition. An example of using ICT with respect to information and dissemination is the Quick Response Code (QR Codes).

Historically the QR Code was launched in 1994 by Denso Wave and Masahiro Hara was responsible for its development. There was still uncertainty on the part of Hara about the ability of her innovation to replace the traditional barcode. Unlike the old code, the bidirectional QR Code intended to "create a simple reading system that encodes a lot of information in several directions, whether transversal, up or down" (SOUSA, 2014).

It is worth mentioning that, due to their high potential for storing information, QR Codes were initially used in the production management of the automobile industry and their dissemination was expanded due to their free availability, without the use of a patent by their creators. Increasing its use more generally, in 2002, with cell phones being able to read QR Codes (SOUSA, 2014). This tool "is also a code that is resistant to damage and corrects errors that may arise, and data can be restored up to a maximum of 30%" (SOUSA, 2014) of the information present in memory. Thus, if the QR Code is streaked somewhere, missing any element will not present any damage that would prevent its reading.

The use of QR Codes with two-dimensional images digitized by cell phone cameras as a digital marketing tool has diversified its area of commercial application in recent years due to the development of mobile technologies, greater popularization of smartphones, greater speed, and digital security in the transmission of information desired.

"The trend in the marketing community is the use of QR code. They are found on magazine pages, billboards, cereal boxes, beverages, weekly advertisement papers, and other marketing mediums. A qualitative focus group study conducted in Japan found that loyal customers would use QR codes to access promotional information and discounted items […]. Even educational institutions, museums, and various public places use QR codes to provide more information about an on-going program, a particular event, or an object […]. The primary goal of marketing is to interact with a customer or a potential customer. The QR code can help to achieve it by providing better engaging service to customers than other traditional ad mediums" (CATA et. al., 2013).

Teuta Cata et. al. (2013) call attention to a Mobile Marketing System (MMS) framework with different degrees of interaction between the product's offer and the customer's consumption. In this way, you can direct the consumer to a static informational website or to an application that involves direct user participation, unraveling the secrets of the codes that advertise the service and products.

It is up to the service / product manager to pass on the necessary guidelines to website and application developers, as well as throughout the marketing process to provide users with autonomous procedures for reading codes for accessing data (software to scan, how to download them) for the mobile device, how to position the camera correctly on the QR Code, etc.).

When addressing the use of ICTs applied to tourism, Mery Morales, supported by the studies about Baeza (Spain) in 2000, emphasizes "usability", that is, the ability of a software to be understood, learned, used, and perceived in an attractive way by the user. Therefore, it highlights five necessary attributes: ease of learning, performance speed, error rates on the part of users, time retention and subjective satisfaction

(MORALES, 2017). Also citing John Cato, he suggests a few more attributes for proper technological use, namely:

"Control: Users should feel that they have control over the application, and not the other way around. Skills: Users should feel that the system supports, complements, and enhances their skills and experience. Privacy: The system helps users to protect their information or that of their clients" (MORALES, 2017).

Michela Grimaldi and Maria Teresa Natale (2016), when addressing the theme of applications at the service of cultural heritage in Italy, highlight the contemporary need for cultural institutions and communities to make use of new technological tools at affordable cost, citing the use of digital cameras and websites to disseminate information and interact. The authors propose the creation of a synergy between culture and technology combined with the routing of heritage sites for the purpose of enjoyment during visits.

The role played by ICT in operationalizing the internal management of organizations, also establishes relationships with their external environment and allows for articulation between all the subjects of the tourism system (SERRA, 2008).

The Future Traveler Tribes 2030 report, Understanding Tomorrow Traveler, published by Amadeus Traveler Trend Observatory in April 2015, stated that travel trends in the coming years will be defined by the intensive use of technologies, given that smartphones can already be used. used in radically different ways by travelers, with apps that allow users to search and store itineraries meticulously, but also improvise on the spot. This mobile technology aims to provide the autonomy of travelers in achieving their goals.

In the perspective of this digital tourism, it is based on the premise that the consumer, his behavior, and tourism profiles significantly affect the operation of the tourism marketing model (HAPP; IVANCSÓ-HORVÁTH, 2018).

Understanding consumer perceptions is the key to the success of technological innovations in any service area, including tourism. Perception is a dynamic process by which the perceiver gives meaning to the "raw materials" of the environment. The individual is not a lifeless object, but an actor. Perception interposes, between the real world and behaviors, as a filter between a transmitter (the real world) and a receiver (men). Therefore, it is affected by several factors such as memory, behaviors, codes, values, beliefs, and way of life (KAZANDJIEVA; FILIPOVA, 2018).

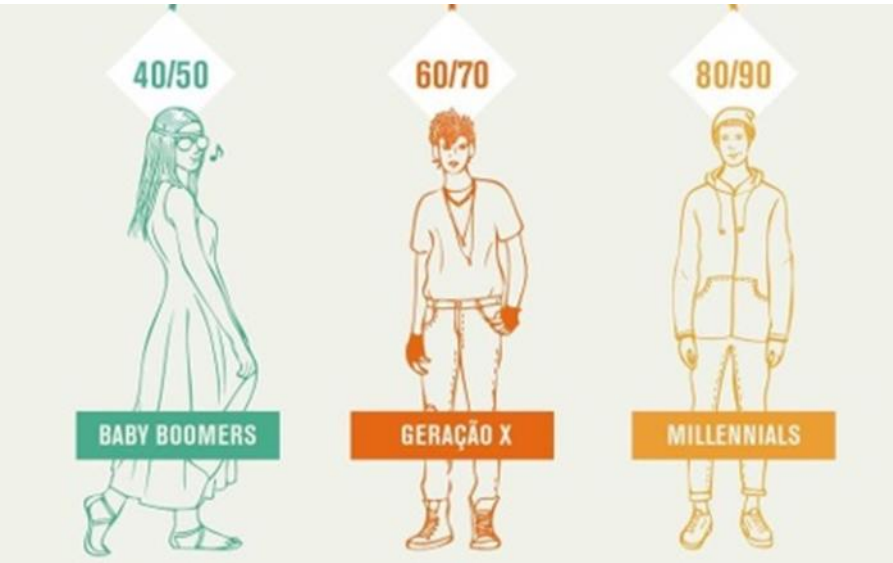
In this regard, four generations of consumers have been worrying researchers in recent years, whose periodization of birth has supported the understanding of their socio-cultural consumption behaviors. These generations are named as: 1) Silent Generation (born between 1925 and 1942 - through the Great Depression and World War II), 2) "Baby Boomers" generation (born between 1950 and 1960, as children of the post-demographic explosion World War II), 3) Generation X (born between 1960 and 1970, those who experienced the most intense times of the Cold War) and 4) Generation Y (born between 1980 and 1990, witnessed the advancement of technology with the creation of Word , Wide, Web - www.). Generation Y - also known as "millenials" - has proved to be extremely influential, adept at cultural, autonomous, individualistic, and anti-corporate diversity, but ethical and in search of qualitative life experiences different from previous generations (DOUGLAS et al., 2018).

Developers of tourism consumer technologies via Apps usually target Generation Y, belonging to the global youth, since they are those who are connected, immersed in social networks, making hedonistic "breaks" that combine work with pleasure, are fans of online crowdfunding platforms, followers of Steve Jobs, move

between different groups, seeking experiences with higher quality of life. Therefore, when dealing with tourism, starting in 2017, it is necessary to consider the opinion of the traveler (to increase customer loyalty) and address the "millenials", offering them personalized experiences in hotels and travel planning. Thus, customers should receive travel ingredients that not only involve airline tickets and hotel stays, but also include VIP access to the newest restaurants and many extraordinary experiences (HENCHE, 2018).

Generation Y wants an integrated technology in all parts of their lives and expects it to be central to their leisure, work, and study experiences. Generation Y embraces technology as they grow up with it. They communicate in the virtuality of social networks and text messages, expecting quick feedback and recognition and, as a result, are sometimes blamed for having poor communication and problem-solving skills in the physical world. Studies show that Generation Y prefers work environments where technology is used more, and they tend to take technology for granted (DOUGLAS et al., 2018).

The Infographic prepared by Ponto Eletrônico Box 1824 gives a playful visibility to the behavior of consumers from the last three generations (from 1940 to 1990), highlighting the roles played by each in the consumption activity from its historical context, experiences, ethics, and attitudes (Figure 2).



Post-World War II	Cold War	World Wide Web
Contesters	Individualists	Connected
Linear Reasoning	Linear Reasoning	Nonlinear reasoning
Peace, Love, Free Sex and Power Flower	Live the search for pleasure without guilt	Make hedonistic breaks and combine work with pleasure
They earned the right to be young	Consolidated economic power	Crowdfunding
Community x City	They are divided into groups	They move in different groups
House key	Room key	World key
Libertarian Youth	Competitive Youth	Global Youth

Figure 2. Comparative behavioral generational infographic.

Note: Adaptation of the Point Electronic Box Infographic 1824 (2018), from: https://www.hypeness.com.br/2012/01/infografico-mostra-a-diferenca-dos-jovens-dos-anos-50-70-e- 90/

The figure above shows an image of three generations of young people related to the changes and an explanatory table of their trends and behaviors.

The development of smart tourism seeks to employ digital mobile connectivity to create smarter, more meaningful, and sustainable connections between tourists and their destinations and represents broader efforts to imagine tourism as a form of deep civic engagement and not just a simple way of consumption (YONGDA, 2017).

Combining the smartness of technology with tourist destinations requires a dynamic interconnection of interested parties through a technological platform on which information related to tourist activities can be exchanged instantly. This integrated platform must have multiple points of contact, which can be accessed through a variety of end-user devices, which will support the creation and facilitate real-time tourism experiences, improving the effectiveness of managing tourism resources across the destination, at the micro and macro levels. In this way, a Smart Tourism Destination takes advantage of: (1) Environments with technological resources; (2) Interactive processes at the micro and macro levels (3) End-user devices at multiple points of contact; and (4) engaged stakeholders who use the platform dynamically as a neural system. The goal is to use the system to improve the tourism experience and improve the effectiveness of resource management to maximize destination competitiveness and consumer satisfaction, in addition to demonstrating sustainability over an extended period (BUHALIS; AMARANGGANA, 2014).

Despite technological innovations for cities and tourism being integrated into the dynamics of globalization, there is an increasing clamor on the part of Generation Y for ambiences of specificities and exclusivity, mostly linked to traditional cultures, experiences in their diversity and attractions related to environmental sustainability and ways of life in smaller towns, far from large cities. At the same time, due to their own definition of hyper connection, they request that the information that leads them to these spaces, experiences and products emanating from popular culture be in the orbs of cyberculture.

The latest trends in demand have revealed that so-called “last or third generation tourists” use their stay in urban destinations to seek out rewarding and unique experiences. This turns passive viewers into active tourists. Instead of “observing”, they travel to a destination to “do” things, interacting more with the local culture (HENCHE, 2018).

On the Sustainable Tourism trail, the need to “maximize social and economic benefits for the local community and minimize negative impacts” is emphasized to encourage social development in the community, employment opportunities, fair trade, sustainable products, policies against harassment and exploitation and equal employment opportunities (HERRERA et al., 2018).

The “know-how” of artisans from small communities, whose products are often recognized as cultural heritage and have quality certification through the IG, has attracted the attention of local managers due to the tourist appeal that this production can represent, enabling the generation of demand for tourism and, consequently, for the other sectors of the production chain. Its link with the creative economy, sustainability and competitiveness can positively re-signify the lives of producers/residents and, at the same time, offer a tourist experience of quality and uniqueness. In this sense, the promotion of these locations through a

digital marketing tool intends to be inserted in this new trend of tourist consumption.

4. Conclusion

Increasingly, tourists who handle the resources of cyberculture seek to plan their visits individually and are no longer interested in a list of standardized attractions, but rather reveal their expectations of experiencing playful, new, surprising experiences that allow them to know the areas outside traditional itineraries, exchange lively and unique ideas with residents and their local culture.

The key software challenge for tourism focuses on creating a good mobile experience that works for its target audience, Generation Y, hyperconnected in contemporary times and eager for interactivity, inspired by an ethics of sustainability, in search of significant travel experiences and sharing them in real time.

The tourist app brings to the heart of the discussions the development of a culture of smartness, smart tech, smart city, smart tourism, smart tourism for communities, ICTs applied to tourism, Intelligent Tourist Destinations, the behavior of tourist consumers before their generations of birth, etc.) providing subsidies for the professional practice of tourism specialists and stakeholders. Learning from digital information and communication technologies helps to offer better products and services to travelers.

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The 4-year Experience of Nursing Activities Score Use in a Brazilian Cardiac Intensive Care Unit

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Abstract

Background: *The assessment of nursing workload offers both support for patient care planning and service management. In an Intensive Care Unit (ICU) this workload is measured by the Nursing Activities Scores (NAS), although in specialized areas such as Cardiology, its use is still diminished.* ***Objective:*** *To describe NAS and the prevalence of its sub-items in a Brazilian Cardiac ICU. We also aimed to evaluate NAS*

oscillation since the opening of the unit, and according to the day of the week. ***Methods:*** *Daily NAS records collected from November 2014 to October 2018 were assessed, totaling 8600 assessments distributed over 49 months. The data were analyzed according to time, day of the week, number of records per day, and dichotomizing if NAS was higher or lower than 50 points.* ***Results:*** *NAS presented mean value of 52.91 points and a median of 53.40 points. The mean NAS values per month ranged from 45.00 to 59.10 points. The percentage of NAS assessments above 50 points ranged from 20.59 to 92.34% per month and proved to be a better indicator for assessing the variability of the monthly workload. When combined two by two, 66.01% of NAS combinations scored more than 100 points, suggesting the need for more than one nursing professional per day. When the data were stratified by year, 2018 had the lowest means compared to the others. When compared to the mean values in function of the day of the week, it was observed that Monday to Friday (with the highest mean on Wednesday, the predominant day for cardiac surgeries) showed higher values than weekends.* ***Conclusions:*** *Overall, NAS showed low values compared to other general or cardiac ICUs, it also presented temporal variability and our results showed risk of workload overload which can compromise patient care and safety. Such results reinforce the importance of the administrative and assistant aspects of the routine use of NAS in ICUs specially in specialized environments as Cardiac ICU.*

Keywords: Nursing; Workload; Intensive Care Unit; Cardiology; Quality Indicator; Patient Safety.

1. Introduction

The Nursing professionals daily work is composed of several assistant and administrative activities, among them are the dimensioning of Nursing staff, preparation of monthly schedules and daily assignment of team activities, and the organization of the service within the hospital units, among others (COFEN, 2017). To stablish work schedules, nurses have some instruments for estimating the Nursing workload being the number of hours that a patient demands from Nursing care in a day of hospitalization (or 24 hours) or in some cases a healthcare in a unit of time and a place (Miranda, Nap, de Rijk, Schaufeli, & Iapichino, 2003; COFEN, 2017).

Intensive Care Units (ICUs) usually present high patient-related complexity of nursing care. In many cases when the dimensioning of Nursing staff is based only on the current legislation the staff in these units may not meet the minimum nursing care needs of the inpatients (Brazil, 2010; Inoue & Matsuda, 2010; Borges et al., 2017). In this scenario, it is essential to measure Nursing workload in these units and debate the work schedules that are recommended and required by the ICUs Brazilian legislation (Brazil, 1998; Brazil, 2010). The currently most used instrument to measure nursing workload in ICU worldwide is Nursing Activities Score (NAS) (Miranda, Nap, de Rijk, Schaufeli, & Iapichino, 2003), validated and translated in Brazil by Queijo and Padilha (Queijo & Padilha, 2009).

The NAS presents the time in 24 hours spent by the nursing team on twenty-three healthcare procedures divided into seven categories. The individual score for each sub-item ranging from 1.2 points to 32 points depending on the activity; the sum of sub-items reaching a maximum of 176.8 total points for the workload. Each point of NAS equals to 14.4 minutes (0.24 hours) of assistance from the Nursing team. (Miranda, Nap, de Rijk, Schaufeli, & Iapichino, 2003). The filling of the items on NAS is performed based

on Nursing activities records performed in the last twenty-four hours of hospitalization, thus providing retrospective data on Nursing workload (Miranda, Nap, de Rijk, Schaufeli, & Iapichino, 2003; Ducci & Padilha, 2008). Although NAS is an instrument that retrospectively assesses workload, it has been used as a measure of workload prediction to be offered in the next 24 hours of assistance with good results (Ducci & Padilha, 2008).

Some studies have shown that NAS application made possible to adjust the number of nursing professionals, as well as to identify nursing shortage, in addition to understand the reality of workload, thus providing essential information to plan out nursing care schedules according to all patient's particularities (Padilha et al., 2010; Nogueira et al., 2013). In this regard, NAS is a helpful instrument both when used as an assistance tool and as an administrative tool, promoting effective management, being able to contribute to an appropriate dimensioning of the nursing team (Macedo et al., 2016).

NAS is widely used in general adult ICUs, but its use on specific settings such as cardiology is still incipient (Coelho, Queijo, Andolhe, Gonçalves, & Padilha, 2011; Reich, Vieira, Lima, & Rabelo-Silva, 2015; Mendes-Rodrigues et al., 2017-b). Some studies carried out with patients in the postoperative period of cardiac surgery have shown NAS ranging from 61.6 points to 96.8 points (Giakoumidakis et al., 2012; Coelho, Queijo, Andolhe, Gonçalves, & Padilha, 2011). Differences depending on the type of ICU on NAS within the same institution are also observed (Mendes-Rodrigues et al., 2017-b). Other studies have shown that cardiac patients in emergency units, in this case in a Chest Pain Unit, have a quite different care profile from other units with higher patient-dependence from the Nursing team (Mendes-Rodrigues et al., 2017-a). This difference between cardiology patients and others could also be present when comparing cardiac or general ICUs or other specialties.

Resolution n. 7, of February 24th, 2010 (Brazil, 2010) and the Consolidation Ordinance n. 3 GM/MS, of September 28th, 2017 (Brazil, 2017) establish that Brazilian ICUs require continuous and mandatory assessment of some indicators as the evaluation of hospital infection rates by Hospitals Infection Control Centers, as the calculation of severity scores or prognosis indexes (e.g. mortality risks), as calculation and presentation of risk of injuries or outcomes, the use of some severity of illness index or systems that help to identify critically ill patients at death risk. Specifically, for nursing, article twenty-three rules the use of the Nursing Care Classification System or a workload index that helps the quantitative and qualitative assessment of nursing human resources needed for patient care. In this case, the workload index currently used in ICUs is NAS. ICUs routinely collect this data from NAS, catalog them, and present them as a public indicator (Brazil, 2010), but often they do not analyze or apply these results in the institution's clinical and administrative practice. Consolidation Ordinance n. 3 GM/MS, of September 28th, 2017 also defines the minimum criteria for staff dimensioning for ICUs (Brazil, 2017).

The applicability of nursing workload estimation instruments has been increasingly emphasized, not only to assist in administrative practices, but also in care practices (Griffiths et al., 2020; Hoogendoorn et al., 2020), since when knowing better the clinical and care profile of their patients, nurses will have a better chance for dimensioning and adjusting their work schedules to make nursing care more efficient and effective. Recently, the interest in studying such instruments as NAS applied in cardiac ICUs has increased (Giakoumidakis et al., 2012; Coelho, Queijo, Andolhe, Gonçalves, & Padilha, 2011), especially since it represents a scarce subject in the scientific literature. In this regard, studying NAS as an administrative and

assistant tool in a Cardiac ICU has the potential to improve the lack of published data on the subject, provide a descriptive study of NAS, and support future studies on the subject. The results of this study can also provide indications of the applicability of quality indicators assessed for ICUs and specifically for Cardiac ICUs. Knowing the impact of nursing care on the quality of health services is essential, and aspects such as workload and staff dimensioning are important factors to explain these results, as what has been reported (Nogueira et al., 2017; Gomes et al., 2019).

Accordingly, the aim of this study is to describe the profile and prevalence of the sub-items of the NAS instrument in the Cardiac Intensive Care Unit of the Clinical Hospital of Uberlândia of the Federal University of Uberlândia based on a four-year experience of using NAS and evaluate its temporal variation since the opening of the unit, and according to years, months and the days of the week.

2. Methods

2.1 Study Design and Location

This is a retrospective, analytical, documentary (internal ICU documents) and longitudinal quantitative study of the experience report of NAS use performed at the Clinical Hospital of Uberlândia (Hospital de Clínicas de Uberlândia in Portuguese), Federal University of Uberlândia (Universidade Federal de Uberlândia in Portuguese), Minas Gerais state, Brazil. This is a teaching complex hospital with about 520 beds. Data were collected at the Cardiac ICU, which helps patients with a cardiovascular disease profile. The unit was opened in November 2014 and consisted of seven beds, with about 30 to 40 monthly admissions documented and mean length of stay between 10 to 15 days, according to indicators of the Statistical Service of the hospital. This Cardiac ICU is classified as type 3, with greater care complexity in Brazilian ICU classification (Brazil, 2017).

2.2 Sample Size and Data Collection

Since NAS is a mandatory daily assessment indicator for all patients admitted to the ICU, based on the unit's accreditation legislation (Brazil, 2010), all records were evaluated from the opening of the unit, November 2014 to October 2018. Besides this, the unit had only seven beds, which reduces the number of records, which based the decision to evaluate all data in the studied period. Assuming an alpha of 0.005 (Benjamin et al., 2018), an expected frequency of 50% for each sub-item of the NAS instrument, and a permissible error of 1%, there would be necessary 19698 assessments of NAS as the minimum sample size to determine the prevalence of a NAS subitem, due to the presence of rare subitems observation.

Data from four years of NAS evaluation were included, grouped into 49 months of evaluation (November 11th, 2014 to October 31st, 2018), consisting of 1482 evaluation days. In these 49 months, 8,600 daily NAS assessments were performed. For each evaluation day, the number of beds evaluated or not was counted. Data were evaluated according to the opening month (month 1: November 2014), day of the week, if it was a weekday or weekend and month and year of evaluation. Data for each NAS evaluation was also dichotomized into NAS higher or lower than 50 points, because Brazilian legislation indicates one nursing professional for every two patients in one shift (Brazil, 2010), which corresponds to a workload of maximum 50 points per patient or added up to two patients up to 100 points. For each assessment day,

where at least two patients were assessed for NAS, the assessments for the day were combined two by two and the sum of NAS of the two assessments was calculated, and each combination was dichotomized as higher or lower than 100 points, once combinations with more than 100 points could express nursing workload overload in a random assignment of patients for a nursing professional

When available, NAS subitems were registered and evaluated for prevalence. We used two bases, considering the patient-day basis (all 4174 available records, representing the prevalence of the sub-items in the records) or as patient basis (673 available records). In the last case, considering the presence of at least one record of sub-item per patient during hospitalization, which represents whether the patient had the record of this sub-item during hospitalization. The patient code registered not permits patient identification.

2.3 Ethical and Legal Aspects

This study did not include any clinical or sociodemographic data of patients in the unit, and neither patients nor their medical records were accessed. All data from NAS are routinely collected in the unit, catalogued and stored in electronic spreadsheets and do not allow identification of any patient. There is no possibility to associate identification of any patient with the collection of data. Since the data were secondary, they were collected from books, spreadsheets and administrative forms from the unit and do not involve approaching patients or their medical records, the study has no indication of submission to the Research Ethics Committee, as it does not involve direct approach to human beings or their hospital records. Some authors of this study are also professionals from the unit, who have unrestricted access to the collected data, and use these indicators in service management. NAS data in the patient base were obtained within the project approved by the Ethics Committee of Federal University of Uberlândia under the number CAAE 38877220.4.0000.5152. Independently, these data are pubic and routinely collected for service management according to regulations for the operation of ICU based on legal requirements (Brazil 2010).

2.4 Statistical Analysis

The data were presented with descriptive statistics according to the type of variable. A significance of 5% was adopted in all analyses. The normality of the data was tested with the Kolmogorov Smirnov Lilliefors test with the package nortest, and the Gamma distribution was tested with the package goft, MASS and fitdistrplus. The frequency of combinations of patients two to two with the criteria of more than 100 points in the NAS was compared to the expected proportion of 1:1 with the Chi-squared adherence test for equal expected proportions (0.5, 0.5). The adjustment of the data of the number of beds evaluated per day to the exponential function was tested with the package (nlseasy). Differences in NAS were analyzed with Generalized Linear Models (GLM) considering as fixed effects in each analysis the year, month since opening, day of the week, and working day dichotomized (weekend and weekday). These effects in GLM were analyzed with Gamma distributions with log link function (Crawley, 2007). The percentage of NAS with more than 50 points evaluated in function of the month of opening were analyzed with GLM adopting binomial distribution with logit link function. When pairwise comparisons were necessary in GLM, we used Tukey test in package (multicomp). All these analyses were conducted using R environment (R Core Team, 2020).

3. Results

Eight thousand and six hundred NAS measurements were included, divided into 49 months and 1482 days, of which only 3.64% of the days no patients were evaluated and in 48.65% of the days, all seven patients from Cardiac ICU were evaluated. Considering at least one patient assessed per day, 96.36% of the days had at least one NAS measurement. The relative frequency or the probability of the number of evaluated patients per day was well adjusted the exponential function with the estimates of the parameters $B_0 = 0.46535651$ ($p = 0.1684$); $B_1 = 0.65934234$ ($p = 0.00046$); (Figure 1). It was also possible to appraise that the number of patients evaluated per day increased over time, although it was not directly tested. Based on records, it was not possible to evaluate the percentage of not evaluation of NAS of patients on a patient-day basis since the real daily occupancy rate was not assessed for the study period.

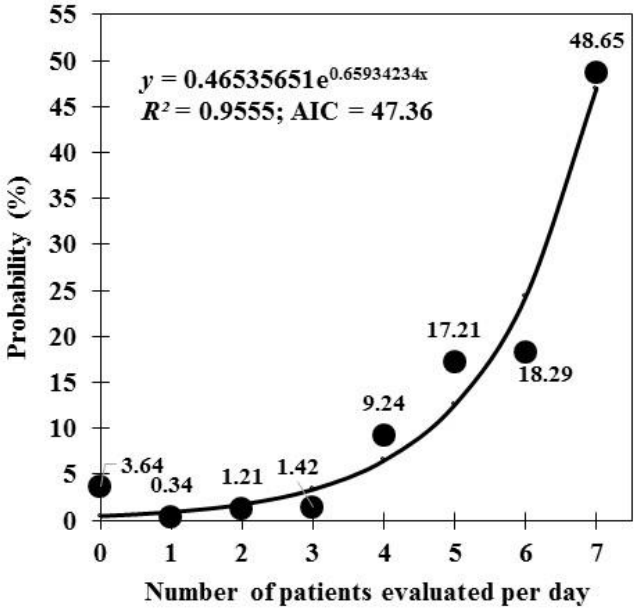

Figure 1 - Relative frequency from number of patients evaluated per day in a Brazilian Cardiac Intensive Care Unit for 1486 days of Nursing Activities Score (NAS) observations for four years (from November 2014 to October 2018).

NAS presented a mean value of 52.91 points (n = 8600, standard deviation = 9.29 points; standard error = 0.10 points, coefficient of variation = 17.56%) and a median of 53.40 points (minimum = 13.60 points; maximum = 140.80 points; interquartile range = 12.60 points). NAS did not adjust a Gaussian distribution (D = 0.081246, $p = 2.2 * 10^{-16}$), and it presented the following quartiles: Quartile 1 = 46.60 points; Quartile 2 = 53.40 points and Quartile 3 = 59.00 points, with an asymmetric distribution of data (Figure 2). The daily NAS evaluation data followed the Gamma distribution (V = -3, $p = 0.06$), with estimated shape parameter of 32.42502 and estimated scale parameter of 0.61290.

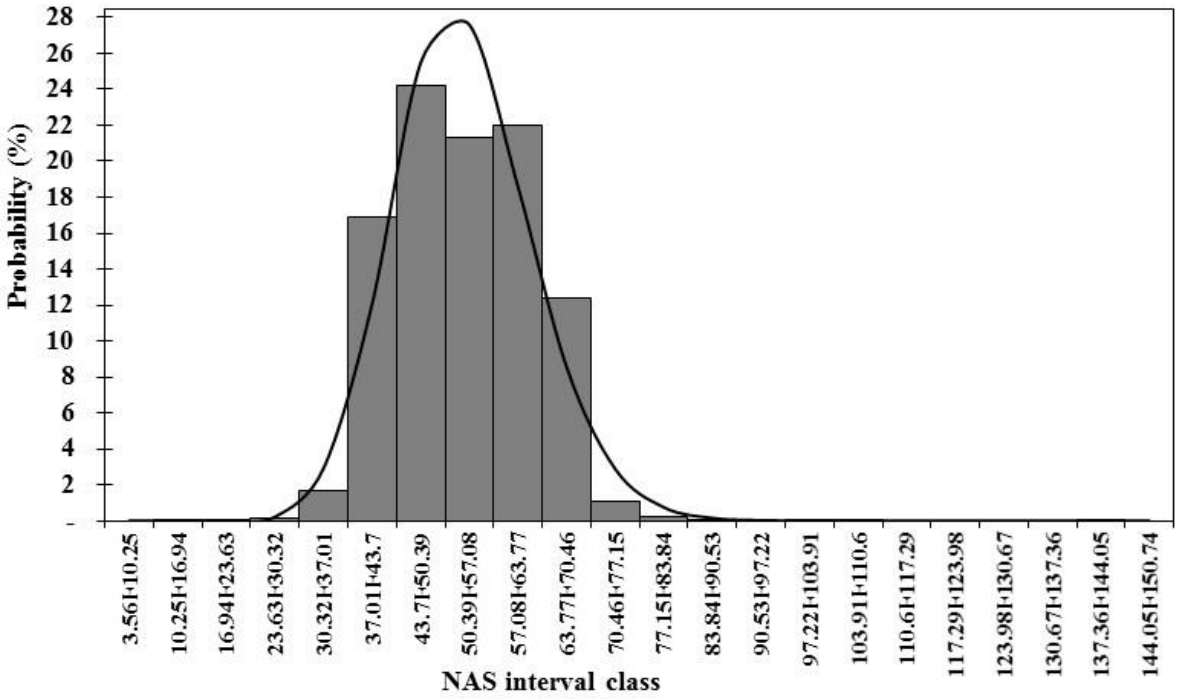

Figure 2 - Histogram and Gamma probability density function (mean = 52.91 points, variance = 23.29 points^2, shape parameter estimative = 32.42502, scale parameter estimative = 0.61290) for 8600 Nursing Activities Score (NAS) observations in a Brazilian Cardiac Intensive Care Unit for four years (from November 2014 to October 2018).

The 49 evaluated months showed mean values that differed from each other (X^2 = 1278.13, *d.f.* = 48, p <0.000001) (Figure 3). The mean NAS values per month ranged from 45.00 points (month 48) to 59.10 points (month 4). The median also differed between the evaluated months (X^2 = 820.32, *d.f.* = 48, p <0.000001) and the median values ranged from 43.60 points (month 42) to 60.75 points (month 40). Based on the adjusted Gamma distribution estimated for all NAS data assessed in this study, the probability of having a NAS assessment greater than 50 points is 60.24%. The percentage of patients above 50 points ranged from 20.59% (month 48) to 92.34% (month 4) (Figure 4) and proved to be a better indicator for assessing monthly workload variability in the unit. This can be observed by detecting the difference between the evaluated months (X^2 = 821.24, *d.f.* = 48, p <0.000001), and by the greater coefficient of variation 28.71% that may show better discrimination between the studied months, against 6.10% for the monthly mean NAS and 8.42% for the median of each month. When combining daily measurements of NAS two by two, workload exceeded 24 hours (> 100 points) in 66.01% of these combinations (14958 combinations in 22659) and was minor than 24 hours in 33.99% of the cases (7701 combinations in 22659). The observed values were different from 1: 1 ratio (X^2 = 2324, p <0.0001), showing a higher prevalence of random combination of patients with a workload greater than 24 hours a day.

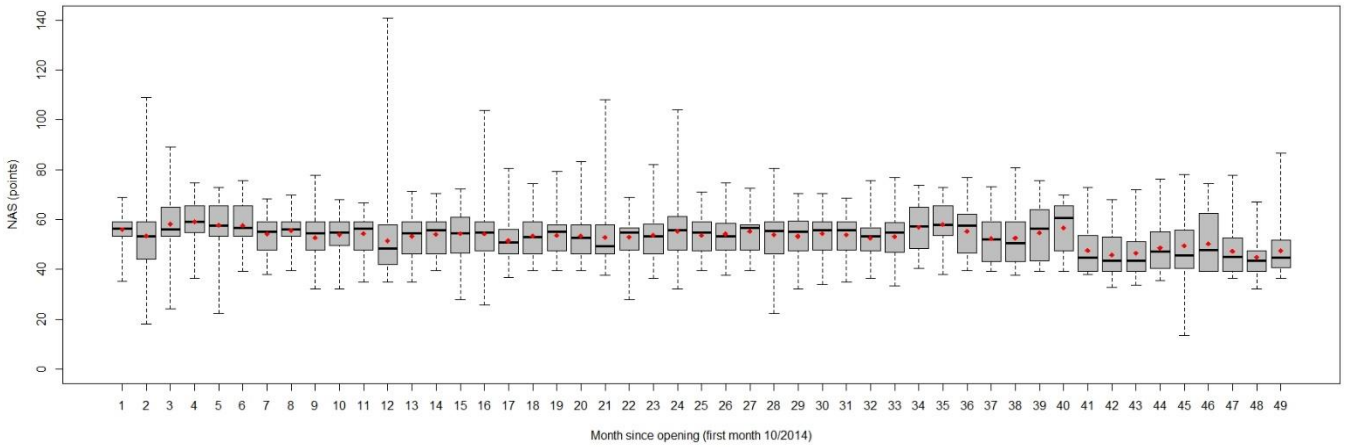

Figure 3 - Boxplots from Nursing Activities Score (NAS) measured during 49 months since opening from a Brazilian Cardiac Intensive Care Unit (from November 2014 to October 2018). Boxplot represented minimum and maximum (whiskers); first quartile, median and third quartile (box); and mean represented by a lozenge.

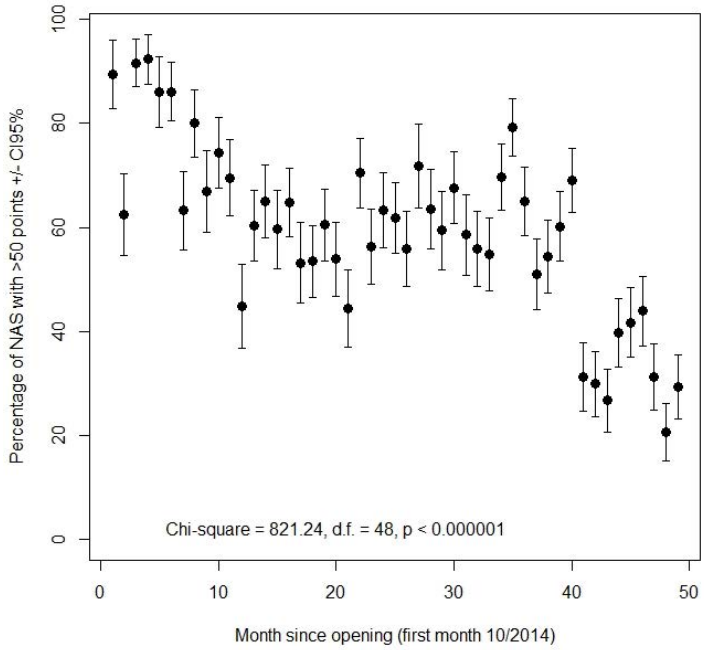

Figure 4 - Plots from Percentage of Nursing Activities Score (NAS) with >50 points ± 95% confidence interval (CI95%) measured during 49 months since opening from a Brazilian Cardiac Intensive Care Unit (from November 2014 to October 2018).

When data were stratified according to the year of sampling, we observed differences between them (X^2 = 1278.13, *d.f.* = 4, p = 0.00042), and when multiple comparisons were performed, year 2018 (mean = 48.51 points) presented the lowest means (Figure 5A) compared to the other years with means between 53 and 56 points. When comparing the mean values in function of the day of the week, a difference was observed between the days of the week (X^2 = 43.29, *d.f.* = 6, p <0.000001). Monday through Friday showed

mean values higher than weekends (Figure 5B). And when dichotomizing these days on weekdays and weekends, we also observed significant differences between the two strata, with mean values being higher during weekdays ($X^2 = 43.29$, $d.f. = 6$, $p < 0.000001$); weekends showed lower mean NAS values with mean of 52.15 points versus 53.21 points for the weekend (Figure 5C).

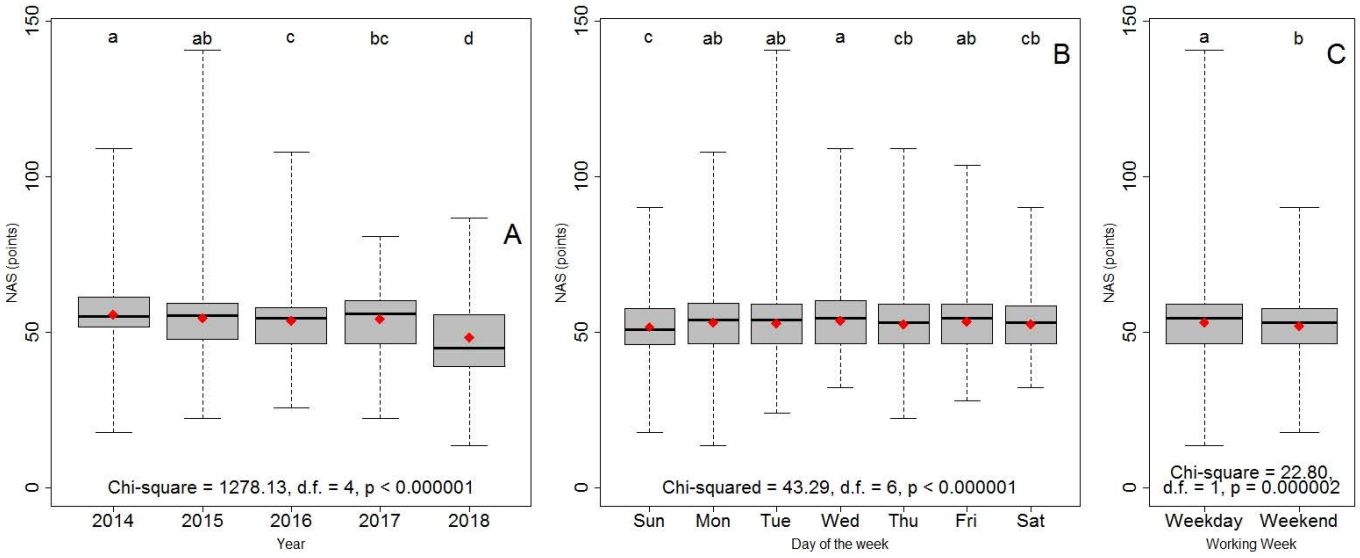

Figure 5 - Boxplots from Nursing Activities Score (NAS) measurements evaluated by year (A), day of the week (B) and working week (C) in a Brazilian Cardiac Intensive Care Unit. Means followed by different lowercase letters, in each boxplot, are different based in Tukey test ($p < 0.05$). Boxplot represented minimum and maximum (whiskers); first quartile, median and third quartile (box); and mean represented by a lozenge.

The most frequently observed NAS items were: 1a - hourly vital signs, regular registration and calculation of fluid balance (97.22%); 2 – laboratory investigations: biochemical and microbiological (100%); 3 - medication, except vasoactive drugs (99.95%); 4 - hygiene procedures (99.66%); 7a - support and care for family members and patients who require exclusive dedication for about an hour in any shift (99.93); 8 - performing routine administrative and managerial tasks (100%); and 17 - quantitative urinary output measurement (94.25%). Items that appeared with lower frequencies were: 1b - presence at bedside and continuous observation or active for 2 hours or more (2.71%); 1c - presence at bedside and active for 4 hours or more (0.07%); 4b - hygiene procedures that last more than 2 hours (0.34%); 6c - performing a procedure with 3 or more nurses at any frequency (0.14%); 13 - intravenous replacement of large fluid losses (1.51%); 14 - left atrium monitoring with or without cardiac output measurement (0.17%); 15 - cardiorespiratory resuscitation in the last 24 hours (1.22%); 18 - measurement of intracranial pressure (0.31%); 19 - treatment of complicated metabolic acidosis/alkalosis (1.22%); and 20 - intravenous hyperalimentation (0.67%). The items that did not receive score on any day were: 4c - hygiene procedures that last more than 4 hours; 7b - support and care for family members and patients who require exclusive dedication for 3 hours or more in any shift; 8b - performing administrative and managerial tasks requiring full dedication for about 2 hours in any shift; and 8c - performing administrative and managerial tasks requiring full dedication for about 4 hours or more in any shift (Table 1).

Table 1. Prevalence (%) for each item and subitem of the Nursing Activities Score from a Brazilian Cardiac Intensive Care Unit, based in patient-day or patient basis.

	Patient-day (4174)				Patient (n=673)			
Sub-items	n	%	LL	UL	n	%	LL	UL
1a	4058	97.22	96.72	97.72	669	99.41	98.82	99.99
1b	113	2.71	2.21	3.20	44	6.54	4.67	8.41
1c	3	0.07	0.00	0.15	1	0.15	0.00	0.44
2	4174	100.00	-	-	673	100.00	-	-
3	4172	99.95	99.89	100.00	673	100.00	-	-
4a	4160	99.66	99.49	99.84	672	99.85	99.56	100.00
4b	14	0.34	0.16	0.51	5	0.74	0.09	1.39
4c	0	0.00	-	-	0	0.00	-	-
5	589	14.11	13.06	15.17	220	32.69	29.15	36.23
6a	2162	51.80	50.28	53.31	598	88.86	86.48	91.23
6b	1993	47.75	46.23	49.26	349	51.86	48.08	55.63
6c	6	0.14	0.03	0.26	4	0.59	0.01	1.18
7a	4171	99.93	99.85	100.00	673	100.00	-	-
7b	0	0.00	-	-	0	0.00	-	-
8a	4174	100.00	-	-	673	100.00	-	-
8b	0	0.00	-	-	0	0.00	-	-
8c	0	0.00	-	-	0	0.00	-	-
9	2346	56.21	54.70	57.71	380	56.46	52.72	60.21
10	1174	28.13	26.76	29.49	199	29.57	26.12	33.02
11	3005	71.99	70.63	73.36	489	72.66	69.29	76.03
12	1603	38.40	36.93	39.88	384	57.06	53.32	60.80
13	63	1.51	1.14	1.88	40	5.94	4.16	7.73
14	7	0.17	0.04	0.29	5	0.74	0.09	1.39
15	51	1.22	0.89	1.56	34	5.05	3.40	6.71
16	872	20.89	19.66	22.12	78	11.59	9.17	14.01
17	3934	94.25	93.54	94.96	659	97.92	96.84	99.00
18	13	0.31	0.14	0.48	10	1.49	0.57	2.40
19	51	1.22	0.89	1.56	29	4.31	2.77	5.84
20	28	0.67	0.42	0.92	4	0.59	0.01	1.18
21	1173	28.10	26.74	29.47	101	15.01	12.31	17.71
22	2327	55.75	54.24	57.26	445	66.12	62.55	69.70
23	514	12.31	11.32	13.31	334	49.63	45.85	53.41

Legend: LL: lower limit of 95% confidence interval for percentage, UL: upper limit of 95% confidence interval for percentage, the LL or UL values not showed refers to items without variance.

4. Discussion

This study presents meaningful results, first revealing that the distribution of the NAS data is asymmetric with concentration to the left since the data's mean is lower than the median, which means that there is a greater concentration of values higher than the mean value of NAS. According to legal regulations criteria (Brazil, 2010; Brazil, 2017), the ICU need a nursing technician (or nurse) for every two patients per work shift and at least one assistant nurse for each eight beds or fraction in each shift. According to our analyzes, 50% of the evaluations were equal to or greater than 53.40 points, which already indicates nursing workload overload for this unit's nursing team based on staff dimensioning legal criteria. This scenario gets worse when our results indicate that 25% of the evaluations are above 59.00 points (quartile 3), highlighting greater nursing workload.

Batassini et al. (2019) showed that less than 10% of NAS measurements have a score below 50 points. The random allocation of two patients to a professional based on previous day can also offer risks to nursing care since in 66.01% of the simulated cases, the NAS of these two patients is greater than 100 points. Consequently, the nurses need to perform a careful assessment of the patient's degree of dependence before design the healthcare in work schedule. The NAS value on the current day or the previous day may be a good criterion for the distribution of work schedule, but this strategy needs to be tested for reliability of NAS's ability to be prospective based on the previous day's reading, although some studies have already shown its good ability to prospect workload. (Reich, Vieira, Lima, & Rabelo-Silva, 2015). All these findings may show a possible insufficient number of professionals in this unit, being that the contrasts of work schedule with the measured workload needed for an adequate work management.

The mean workload values of 52.91 points (12.7 hours of nursing care) observed in our study were lower than in various studies (Ortega, D'Innocenzo, Silva, & Bohomol, 2017; Toffoletto, Oliveira, Andolhe, Barbosa, & Padilha, 2018; Oliveira et al., 2015; Bruyneel et al., 2019; Lucchini et al., 2019). This mean was lower than other ICUs evaluated from the same institution, being this the general adult, neonatal II, neonatal III and pediatric ICUs (Mendes-Rodrigues et al., 2017-b).

The same is observed in comparisons with other general Brazilian ICUs, in a study performed in a university hospital from São Paulo, Brazil, the mean NAS was 66.5 points (Gonçalves, Garcia, Toffoleto, Telles, & Padilha, 2006), and in an adult ICU in the inner of the state of São Paulo, the mean NAS was 62.2 points (Panunto & Guirardello, 2012). Other studies reported a mean NAS value of 65.6 points, with a minimum of 32 points and a maximum of 114 points in a general ICU also in São Paulo. (Ortega, D'Innocenzo, Silva, & Bohomol, 2017) and a mean value of 73.7 points was found (Dias, 2006; Ducci, Zanei, & Whitaker, 2008), both in São Paulo hospitals.

When compared a more specialized scenarios or subpopulation we observed one higher mean NAS too in other ICUs. Mean NAS of 73.40 points was found in a trauma ICU in São Paulo, with a minimum of 35.00 points and a maximum of 123.00 points (Padilha et al., 2017). In another study, the mean NAS found was 74.27 points in patients' victims of adverse events hospitalized in nine ICUs in the city of Sao Paulo, and those who did not suffer adverse events had a mean NAS of 71.20 (Toffoletto, Oliveira, Andolhe, Barbosa, & Padilha, 2018).

In the international scenario we also found higher mean NAS, in a study performed in ICUs of 16

Belgian hospitals, mean NAS of 68.6 points was reported (Bruyneel et al., 2019). Another study executed in a Spanish ICU found mean NAS of 70.9 points (Zuazua-Rico, Mosteiro-Diaz, Maestro-Gonzalez, & Fernandez-Garrido, 2020). In a survey performed in a general ICU from an Italian university hospital mean NAS of 72.5 points was reported. And another study performed between 2015 and 2016 at five university hospitals from Rasht city in Iran, obtained mean NAS of 72.8 points (Moghadam et al., 2020).

Regarding direct comparisons with Cardiac ICUs, data are scarce, but our mean NAS is lower than other ICUs that treat some cardiologic aspects. Mean daily NAS of 74.6 points was reported in a study from a public teaching hospital in São Paulo, Brazil, in a specialized postoperative period of heart surgery ICU (Dias, 2006). And in the same city, mean NAS of 82.4 points was found in a study performed in a surgical ICU from a cardiac specialized institute (Oliveira et al., 2015). Another study performed in a cardiac ICU in an Italian university hospital found a mean NAS of 63.5 points. In all this cases, the mean NAS observed was higher than found by us.

All these findings show that both developed and developing countries can find NAS values higher than what was observed in our study, and even when comparing to general or cardiac ICUs, previously observed NAS values are higher than those reported by us, even when evaluating variation in months that had NAS values between 45.00 and 59.09 points. The NAS lower values could be justified by two hypotheses as differences between the units or the inaccurate use of the NAS instrument. In the beginning of NAS implementation in the unit, data were not routinely evaluated by the nurse team. It is fundamental to emphasize the need for future studies to evaluate nurse's capacity and efficiency to apply NAS daily, and to create strategies to avoid misuse and misinterpretation of NAS. Since this study is of administrative nature, it was not possible to associate NAS with the patients' profile, and the fact that most other similar studies were performed in Sao Paulo city in higher care complexity and larger ICUs than this unit in Uberlândia, could also explain why our mean NAS is lower. Another hypothesis is that NAS reflected the unit's evolution through the 49 months, a long period, with several phases of development and growth of the area covered by the Clinical Hospital of Uberlândia. Despite this, we observed a tendency to decrease the NAS values and the percentage of patients with NAS greater than 50 points over time, which does not corroborate the previous hypothesis. More studies are still needed to clarify the determinants of lower values of NAS in the studied ICU.

We observed the highest NAS values on Wednesdays, which for a long time was this units' cardiac surgeries day, which in the following years were scheduled for Mondays and Fridays, although this pattern was not constant, thus it does not allow direct associations. Also on Wednesday is the day in that the most severe patients were selected to surgery since in the middle of the week the medical team was able to better prepare patients for surgical procedures. They avoided operate more severely ill patients on Fridays due to the proximity to the weekend, and on Mondays, since they were unable to organize the logistics at the weekend to perform more complex surgeries. On other days of the week, the profile of patients seen in the unit was different, with patient healthcare related to before and after coronary angioplasty, pre- and post-operative of cardiac pacemaker implantation, care for postpartum women with heart disease, among others. With this resulted in patients demanding less attention from the nursing team, and consequently lower NAS means when compared to complex ICUs in metropolitan regions with often cardiac surgeries in all days. Although our study does not consider the patients' causes of ICU admission several studies associate diagnosis with workload (Gomes et al., 2019; Kraljic et al., 2017). Reich, Vieira, Lima, & Rabelo-Silva (2015) reported that hospitalized patients with heart failure and endovascular aneurysm have higher demands from the

nursing professionals. In clinical practice, certain more severe health conditions cause greater dependence on nursing care, thus generating greater workload (Reich, Vieira, Lima, & Rabelo-Silva, 2015). Sousa, Gonçalves, Toffoleto, Leão, & Padilha (2008) stated that the unique variable correlated with nursing workload with significant values was the cause of hospitalization, verifying that surgical patients need longer time of assistance when compared to inpatients with other clinical dysfunctions. Another study reported that surgical patients are 2.79 times more likely to require long times of assistance in the first 24 hours of hospitalization than patients undergoing clinical treatment (Inoue, Kuroda, & Matsuda, 2011). Apparently, our studied unit's patients' profile may be associated with low NAS values compared to other ICUs, but this hypothesis has yet to be tested.

Regarding nursing care needs, the items and sub-items most frequently observed were routine tasks, hourly vital signs, regular registration and calculation of fluid balance, biochemical and microbiological investigations, medication, quantitative urinary output measurement, hygiene procedures and support and care for family members and patients for about an hour. A study performed in a Cardiac Unit in the Southern region of Brazil brings results like ours (Reich, Vieira, Lima, & Rabelo-Silva, 2015), and other surveys in general and cardiac surgery ICUs confirm our results about the frequency of the items laboratory investigations, medications, quantitative urinary output measurement and support and care for family members (Conishi & Gaidzinski, 2007; Dias, 2006). The high frequency of these nursing activities illustrates the ICUs routine and considerably contributes to increase of workload, since they are customary and repetitive tasks, in addition to requiring knowledge and skills beyond technique (Reich, Vieira, Lima, & Rabelo-Silva, 2015).

4.1 Experience, strengths and limitations of the study

Since the opening of the Cardiac ICU at the Clinical Hospital of Uberlândia of the Federal University of Uberlândia, NAS collection has been done by the team of nurses from the unit, obeying legal requirements and supplying internal indicators. How NAS has been collected from the beginning of the unit's activities, it was possible to execute a broad study with many collections, which allowed us to obtain more accurate descriptions from NAS, as well as to draw a clear profile of workload and its many elements such as the time variation and variation depending on the day of the week. In addition, it allows construction of indicators that may have great applicability in the staff's work. Long-term studies of workload indicators are rare. We can mention Nogueira et al. (2017) that correlates the effect of hours of nursing care on the results of intensive care assistance for a period of 36 months, evaluating indicators such as phlebitis and pneumonia. However, long term studies like ours, in which NAS has been evaluated over time are scarce in the scientific literature (e.g. Castro et al. 2020).

Some limitations of our study must be considered. We can mention the fact that we do not include the assessment of the patients profiles, since with certain information such as history of illnesses and lifestyle habits, therapeutic interventions or surgeries performed, organ dysfunction, severity index (Simplified Acute Physiologic Score), length of stay , death, among others, we would have the opportunity to observe from other perspectives how the patient's profile collaborates with the fluctuation of the workload, as analyzed by Oliveira et al., (2015). Another limitation would be the validation of the data, since during NAS collection, divergent and sometimes inconsistent data were found, such as wrong sums, copy of previous day's collection and spelling errors, and even after deletion and correction of these values,

these errors could limit our study.

In the present study, in only 3.64% of the days there was no NAS collection, and in 51.35% of the days not all patients were evaluated, which may indicate a weakness in the workload assessment system in the unit in initial years, which reflects in the daily work planning and indicators. However, it was a limitation of the unit itself, since at the beginning of NAS implementation, not all professionals performed collections or were trained to perform the assessment, but this scenario started to change from the moment more training was implemented with the unit's nursing team, and over time the number of collections increased. Despite this, most studies with NAS have evaluated a limited number of NAS assessments in some scenarios (Mendes-Rodrigues et al., 2017-b; Camuci et al., 2014; Cyrino et al., 2017).

One of the main factors that can hinder adherence and proper application of NAS is the insufficient number of human resources (Ferreira, Machado, Vitor, Lira, & Martins, 2014). As a routine, NAS is applied in the studied unit at night, and analyzing work schedules available in the online and public scales system at the Clinical Hospital of Uberlândia, on most nights the Cardiac ICU had only one nurse responsible for assistant and administrative activities. Another hypothesis is the communication failure (predominantly in nursing notes and shift change) among professionals, which could lead to the loss of information and a mistaken analysis of the NAS. The obvious workload overload of this professionals could be combined with lack of preparation and insufficient knowledge to correctly apply the NAS instrument, resulting not only in failure to efficiently perform their tasks, but also in failure to use NAS, causing a cascade of irregularities.

4.2 Recommendations

The Nursing Activities Score is a valuable instrument used in ICU as an administrative tool to assess the required amount of care for a patient in the next work shift, and to estimate workload more effectively and even improve financial resources (Inoue & Matsuda, 2010). The application of this instrument aims to avoid inaccurate dimensioning, which if used correctly can improve nursing assistance quality, as well as assist in the allocation of human resources, monitoring of productivity and financial processes, thus stipulating minimum criteria for the organization of an adequate nursing staff and nursing technicians to meet demands of the service (Morais et al., 2011). The impact of use and application of workload instruments is still incipient (Griffiths et al., 2020).

Accordingly, the importance of assessing workload and dimensioning the nursing team is unquestionable, since adequate quantity and quality of human resources is fundamental for patients' integral care (Panunto & Guirardello, 2012) and safety. Correspondingly, our work should encourage other researchers to expand the study of NAS in Cardiac ICUs and in other specialized units to improve investigations of which factor could affect nursing workload and impact adequate work conditions for nursing professionals, as well as safety and quality of life for professionals and patients.

5. Conclusion

In conclusion, although the mean value found here for NAS in this Cardiac ICU is relatively lower than what has been found in other general or cardiac ICUs, it has temporal variability and as it is above 50

points it may indirectly represent workload overload, which can compromise patient care. The temporal variability and the high frequency of high NAS values (higher 50 points) demonstrates the need for continuous monitoring of nursing workload indicators and continuous assessment of the dimensioning of the nursing team for the unit, allowing better planning of integral care, reducing risks and promoting greater patient safety and quality of life for both professionals and patients.

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The Use of Open-Ended Student Worksheet to Improve Mathematics Communication Skills in Algebra

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Abstract

Communication is the foundation of every learning activity. Mathematical communication is a skill to represent ideas in mathematical language so that it is understood by others who are used in problem-solving activities. This study aims to improve mathematical communication skills by using open-ended student worksheets in algebra. The research sample involved 6 junior high schools in Purworejo Regency, Indonesia which is divided into 2 groups, the experimental group consists of 91 students and the control group consists of 96 students. The study design used a randomized static group comparison design. The research instrument used 5 item essay tests that contained non-routine problems. The data analysis technique used an independent sample T-test. The results showed that the communication skills of students who were subjected to learning using open-ended student worksheets were better than the communication skills of students who were subjected to learning using student worksheets that are commonly used by teachers. These results provide an important impact that teachers should always integrate the presentation of non-routine problems in the form of worksheets as an integral part of mathematics learning.

Keywords: Open-Ended Student Worksheet; Mathematic Communication Skills; Group Discussion

1. Introduction

The implementation of the 2013 curriculum by the Ministry of National Education of the Republic of Indonesia in response to the 2011 TIMSS and PISA 2012 study reports is accompanied by hopes of a significant improvement in the quality of education in Indonesia. However, it seems that this is not enough, the 2015 TIMSS results ranked Indonesia 44th out of 49 participating countries and the 2015 PISA results ranked 62nd out of 70 participating countries.

The PISA 2015 results show that the average mathematics score with a score of 386. Based on the average score, Indonesia falls into the Level 1 category which is characterized by students who can complete assignments with low problem complexity and complexity with limited collaboration. They can provide the information requested and take action to make plans when requested. Students can confirm actions or proposals made by others. They tend to focus on their roles in the group. With the support of team members, and when working on simple problems, these students can help find solutions to the problems given.

The PISA results imply that Indonesian students still find it difficult to solve problems with a high degree of complexity. This happens because students are accustomed to dealing with problems with a low level of difficulty and do not require advanced thinking processes. This is reinforced by the results of the analysis of students' mathematical skills in which nearly 30% of Indonesian students showed medium performance and less than 5% showed high performance. The rest shows low performance.

The results of the National Mathematics Examination for Junior High School students in 2019 showed that only 51.24% of students answered correctly on algebra material. Algebra is one of the mathematical material that is very important to study because it is closely related to material calculus, geometry, trigonometry, and others. Algebra material is also very close to its application to everyday life. A teacher needs to remind that, algebra is the key to any success in mathematics at all and abstract algebra is critical to work in advanced mathematics' and life and work opportunities (Katz 2007). Success in learning algebra can be a gateway to obtain other more advanced mathematical skills in today's technology society (Hill 2020 & National Mathematics Advisory Panel 2008). No doubt that algebra is very closely related to other applied mathematical materials such as geometry, arithmetic, trigonometry, calculus, linear programs, and others. The main thing attached to the concept of algebra is the variable in which the concept is a basic construction in teaching mathematics in general and teaching algebra in particular (Sahin & Soylu 2011).

Presentation of algebraic problems is often associated with the context of everyday life in the form of story problems, in which problem solvers are required to be able to change the facts of the problem into mathematical equations that contain constants, variables, coefficients, and operations that correspond to the requested problem. The ability of students to use mathematical language, in this case, is very necessary. Failure to identify and change the facts of a problem into mathematical equations in algebraic form is the beginning of the difficulty of learning algebra. The use of mathematical language is closely related to mathematical communication. Why? Because mathematics is the language of communication itself.

Many findings in class in the form of student work shows the failure of students to understand the

language of mathematics communication, especially algebra. For example $x + x = x^2$, or $x \,.\, x = 2x$. These errors are only a few of the many errors that may occur experienced by students. Thus, based on the description of the problem mentioned above, it is considered important to be seen in more depth about how the right way to improve and enhance mathematical communication skills in the concept of algebra. A good understanding of the concept of algebra will certainly help students in problem-solving activities in the form of story problems in the form of non-routine problems.

Communication is a vital skill for almost any profession, especially for teachers, in teacher-student relationships (Center for Excellence in Teaching 1999, 21). The idea of communication is more than a skill, it is a foundation for learning (Gorman 2020). Effective communication is essential to the success of both the student and the teacher. In the educational system, teachers and learners play a vital role in the communication process, in other words, it is possible to find a situation where two people say the same thing to a given audience, using the same language, even the same words, but the two will end up passing two different messages" (Abura 1998 in Osakwe 2009, 58). However, communication constraints and obstacles often occur in the learning process. The emergence of these communication barriers or obstacles will of course fail students in understanding the material being taught. One example of a case of communication barriers in the classroom is as follows: a typical situation of accessibility barrier for deaf or hard of hearing students is when the teacher is writing on the board while still talking. Students who need to read the lips miss all the information that the teacher is transmitting in this situation (Iglesias, Jimenez, Revuelta, & Moreno 2014). Not only that, but communication barriers will also make students unable to use their potential thinking abilities so they cannot convey ideas, opinions, and reasons to others. Many cases show that there are smart students, but he cannot help other students because he is not able to communicate his understanding well. If this happens, then the student will find it difficult to work in a collaborative team. This situation is exacerbated if students are not actively involved in learning activities.

Communicating effectively often means using a variety of modes (spoken, visual, etc.) to reach students who learn in different ways (Duta 2015, 626). In traditional classes that use spoken language as the main medium of the communication process, obstacles are more common. In these classes, the teacher is often the main actor, and students passively listen to the teacher's explanation, record what is on the blackboard, and get very few opportunities to express their ideas. This is further exacerbated by the teacher's reluctance to present open-ended questions to explore students' thinking abilities and to ask more questions that are merely repeating facts. As a result of this, of course, the function of communication as a tool to improve the ability to think becomes neglected and its potential cannot develop as it should.

Communication skills are important to be mastered by students because they are related to the development of one's creativity. Decision-making is what enables you to turn a jumble of ideas into a coherent communication (Intratot 2016). Decision making must be based on the ability to think, express ideas, write ideas, and design all of which lead to the acquisition of creativity. The learning process of a student that produces a pile of ideas that settles in his mind must be expressed in the form of oral and written ideas so that they can be understood by others. Ideas that continue to develop ultimately can create thinking creativity that ultimately can produce many ideas of problem-solving procedures. Solving these problems is the main focus of mathematics learning. A problem-solving approach is not only a way

of developing students' thinking, but it also provides a context for learning mathematical concepts. Problem-solving allows students to transfer what they have already learned to unfamiliar situations. A problem-solving approach provides a way for students to actively construct their ideas about mathematics and to take responsibility for their learning (Klerlein & Hervey 2019, 4).

Based on the foregoing, research related to mathematical communication skills is important to apply and must be integrated into the whole mathematics learning process. Two-way communication that is well established between the teacher and students will greatly help students complete their learning tasks so that they will play an important role in problem-solving activities. Problem-solving activities as the core of the mathematics curriculum are closely related to the ability to produce creative ideas to produce problem-solving with a variety of procedures and unexpected.

Communication as a fundamental part of learning in the classroom plays a very important role in the realization of quality education. Communication in learning is a means by which teachers and students can share the process of learning, understanding, and doing mathematics. Mathematical communication is an essential process for learning mathematics because through communication, students reflect upon, clarify, and expand their ideas and understanding of mathematical relationships and mathematical arguments (Ontario Ministry of Education 2005). Therefore effective communication is needed between the teacher and students. Effective mathematical communication as a respectful but engaged conversation in which students can clarify their thinking and learn from others through talk (Chapin, O'Connor & Anderson 2003, 5). Students need to be able to express their thoughts and problem-solving processes both in written and oral form. Furthermore, the communication between the teacher and students must be clear and complete enough to be understood by others (Cai, Jakabscin, and Lane 1996).

A fundamental difficulty in learning mathematics is understanding mathematics as a language of communication. Mathematics is itself a language (i.e., algebraic language and geometric language) for communication (Capraro, Capraro, & Rupley 2011). Mathematics is so often conveyed in symbols, oral, and written, communication about mathematical ideas is not always recognized as an important part of mathematics education. Students don't necessarily talk about mathematics naturally; teachers need to help them learn how to do so (Cobb, Wood, & Yackel 1994). Therefore, assistance from teachers and other students is needed to produce good communication. Communication is not only limited to the delivery of material but also related to the problem-solving process. Problem-solving activities that often involve problems in the form of story problems require a proper understanding of the written mathematical communication language. Solving problems with a story requires clarity and complication of the complete procedure so that it can be understood by others.

Presentation of problem-solving is part of written mathematical communication. Writing develops students' mathematical content learning (Meel 1999). Writing is seen as a way for individuals to reflect on or explain in detail certain mathematical ideas. It helps students to articulate strategies, therefore increasing their procedural knowledge and producing cognitive benefits in general (Silver, Kilpatrick, & Schlesinger 1990; Whitin 2004; Jurdak & Abu Zein 1998; and Kroll & Halaby 1997). Writing will not only clarify students' thinking but also provide other students with fresh insights gained from viewing the problem explanation from a new perspective (Lomibao, Luna, & Namoco 2016, 379). Based on this, the presentation of the results of student work as outlined in the worksheet should be something that teachers

also pay attention to. The teacher should help students to arrange solutions coherently and logically so that it can be understood by others. The most important thing about a student's work is that the procedure for addressing the problem must be shared with others. So that a settlement is not monopolized by students themselves but can also be emulated by other students. Sharing the results of the work to all students will give effect to the mastery of the procedure for handling problems by the whole class. This means that the quality of education will improve.

Many attempts were made to improve the quality of mathematical communication skills. Encouraging children to discuss and share ideas can enhance the assimilation of new and old experiences as well as facilitate the use of appropriate, informal mathematical communication (Cooke & Buchholz 2005, 369). Teachers must foster children's emerging abilities to participate in 'reflective' and 'collective' discourse and to become skilled at supporting such conversations. They argued that children actively construct their mathematical understandings as they participate in classroom social processes (Cobb, Boufi, McClain, & Whitenack 1997). Some of the opinions above complement other opinions stating that mathematical communication skills can be improved through small group discussions and whole-class discussions. Discussion activities can help students to convey ideas, opinions, rebuttal, and reasons to others in a comfortable atmosphere. Under these conditions, the potential for students' thinking will be more optimal because they do not feel under pressure, worry, and the same feeling in their academic abilities. Democracy in an atmosphere of learning like this provides equal opportunities for each student to develop according to his abilities and support from other students.

Another method used to improve mathematical communication skills is through the provision of open-ended tasks/problems. Open-ended and challenging tasks that build on students' prior knowledge are conducive to discussions because they encourage students to think collaboratively and build upon one another's ideas (Stein, Smith, Henningsen & Silver 2000). Giving challenging assignments to students has a far more satisfying impact on building relationships between mathematical concepts compared to giving routine problems, namely problems that have procedures that have been defined and memorized in daily life (Stein & Smith 1998). Emphasis on the use of open-ended tasks supports student involvement in classroom activities and encourages them to explore and investigate, increase their motivation for generalization, finding models and links, communicating, discussing and identifying possible problem-solving alternatives (Osana, Lacroix, Tucker & Desrosiers 2006).

This research will use a new approach to improve mathematical communication skills, modifying what has been done before. The class discussion that has been taking place in the form of the delivery of ideas will be changed to a more systematic discussion performance using 4 steps, namely: reason, express, write, and share. Each student is encouraged to think logically about the problem given to obtain an idea that might be used to solve the problem. Students then express ideas in their minds comfortably and confidently. Students write down all possible alternative solutions that have been submitted before and rethink the best alternative procedure. The final answer is then shared with other students. To increase the effectiveness of the discussion, a challenging task must be given, in this case, an open-ended student worksheet is used. Open-ended student worksheets are student worksheets that contain problems related to the context of everyday life that enable the discovery of various alternative answers. Open-ended student worksheets are given as a group assignment, consisting of 3-5 questions and arranged in such a

way that each question is not solved by the same procedure. Thus, students will have many alternative problem-solving procedures that can be applied to new problems given at other opportunities.

It is hoped that with this new approach, students will have learning experiences that can elevate their mathematical communication skills. Through this approach, it is very possible to achieve an increase in mathematical communication skills given the integration of two learning activities that have proven effective for learning to communicate mathematics.

The problem raised in this study is whether the use of open-ended student worksheets can improve students' mathematical communication skills? The giving of open-ended student worksheets in this study was carried out through small group discussion activities in the hope that an exchange of ideas could occur during the completion of the given task. Open-ended student worksheets are arranged to contain non-routine problems, namely problems that are based on real situations and allow the discovery of several settlement procedures. This open-ended student worksheet is expected to be able to encourage students to communicate all ideas and opinions to produce several alternative problem-solving procedures. Thus, communication can take a role in the ability to think that can be applied in a variety of situations.

2. Method

2.1 Research Design

This research is a quasi-experimental research with the randomized static group comparison design. The study was conducted from September to October 2019. The research population was all 7th-grade junior high school (SMP) students in Purworejo Regency, Indonesia. Two groups are compared, namely groups that are subjected to open-ended student worksheets (experimental groups) and groups that are subjected to worksheets that are commonly used by teachers (comparison groups).

Both groups have the same characteristics, which are both taught by teachers who are certified as professional educators, using the same teaching material in the form of electronic school books published by the Ministry of National Education, and learning is carried out at the same time between 07.30 - 12.00 am. The equality of ability or achievement characteristics before treatment was given to each group was further measured by an equilibrium test using an independent sample t-test.

2.2. Population, Sample, and Technique Sampling

The population of this research is all 7th-grade students of Junior High School (SMP) in Purworejo Regency with an average age of 13 years. The number of SMP in Purworejo Regency is 43 schools. The sampling technique used is stratified cluster random sampling. All schools are categorized into 3 levels of the high, medium, and low achievers based on previous National Examination results. In each category taken one school by drawing. Obtained SMP N 5, SMP N 12, and SMP N 13 as an experimental group and SMP N 3, SMP N 16, and SMP N 14 as a control group.

In the experimental group, 91 students were consisting of 42 male students and 49 female students. In the control group, 96 students were consisting of 47 male students and 49 female students.

Table 1: Description of Research Sample

	Experimental Group			*Control Group*		
	SMP 5	*SMP 12*	*SMP 13*	*SMP 3*	*SMP 16*	*SMP 14*
Male	14	16	12	15	18	14
Female	17	14	18	17	14	18
Total	31	30	30	32	32	32

2.3. Reasearch Instrument

The research instrument used 5 essay test items to measure mathematical communication skills. The test was composed of non-routine problems that were worked on for 75 minutes. Measurement of mathematical communication skills using a holistic scoring technique shown in Table 2. Tests are given to each group (experimental and comparison groups) after learning in 5 meetings.

Before being used in data retrieval, the test was tested for content validity through expert judgment involving 3 experts. The results of the assessment of the three experts revealed an average score of 3.6 (maximum score of 4.0). Furthermore, the test instrument was improved according to the advice given by the expert (validator). Instrument reliability was measured using the Alpha Cronbach test resulting in a reliability index of r_{11} = 0. 857.

Table 2: Rubric Holystik Scoring Technique

Criteria	*Score*
Provide complete responses with explanations and/or clear, unambiguous descriptions; can include appropriate and complete diagrams; communicate effectively; presents strong, logical and complete supporting arguments; can provide, distinguish, explain, and identify algebraic forms (variables, coefficients, and constants)	4
Provide explanations or descriptions that are quite complete and clear; can present almost complete and appropriate pictures/graphs/diagrams/tables; generally can communicate effectively explanation; presents supporting arguments that are logical but may contain some minor errors	3
Make significant progress toward solving the problem, but the explanation or description may be somewhat ambiguous or unclear; communication may be somewhat vague or difficult to interpret, and arguments may be incomplete or may be based on unclear logic	2
Has a pretty good explanation but fails to resolve to be a complete answer; eliminating some important parts of the problem so it is difficult to follow/understand; including in making drawings/ graphs/diagrams/tables that are not following the existing problem situation	1
Ineffective explanation; the explanation does not reflect the problem at hand; including in making drawings/graphs /diagrams that are completely incompatible with the existing problem situation	0

The results of student work are also carried out a content analysis to see the extent of the quality of student work in each group. Content analysis is focused on 5 things: 1) Awareness of answers, 2) Clarity of delivery, 3) accuracy of the use of mathematical language, 4) use of non-routine procedures, and 5)

Appropriate conclusions of answers. The results of the analysis are outlined in the form of an observation table that will be compared to descriptively between groups.

2.4. Data Analysis Technique

Students' mathematic communication skills test scores are then analyzed using an independent sample T-test to see whether groups that are subject to open-ended student worksheets are better than groups that are subject to learning sheets that have been used by teachers. The results of student work are also carried out by content analysts to see how far the students' communication skills are. This will be seen in how the resolution settlements and whether found a variety of problem-solving procedures.

3. Result.

The data to be analyzed in this study is in the form of a score of the mathematics communication test results. Furthermore, based on the results of the test will be obtained the final test score data and observation score data achievement mathematical communication indicators. Both of these data are used to compare which treatment is better for improving students' mathematical communication skills, whether the treatment is with an open-ended student worksheet or with a student worksheet that has been used by the teacher.

The provision of treatment at the experimental group has been done with open-ended student worksheets is done through learning through spontaneous exploration with small group discussions (4 students per group). Each group is given the assignment to complete an open-ended student worksheet, which is a student worksheet that contains questions with non-routine types. Students in each group discuss the solution to each problem given by using 4 steps, namely: reason, express, write, and divide. Students in each group are asked to think carefully about the subject matter that is given and think about the right solution to each problem that is given. Students are encouraged to express (convey) the idea of completion that has been thought to other friends in turn. The idea is written in the answer sheet by one group member and supervised by the other group members as a form of correction so that answers are obtained that are coherent and easy to understand. The results of the answers are shared (delivered) to each group member and students in the other groups in the form of class discussions so that an exchange of ideas occurs so that in 1 problem a variety of ideas will be obtained. During class discussions, it is possible for debates between students. The teacher acts as the mediator of the discussion to direct the conclusion obtained from the given problem.

The provision of treatment in the comparison class is done by giving students worksheets that have been used by the teacher. worksheets that have been used by teachers in the form of worksheets that are published commercially by a book publisher appointed by the school to provide worksheets at the school. The worksheet consists of a summary of teaching material and some practice exercises for students to do individually (independently). The questions presented on the worksheet are arranged with varying degrees of difficulty but are dominated by questions with routine problem types that merely reveal facts and do not require higher reasoning abilities. The results of student work on worksheets will be assessed by the teacher by being collected and corrected independently by the teacher.

Before giving treatment, a balance test is first performed to ensure that the abilities of each group are the same. so that the difference that occurs between the two groups at the end of learning is caused by differences in the treatment given. Average t-test results indicate that t_{obs} = 1,245 < t_{tab} = 1,973 it is considered that H_0 is accepted. thus it was concluded that both groups had the same ability before the treatment was given.

4.1. Mathematics Communication Skill Result

The results of the problem communication skills test by giving 5 essay test items containing non-routine problems can be seen in Table 3.

Table 3: Description of Math Communication Score

Groups	*Score test*				
	N	$\bar{X}$	*sd*	*Score max*	*Score min*
Experimental Group	91	70,242	15,975	95	25
Control Group	96	51,198	18,435	90	15

Based on the summary of the results of the test scores above, then the average t-test is performed, the following results are obtained in Table 4.

Table 4: Summary of T-test

Group	*n*	$\bar{X}$	*Sd*	*Sp*	t_{obs}	t_{tab}
Experimental Group	91	70,242	15,975	17,282	7,532	1,649
Control Group	96	51,198	18,435			

In the Table 4, it can be seen that the results of the average comparison between the two groups obtained t_{obs} = 7,532 > 1,649 = t_{tab} so that the decision obtained by the H_0 test is rejected. Thus it can be concluded that students' mathematical communication skills that are subjected to open-ended student worksheets are better than students' mathematical communication skills that are subjected to student worksheets that have been used by teachers.

4.2. Observation Data on Mathematical Communication Skill Achievement Indicators

Indicators of achievement of mathematical communication skills are set as follows: 1) Rareness of answers, 2) Clarity of delivery, 3) accuracy of the use of mathematical language, 4) use of non-routine procedures, 5) Appropriate conclusions of answers. Observation data on the achievements of each indicator can be seen in Table 5.

Table 5: Observation Math Communication Data

Indicator	*Average Score*	
	Experimental Group	*Control Group*
Rareness of answers	75.206	56.497
Clarity of delivery	72.316	50.356
accuracy of the use of mathematical language	67.236	48.483

use of non-routine procedures	67.954	47.541
Appropriate conclusions of answers	68.514	53.109

Based on the data on the achievement score of the mathematical communication skills indicator as shown in the table above shows that the score of the achievement indicators of the groups that are subjected to open-ended student worksheets is better than the groups that are subjected to student worksheets that are commonly used by teachers. This shows that learning through discussion of solving non-routine problems in the experimental group can empower students' thinking potential so that they can express ideas and opinions in solving non-routine problems.

4.3. Content Analysis of Student Work Result

This research is a quasi-experimental research with the randomized static group comparison design. The study was conducted from September to October 2019. The research population was all 7th-grade junior high school (SMP) students in Purworejo Regency, Indonesia. Two groups are compared, namely groups that are subjected to open-ended student worksheets (experimental groups) and groups that are subjected to worksheets that are commonly used by teachers (comparison groups).

Analysis of the results of student work shows a very striking difference between groups that are subject to open-ended student worksheets and groups that are subject to student worksheets that are commonly used by teachers. in groups that are subjected to open-ended student worksheets showing the results of work that is coherent, easy to understand, and shows the existence of several different problem-solving procedures. This happens because students are accustomed to expressing ideas of problem-solving and writing them down with other students' corrections during the discussion.

In groups that are subjected to student worksheets that are commonly used by teachers, students tend to answer carelessly. Some even only write down the final result without a description of the settlement procedure. Students in this group tend to use the same problem-solving procedures. Even in 1 class only found 1 type of problem-solving procedure. This happens because there is a habit for students to follow what was exemplified by the teacher before. On the one hand, the teacher also does not try to solve a problem with a variety of solving procedures. The percentage of many students who use problem-solving strategies can be seen in Table 6.

Table 6: Problem-Solving Strategies

Strategies	*Experimental Group*	*Control Group*
Algebraic Manipulation	35%	52%
Bar Model	26%	0%
Backward	19%	16%
Tables/ Graphic	12%	9%
Trial and error	8%	29%

Table 6 shows that the use of problem-solving strategies in the experimental class that is subjected to open-ended student worksheets is more even and diverse. Whereas in the control class almost half the

population uses only one strategy. This result clearly shows that the communication skills of students in the experimental group are better than the control group. The ideas conveyed during group discussions and whole-class discussions can be implemented by each student in solving new problems independently. A striking difference from the results of the work in the two groups is creativity. Creativity thinking to solve problems is very necessary for problem-solving activities. Thinking creativity can occur if a student can optimize all the potential that exists in him, including communication skills. Through proper communication empowerment, students can be encouraged to express and share ideas with others freely and without worrying so that they can make the right decision about a thing (in problem-solving activities). Confidence, learning motivation, and a feeling of equality of abilities developed during discussions in completing open-ended student worksheets have a positive influence on the creation of a comfortable and pleasant learning environment. This environment will make it easier for students to bring up all their potential thinking. The absence of efforts to encourage students to be creative would certainly be a negative impact that can not be avoided because communication skills are not considered during the learning process.

5. Discussion

The communication skills of students who were subjected to learning using open-ended student worksheets were better than the communication skills of students who were subjected to learning using student worksheets that are commonly used by teachers. This happens because with the use of open-ended student worksheets students are free to express their ideas and opinions verbally and in writing. The emergence of a variety of ideas is triggered by the characteristics of open-ended tasks that allow to be completed with erratic procedures. Thus, each student will be free to propose a completion strategy following what he understands. This is certainly different in the application of student worksheets that are commonly used by teachers. The worksheet only contains questions with procedures that are commonly exemplified by the teacher. Students are not challenged and it is not possible to solve them in different ways. Therefore, communication skills are not honed because of learning mechanically.

The results showed that the use of open-ended student worksheets in small group discussions by applying 4 steps: reasoning, expressing, writing, and for being able to improve mathematical communication skills. Giving open-ended problems in the form of non-routine problems allows the use of various problem-solving procedures. The discovery of various solving procedures can occur through group discussion activities. Students' habits in problem-solving activities through various non-procedural solution alternatives through discussion activities will help students achieve mathematical communication skills. Group discussion allows each student to try to get students to present their ideas and ask each other questions by taking on a more moderating role (Stein et al 2008). It is this habit of expressing ideas in a comfortable setting that encourages students to use these abilities on other occasions at different points, both individually and in groups. By regulating the social interactions that are generated in the classroom, communication enables the sharing of ideas and clarification of mathematical understanding (Viseu & Oliveira 2012, 288).

The use of open-ended problems in the form of student worksheets can encourage students to solve given

problems with a variety of problem-solving strategies. In this case, giving open-ended problems can encourage students to think creatively to produce a variety of problem-solving that is not procedural. Creativity in finding various strategies emerged as a result of the delivery of ideas and opinions from several students through discussion activities. The purpose of open-ended is to help develop creative activities and mathematical mindsets in problem-solving activities. Submitting ideas, both orally and in writing will help improve students' communication skills (Nohda 2000).

Open-ended student worksheets are one of the most effective strategies in the process of improving mathematical communication. Giving an open-ended student worksheet to a student discussion group will be more effective in improving mathematical communication. Open-ended and challenging tasks that build on students' prior knowledge are conducive to discussions because they encourage students to think collaboratively and build upon one another's ideas (Stein, Smith, Henningsen, & Silver 2000). Discussion is one of the active learning that should be able to provide equal opportunities for students to be actively involved in problem-solving activities. One aspect of taking students' ideas seriously is ensuring that their classmates attend to the ideas and work to understand them (Koellner, Jacobs, Pittman, & Borko 2005). Thus, a good discussion is a discussion that engages students actively and guarantees that no student will just listen. Thus, the process of communication through the delivery of ideas from each group member can occur.

The provision of open-ended problems has a great effect on the emergence of students' mathematical communication skills by producing various alternative solutions to problems. This can occur because the nature of open-ended problems that can present a variety of problem-solving strategies can be raised through discussion activities through the exchange of ideas. Each student in the group shares ideas and responds. The process of delivering ideas from students to students can be recorded by students in their memory so that it can be applied by students in solving other problems individually. Through discourse, students can elaborate, extend, and refine their thinking. As a result, students are learning mathematical content as well as habits of mind that will strengthen their mathematics problem-solving capabilities (Carley 2011). Thus, students' habits in conveying ideas and responding to ideas can make students able to improve their mathematical thinking skills so that they can solve problems in various ways.

Completing the open-ended student worksheet through discussion activities provides an opportunity for students who provide ideas to convey their ideas clearly to other students. This of course can help students in the communication process in the classroom. The open-ended assessment tasks ask students to show their solution processes and provide justifications for their answers (Cai, Jakabscin, & Lane 1996). In other words, the ability of students to explain problem-solving ideas can mean that students can communicate their ideas to others.

The results of this study also show that giving open-ended student worksheets through discussion activities can provide a great opportunity for students to convey all ideas both verbally and in writing. Mathematical communication skills by conveying ideas can increase understanding in depth of concepts so that they can be used for further problem-solving activities. The collaboration of ideas between students will create various alternative solutions to problems that can be applied to other problem contexts.

6. Conclusion

The results showed that the communication skills of students who were subjected to learning using open-ended student worksheets were better than the communication skills of students who were subjected to learning using student worksheets that are commonly used by teachers. These results provide an important impact that teachers should always integrate the presentation of non-routine problems in the form of worksheets as an integral part of mathematics learning.

Mathematical communication skills must be constantly improved so students can convey messages clearly to others, both verbally and in writing. Successful communication will overcome the obstacles of misunderstanding so that the problem-solving process can occur properly. Therefore, teachers should provide opportunities for students to express ideas, opinions, and reasons so that they are accustomed to thinking freely.

As a follow-up to this research, mathematical communication skills can be tested verbally or its application in other teaching materials. Research on mathematical communication more broadly will greatly assist the management of learning to provide appropriate skills for students in the future.

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THEORETICAL AND METHODOLOGICAL CONTRIBUTIONS OF THE KNOWLEDGE ECONOMY: The applicable "steps" in Brazilian recycling[1]

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Abstract

With the emergence of new paradigms in social and labor relations, before the property or assets of a company are valued. However, today, in addition, it is also considered that knowledge (in innovations, technology, experience, trade secrets, among others) adds value to an institution. Therefore, this research seeks to detail the phenomenon of the knowledge economy, in job prospects, education, environment and innovation, in addition to relating this concept to the collection of recyclable materials. The problem question developed to initiate the reflections was: How is the knowledge economy related and positively influences work activities such as the collection of recyclable materials? The general objective, on the other hand, is to understand how knowledge, experience and innovations are configured as fundamental for the improvement of processes and work in industries and organizations,

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here, specifically, the recycling industry. The specific objectives are focused on: detailing the emergence of the concept of the "Knowledge Economy"; understand how the knowledge economy relates to aspects of education, labor and the environment; understand the concept of social innovation and how it applies to third sector organizations; and learn about the "Steps of knowledge" applied to the activity of recycling materials. The methodology was an analysis of the recurring literature related to the topic of the knowledge economy and the recycling industry. It is concluded, therefore, that the workers of this branch make up the large group of Brazilians in conditions of informality and social exclusion and rights, and that is why the discussion addressed here is so important. for believing that the condition of these recyclers continues to be highly undervalued, despite being so important, both for society and for the environment.

Keywords: Knowledge Economy. Recycling. Informal Job.

1. Introduction

Globalization has motivated profound economic and social transformations that ended up being incorporated by society and studied in detail, over the years, so that they could be better understood. New paradigms have also emerged in labor relations, as well as a consumer market with new requirements. If before what was mainly valued was related to the material goods or assets of a company, as well as a professional with knowledge formalized by the diploma, today, in addition to these aspects, what adds more value to a company is the knowledge that provides possibilities for profit, financial advantages and procedural improvements, through innovations, technology, experience, trade secrets, among others.

In this sense, nowadays the importance of knowledge is already recognized for the execution of any labor activity, where the worker offers, in addition to the manual labor force, their intellectual strength and their knowledge based on experiences. This phenomenon, as will be detailed in this book, is called Knowledge Economy and also attributes an essential role to innovations and technologies, demonstrating how these aspects can positively influence management and work processes in companies or any other institution.

Then, this research seeks to detail the phenomenon of the knowledge economy, from the perspectives of work, education, environment and innovation, demonstrating how they are inseparable issues, functioning as a mechanism, which requires each component to act in a certain way to that the apparatus works effectively. In addition, it relates this concept to the activity of recycling materials, which, even though it is so current, is still in a precarious position and needs urgent intervention by this intellectual capital.

In this sense, to support the reflections proposed here, the question of the problem was developed: How does the knowledge economy relate and positively influence work activities such as the collection of recyclable materials? Therefore, the general objective of this work is to understand how knowledge, experience and innovations are configured as fundamental for the improvement of processes and work in industries and organizations, here, specifically, the recycling industry.

The specific objectives are focused on:

- Detail the emergence of the concept of the "Knowledge economy;
- Understand how the knowledge economy relates to aspects of education, work and the environment;
- Understand the concept of social innovation and how it applies to third sector organizations;
- Know the "Steps of knowledge" applied to the activity of recycling materials.

Regarding the methodology, it is stated that the main path followed was an analysis of the recurrent literature related to the theme of the knowledge economy, based on readings of articles and materials found in the main publications. Thus, from this bibliographic review, a compilation of information was made by important authors in the field, such as: Lodi's material (1968) [27], which analyzes the works of the precursor to the Knowledge Economy, Peter Drucker; Gouveia (2018) [19], who explains several concepts about work relating them to the knowledge economy, in the view of authors such as Lundvall; Karolczak and Souza, (2017) [22] who approach the Human Capital Theory; among other aspects, including the most important and the most related to the researched area, which is the work of Bunchaft and Oliveira Filho (2015) [33] concerning the steps of knowledge in the scope of the recycling industry.

The discussion of this article is divided into two parts. The first part seeks to introduce and contextualize the idea of the Knowledge Economy. It mentions the works of Peter Drucker, from the perspective of Lodi (1968) [27], demonstrating how his ideas were fundamental for the understanding, nowadays, of the importance of considering knowledge as a fundamental part within an organization or work activity.

Then, he relates the work to the concept of the Knowledge Economy, demonstrating the profound changes in labor relations in the globalized world, arising from new ways of seeing entrepreneurship, based on innovation and the valorization of knowledge / experience in the market.

It also seeks to reaffirm the importance of education for the practice of the knowledge economy and how it provides an essential differential in improving labor and business processes. In addition to education, it also seeks to detail the role of innovations in this context and how they can ally with the environment, aiming at the creation of new but responsible ways of using natural resources. So, it is about Social Innovation, which refers to those innovations that do not aim at profit, but rather improve the quality of life and the well-being of people and workers, a concept more present in third sector organizations.

Finally, the second part relates the concept of the Knowledge Economy to the recycling activity, detailing the knowledge steps in which each type of waste picker fits, and making a qualitative and quantitative analysis of its main aspects and assumptions. It is observed that these steps follow an order that begins with the one where more knowledge is invested, as is the case of recyclers who organize themselves in cooperatives that use more technologies and innovations to improve work processes. This order ends with

those workers who are not organized, and therefore work alone, having greater difficulties in leaving their condition of vulnerability.

It should also be noted that the importance of this work lies in the fact that it raises reflections on a group of workers in need of public policies, a view of the political authorities, so that they can provide them with access to social welfare, through a greater appreciation of their workforce and especially his work, which, despite being of such importance, is not seen that way by society.

2. The knowledge economy: Contextualization

As mentioned in the Introduction, this new dynamic, or new way of thinking about management, is called the "Knowledge Economy" and advocates, in general terms, that the most important asset of an institution is knowledge. In this context, it is essential to mention the works of the researcher and philosopher Peter F. Drucker, who was a precursor of the idea of the Knowledge Economy, in the light of the analyzes of João Bosco Lodi (1968) [27].

2.1 The work of Peter Drucker

Tracing a path in relation to Drucker's works, Lodi (1968) [27] begins by mentioning his first works, written before the end of the second war, which did not yet directly address the theme that would be part of his most important legacy: the Knowledge Economy, being influenced mainly by his career in the area of public and international law, with reflections on the legality of power and the status system in a society considered industrial (LODI, 1968) [27].

These works have as premise that society is increasingly represented by industrial corporations, represented not in the sense of quantity, but in relation to the characteristics and essence of an era (LODI, 1968) [27]. Lodi (1968) [27] further states that Drucker believed, however, that the rise of these corporations "will not be complete until they represent values widely recognized by today's man. One of these values is the belief in freedom and equal conditions" (LODI, 1968, p. 84) [27].

In this sense, the author also states that Drucker considered profit as a trivializer of human behavior, in a free and capitalist society, while socialism would be that same society, however without classes, under conditions of equality. Nonetheless, industrial society meant that neither of these two ideals (freedom and equality) prevailed, and then another economic model was generated (LODI, 1968) [27].

Thus, this new society is based on the following characteristics: every subject has they function in society, linked to their occupation, in addition to a recognized social status and legitimate social power (LODI, 1968) [27]. So, it is possible to affirm that his first works discussed the aforementioned issues, as well as the new social and power relations involved in the "industrial company", as Drucker calls it.

Some time later, Drucker published The Concept of the Corporation (1946), which dealt specifically with

large corporations, using General Motors as an example and arguing how decentralization was important to strengthen the management process of a large company. Decentralization would then be a large corporation that carries out the entire production process, without delegating to other small companies, whose administration is divided into sectors, according to each activity, with each sector managed by a professional (LODI, 1968) [27].

Thus, in summary, according to Lodi (1968, p. 88) [27], the book was divided into three parts, namely:

> In the first part, entitled "The Corporation as a Human Effort", the author analyzes the organization of General Motors, its decentralization and its marketing problems. In the second part, entitled "The Corporation as a Social Institution", the author analyzes the various social levels of the organization, focusing more on the level of foreman and supervision. The corporation is identified with the American class system and especially with the social values of the middle class. In the third part, whose title is "Economic Policies", the author analyzes several related problems: the question of size, monopoly, production objectives and the problems of full employment policy.

It is observed how Drucker sought to reflect and discuss about the management processes of the time, considered innovative, and also about the intellectual resources necessary for the dynamics to be successful. By intellectual resources, it is understood that it would be the knowledge, talent and experience of the professionals, that is, a set of skills necessary to achieve the proposed result (LODI, 1968) [27]. From there, then, the idea of the knowledge economy begins to take shape, when intellectual knowledge becomes more valued, due to its ability to improve processes and innovate, consequently generating economic advantages.

Since then, Drucker has developed this concept in publishing other works such as The New Society (1950) [15], which discusses basically two themes:

> The first is that the industrial society of the twentieth century is an entirely new and peculiar society of worldwide more than Western or capitalist. The second is that this new society has a specific institution: the industrial company, with its administration, its manufacturing community and its twin brother, the labor union (Drucker, 1950) [15].

Another interesting point to be observed in this work is when the author talks about a certain “administrative attitude”, and how it is able to increase the efficiency and productivity of the work. Its basic premise is to encourage employees to feel that they are part of the company as a whole, integrating them to their main objective, so that they can fight for the proposals and work more motivated.

It should be noted, still according to Lodi (1968) [27], that the book had been released before the Korean War, so Drucker had to reissue it a few years later, due to the changes that took place in society after the war, which gradually became increasingly “restless and tormented”.

In 1954, Drucker published one of his most important contributions to management theory, Business

Administration Practice. The book deals with, among other secondary aspects, the technique of management by objectives, which consists of "a method of planning and administrative control, based on the premise that in order to achieve results the company needs to define what business it is and where it intends to reach" LODI, 1968, p. 104) [27].

In addition, the work is considered an important guide for the professional behavior of the manager of a company, with precise instructions and reflections on how a manager should act and act, in general, and in certain situations, in order to achieve the goals of an institution, without the need to act only in emergencies or through campaigns (LODI, 1968) [27]. The author still works with the hypothesis that management by objects would be a philosophy that "is based on the principle of motivation of human behavior, applies to every manager and ensures genuine freedom for the executive" (LODI, 1968, p. 108) [27].

Shortly thereafter, with the publication of Frontiers of Tomorrow, in 1959, Drucker shifted the focus of his discourse a little, continuing on the path to potentiate the idea of the Knowledge Economy, by addressing the changes that occurred in the postmodern world, mainly those related to technological innovations and the revolution in the educational area. In other words, the main concern is no longer with managerial efficiency, but with transforming aspects outside this process.

In 1964, the author returned to the theme of business administration, with the publication of Administration for results, however, bringing new ideas, complementary to the others, more enlightening and compatible with the moment of transformations that the world was going through, at the time. He changes the focus on efficiency in processes, for the analysis of results: "[...] the company needs to introduce an economic system of marketing planning and evaluation that allows it to replace the focus of work with that of results" (LODI, 1968, p. 120) [27].

In addition, Drucker makes a market analysis, proposing: that the products are observed, according to several categories, so that the company can decide which products are worth, or not, to keep in a company's catalog; that customers and non-customers are analyzed, according to different parameters, in order to discover how to attract more customers or compete in other markets (LODI, 1968) [27].

The author also proclaims what, for this work, can be considered fundamental for the practice of a knowledge economy, where know-how and expertise, then, become one of the most valuable capital of a company. As follows:

> As a consequence of the analysis of these "market realities", the company must evaluate the capital formed by its knowledge. See the things he did well and the things he did poorly. Asking: what is our business? What are we able to do well? "Knowledge is a perishable good. It needs to be reaffirmed, relearned, reprized all the time. A person needs to work constantly to regain his own specific leadership. All knowledge becomes wrong knowledge. It becomes absolute. The

> question should be: What else do we need? Or, do we need something different? " (DRUCKER, 1964) [16].

Finally, it is important to mention the work in which the author introduces the idea of the Knowledge Economy, The Effective Executive, from 1967, which focused mainly on the efficiency of the work of the manager / administrator / executive. In the Introduction, the author seeks to demonstrate that having knowledge and intelligence does not guarantee the efficiency of the manager's work: “it is common to find executives of good intelligence, solid knowledge of the function, bright and imaginative people. However, few of these people are efficient” (LODI, 1968, p. 127) [27].

In the book, Drucker mentions and details the five basic principles of efficiency, namely:

- Know where to spend your time;
- Focus efforts on results rather than work;
- To be based on the strongest personal qualities;
- Focus on key tasks;
- Make effective decisions (DRUCKER, 1967) [15].

Among these principles, the most important is the one that speaks of the focus on results, to the detriment of the work itself:

> The focus on contribution turns the executive's attention away from their specialty, from his limited skills, from their department, towards the whole. They turn their attention to the outside, the only place where there are results (DRUCKER, 1967) [15].

In this sense, Drucker's basic premise is that efficiency is a habit, something you learn, not atavistic. For him, administrators focus a lot on graphs, tables, numbers and quantitative analysis, when in reality, they should look outside, acquire a more subjective and qualitative view of what happens with their product when they leave the company, also a view of the transformations of the market, and, as mentioned earlier, acquiring this vision takes time, experience, discussions, learning, and that is exactly how a manager becomes efficient (LODI, 1968) [27].

Lodi exemplifies this by citing thalidomide, showing that many lives would have been harmed if they had waited for the statistical results instead of listening to a physician who did a more subjective analysis of the problems that this medication was causing (LODI, 1968) [27].

Therefore, it is worth mentioning how Drucker was essential for the idea of the knowledge economy to be built, especially when he mentions how valuable knowledge and experience is for the management of a company. In this sense, now thinking along the lines of contemporary society, it is worth stating that the knowledge economy also includes, in addition to knowledge and experience, scientific research, technological innovation, knowledge that turns to sustainability, etc., which is possible to observe in the work of Roberto Mangabeira Unger, who proposes a new knowledge economy.

This author can be considered as one of the most important scholars on the knowledge economy, in the current context, and highlights the great potential that exists in this model of transforming human life and promoting strong changes in economic and social organizational dynamics. However, his vision also addresses another side of this theme, which is the fact that the knowledge economy as it is practiced today, "ends up accelerating the deterioration of working conditions worldwide, restricting the benefits of productive innovation and concentrates capital and power [...] "(MANZATTO, 2020, p. 1) [31], therefore having an exclusionary character.

In addition, the author reaffirms the need for changes to be made to current educational models, so that the practice of the knowledge economy can be truly effective and inclusive. For him, it is necessary to transform that view that education serves as a simple transmitter of knowledge, for a view of education as that tool that teaches how to think, know how to do, find answers to questions and solutions to problems (MANZATTO, 2020) [31].

> [...] argues that educational methods incorporate teaching practices that prioritize the development of the analytical, synthetic and creative capacities of students and teachers. In this proposal, teaching ceases to privilege the direct transmission of content, which is now transmitted only as a context that facilitates the acquisition of specific skills (UNGER, 2018, p. 92-95) [42].

This type of thinking is connected to Drucker's thinking, in believing that that content knowledge, and formalized, does not necessarily guarantee the efficiency of the work. What this effect can bring is much more related to the skills of analyzing a situation and adapting to it, making decisions based on more subjective experiences and analyzes, than on that theoretical and often cast knowledge, which is recommended in most of the school institutions. Another important point mentioned by the author as a factor in recovering the healthiness of the knowledge economy is the recovery of values such as cooperation and solidarity (MANZATTO, 2020) [31].

Therefore, it should be noted, from all that has been said so far, that the Knowledge Economy has emerged as a possibility of transforming values, being part, today, of the many reflections and research related to business administration and the industrial environment, where new ways of producing with less expense, more efficiency, less impact on the environment are sought every day, thus using technological and innovative resources derived from knowledge that come from scientific research and empirical experiences. Thus, as a way of illustrating and exemplifying this perception, the next section will deal with the Knowledge Economy, from the perspective of the recycling industry.

2.2 Work and the Knowledge Economy

As previously mentioned, modernity has brought profound changes in labor relations, with new ways of looking at entrepreneurship based on innovation and the valorization of knowledge / experience in the market. Thus, the expression "knowledge economy" emerged, which, roughly speaking, is configured as a process of recognizing the importance of knowledge for the performance of any work function, adding

not only the manual labor force, but also the intellectual and the expertise. Within this context, other concepts such as knowledge worker, living work, Theory of Human Capital, material and immaterial work, among others, will also be addressed.

According to Carmo (2008) [8], the knowledge economy could already be observed from the end of the twentieth century, bringing several changes in the industrial, commercial, economic and social sectors. For Izerrougene (2010)) [21], it was encouraged due to labor conflicts that intensified since the 1970s, showing a certain crisis in profit rates and in the Fordist model of production and accumulation.

Carmo (2008)) [8], also observes that, in this context, innovations and technology play an essential role, and their practice should be constantly encouraged through learning and training. In addition, "[...] Productive activity, in this new form of capitalist accumulation, is subject to knowledge, whereby the worker must be creative, critical and thinking, prepared to act and adapt quickly to changes [...]" (CARMO, 2008, p. 188)) [8].

The author also mentions the concept of "knowledge worker", who has the skills "[...] to establish relationships and to assume leadership, [...] they are people capable of allocating knowledge to increase productivity and generate innovation" (DRUCKER, 1997; ASSMANN, 2005) [18] [3], thus being a strategic tool that combines learning, reflections, experiences, experiments and the creation of new concepts (CARMO, 2008) [8].

Izerrougene (2010) [21] points out that in order to better understand the nature of the knowledge economy, it is necessary, first, to understand how knowledge produces knowledge, also creating economic value, a process that gives greater value to intellectual work. Marx himself, as pointed out by Izerrougene (2010) [21], has already spoken about the importance of valuing the intellectual capacities of creation and the social capital of individuals.

Next, it should be noted that "[...] innovation is not just a matter of investing in capital goods and creating new products. This specificity is in the priority given to the place of human intelligence in the process of production and reorganization of social relations in communication networks (IZERROUGENE, 2010, p. 689) [21]. In other words, innovation is valued not only for its ability to be transformed into something tangible, but also for the fact that it is the most expressive representation of human intelligence and knowledge.

According to Carmo, this new process:

> [...] of capitalist accumulation emphasizes that the recognition of this productive increase is based on the capacity to deal effectively with information and transform it into knowledge. This consists of valuing tangible and intangible resources in the economy, in their way of managing knowledge and learning for work. The intensification of the relevance of intangible resources in the economy, such as information and communication technologies, point to the development of new ways of

> generating and distributing information that make it possible to increase the exchange of information and enable the interaction between different units within a company (CARMO, 2008, p. 189) [8].

Therefore, it is worth stating that all these changes in the forms of production, in the relations between capital / labor, etc., ended up generating a disarticulation in the social and productive bases of the capitalist system, in the path of new parameters of accumulation, where what is explored is the ability to produce. It then becomes more relevant "the acquisition of knowledge and its objectification in the material element for its production and construction as a true productive force, a reason for exploitation and a source of valorization, linked in a diffuse network of devices that directly regulate labor practices" (IZERROUGENE, 2010, p. 689) [21].

In view of this, the concept of "cognitive capitalism" emerged, which, according to Costa (2008) [11], is based on the activity that converts information and knowledge into wealth and / or economic values, depending, also, on a relationship of intellectual cooperation between the subjects. This model of capitalism thus characterizes a new way of developing capital that uses knowledge from collective and cooperative labor forces. "[...] this form of capitalism promotes active, collective, social (social capital) and abstract work, so that the production of intangible goods occurs, where the basis is information for the production of knowledge (GOUVEIA, 2018) [19].

That is why it is so important to consider the learning element in this context of the knowledge economy, since it causes a great demand for training and specialization, in order to meet the growing needs of the market in terms of technologies and innovations, whether in products or in the processes. Carmo (2008) [8] highlights how the knowledge economy needs investment in research, since learning is important for the generation and diffusion of knowledge, and consequently, for the growth of the current economy.

The author also states that the learning process consists mainly of developing a set of cognitive skills, such as: the know-how, represented by practical, technical and scientific studies of the work, from courses, training and even from professional experience.; knowing how to be, which is related to the social behavior of work, such as communicative and leadership skills, among others; and knowing how to act, which relates to the ability to make decisions or intervene appropriately.

In this same sense, Gouveia (2018) [19] points out that:

> [...] knowledge is formed through formal education, but not only, the knowledge acquired through a routine that is unique to each individual, the tacit way of doing things, is also a source of knowledge. More than that, there is also the role played by cognition in the transformation of information into knowledge. Therefore, knowledge is the result of an individual's interaction with society, the result of their way of doing and thinking things and also the result of educational and informational opportunities, which he has / had access to" (GOUVEIA, 2018, p. 63.) [19].

The author also presents 4 types of knowledge, based on the work of Lundvall and Nielson (2006) [29], namely: the “know-what”, which is the knowledge of facts and information; know-why, which is the knowledge of the principles and laws that govern any sphere of life; the "know-how", which is related to the skills that an individual has to perform any activity; and, finally, the “know-who”, which is the knowledge about who can solve or help solve a certain type of situation (GOUVEIA, 2018) [19].

Regarding the ways of transmitting knowledge, Gouveia (2018) [19] mentions three: symbolic communication, imitation and incorporated knowledge. The first refers to the transmission of the set of symbols, that is, it represents that knowledge acquired in schools, training courses, etc..; the second demands an environment totally shared by others, where some learn from each other through observation and imitation; finally, the incorporated knowledge is that which is materialized in goods or services that are commercialized, that is, every final product contains some level of incorporated knowledge (GOUVEIA, 2018) [19].

Within this context, the Human Capital Theory (TCH) also emerged, which seeks to quantify and parameterize the levels of knowledge and skills of individuals in certain professional functions, that is, “The greater the investment in training, the greater the specialization and, consequently, the greater the stock of human capital ”(KAROLCZAK and SOUZA, 2017, p. 67) [22]. The authors further argue, based on Schultz (1961), that investing in the acquisition of people's skills and knowledge and in education is a factor that confers a certain degree of superiority to some capitalist countries, with the ability to produce for humans an aspect that goes beyond all other possibilities of wealth (KAROLCZAK and SOUZA, 2017) [22].

According to Schultz (1961) [37] and Becker (1962) [4], individual capital occurs through the acquisition of knowledge and skills, thus forming the stock of human capital that, in itself, can be considered a return on investment made in this capital by generating more productivity and, consequently, more profit or resource savings. Thus, the influence of theory is perceived in the behavior of the labor market with an impact on the availability / shortage of qualified professionals.

The theory also explains that the subjects have independence in relation to their qualifications and can seek them internally or externally, however, in the second case, the professional may end up not returning to the company, that is, the do not return to the company, in the form of work and knowledge, the investment that was made in it (KAROLCZAK and SOUZA, 2017) [22].
For this reason, measuring the value of human capital is something so complex and Schultz (1961) [37], motivated by this difficulty, proposed some examples of activities that could better qualify human capital, such as: access to health services, which guarantees more vitality; formal education at all levels; training in and out of the work environment; immigration to adjust to the job opportunity (KAROLCZAK and SOUZA, 2017) [22]. Some time later, Schultz (1973) [38] created new parameters for these measures, arguing that “although human capital, as such, cannot be bought or sold, it is comparatively easy to

estimate the value of the production services of this capital, as they are expressed in prices in terms of wages in the labor market" (SCHULTZ, 1973) [38].

In addition to the Human Capital Theory, there is also a lot of talk about "Live work" and "Creative work", or "Manual work" and "Intellectual", or "Material work" and "Immaterial", as explained below. Gouveia (2018) [19], shows how the practice of an economy based on knowledge has significant differential aspects in relation to more traditionalist capitalism, which occurred through an expenditure of energy, material work, for the generation of surplus value, the so-called "Living work". However, in this new paradigm the exploitation of capital is modified, giving way, still, to creative work, where "the use of the technical tool depends on the performance of concrete, heterogeneous and shared living work, where creativity and the capacity for invention present themselves as an immediately intersubjective action "(IZERROUGENE, 2010, p. 694) [21].

Also, for Izerrougene (2010, p. 695) [21]:

> In the cognitive activity of creating, transforming information and incorporating it into the knowledge of living work, the extraction of surplus value presupposes the reproduction and preservation of complex work as living work and not as a capital good. Capitalist appropriation is determined by the conditions of subjugating living work in the totality of the realization process, as living work that reproduces itself throughout the process as living work independent of dead work.

The author also states that this antagonistic and even conflicting relationship ends up causing an imbalance in the connection between capital and labor, since the success of an investment is linked to the ability to work creatively, in an increasingly autonomous way, still demanding a transformation in the professional molds, since creativity is unpredictable and can generate unexpected results in comparison to live, or mechanical work (IZERROUGENE, 2010) [21]. Precisely for this reason, this capacity can be considered innovative, in addition to adding high value to organizations that invest in education, training, research, that is, they invest in the acquisition of knowledge of their workforce.

Sicsú and Bolaño (2004) [39], on the other hand, use the terms Manual and intellectual work to refer to live work and creative work, as previously mentioned. For the author, there is a very fine border between these two types of work, however, both constitute the collective intelligence that acts in favor of capital.

The author also explains that there was a rupture between these two modules and, in addition, functions such as those of communication or coordination started to have a much greater relevance, that is, the new forms of consumption also demand that there is an intensification in the level of knowledge of the interested public, which ends up reinforcing the mediation character of intellectual work (SICSÚ; BOLAÑO, 2004) [39].

In this sense, Gouveia talks about material and immaterial work, as can be seen below:

> Social capital, which comes from the way in which economic actors interact and organize themselves, by acting in the exchange of knowledge and information through social networks, to generate growth and development, is a source of value based on work immaterial that produces "material" wealth.", And immaterial, knowledge that generates more knowledge. (GOUVEIA, 2018) [19].

Therefore, the difference that exists between these two extremes is highlighted, which consists of the limit imposed by material work, which does not occur in immaterial work, since it is not palpable and can be infinite (GOUVEIA, 2018) [19]. However, the author considers this assertion that relates material work with merchandise to be radical, detaching it from the knowledge that was used for its creation, stating that knowledge can also be represented by material wealth, such as innovations (GOUVEIA, 2018) [19], like the New Information and Communication Technology (NTIC's), "which have the particularity of being both an object of consumption and a work tool" (IZERROUGENE, 2010, p. 689) [21].

For Sicsú and Bolaño (2004) [39], the emergence of information and communication technologies was a remarkable fact for the tendency to erase the boundaries that exist between manual and intellectual work, "it manifests so much in what I have been calling the subsumption of intellectual work, as well as in the general intellectualization of work processes in industry and in the service sector "(BOLAÑO, 1995) [5].

Therefore, in this context of the knowledge economy, it is essential to deepen the approach on the role of technologies and innovation in contemporary labor relations, as is the case with the innovations that are put into practice in the recycling industry, which serve to improve and to optimize the work processes and the life of the professional who picks up recyclable materials, in addition to generating more financial advantages and reducing unnecessary expenses, as will be discussed later on.

2.3 The transformations of education and its importance in the knowledge economy

Understanding and applying the concepts of the knowledge economy also caused major changes in the area of education and learning, especially with regard to the ability to generate innovation. For Lundvall (2001) [28], finally "it was admitted that knowledge is a good characterized by economic values and uses in its production and employment and that its use produces positive results" (p. 201) [28].

For Guile (2008) [20], higher education could be seen as the axis of the knowledge economy, despite encompassing different conceptions, such as traditionalist, utilitarian and postmodern. The first asserts that there is a certain level of fundamental scientific and literary knowledge to be transmitted by universities, and should therefore be part of the curriculum. "It also consolidates the foundational and canonical status of the disciplines by accepting that they and the scientific method constitute the only basis for conducting research (GUILE, 2008, p. 630) [20].

The most updated view, from the point of view of Dowbor (2010, p. 3) [14], emphasizes that "In our university area, instead of locking up our knowledge, imitating the outdated behaviors of the private company, we have to become vectors multiplication and dissemination of knowledge.
Thus, although formal education is not mandatorily the main necessary premise in the knowledge economy model, it also represents an important part in the new ways of acting economically, together with the knowledge derived from expertise, practice, among others, known as "tacit knowledge".

Also for the author, practical and analytical knowledge can be acquired through experience and the exchange between people in relationships, in general, through imitation, cooperation and communication. When problems are solved together, there is a sharing of knowledge, and this type of learning, where the social context is also relevant, is an important part for the understanding of tacit knowledge (LUNDVALL, 2001) [28].

> The classic examples of tacit knowledge in the literature are typically practical skills of individuals (such as cycling, climbing, etc.) that cannot be made explicit and that cannot be transmitted, for example, by network telecommunication. However, it is worth mentioning that there are other types of tacit knowledge that are more at the center of economic dynamics. Managers use experiences based on tacit knowledge when making complex decisions and less experienced scientists would not be able to do it (LUNDVALL, 2001, p. 202) [28].

In other words, tacit knowledge can also be described as that which is acquired through a process of incorporation, even with a certain level of unconsciousness. A person who works in a team and incorporates the knowledge of several team members through practice and coexistence. Another person who, as a manager, made several wrong decisions and, learning from mistakes, created new, more satisfactory protocols. And so on.

For Dowbor (2010) [14], the incorporated knowledge occupies a primordial position in the creation of value for the goods and services that are currently produced. Knowledge, the raw material of the educational process, is at the center of innovations and technological changes, however, it still retains some ideals of the past, based on the formality of education, on the added importance of the diploma, the classroom, the disciplines. "Education faces a profound transformation, in the sense of being less a teacher of classes, and more articulating of the multimodality that characterizes knowledge management today. The change is just beginning" (DOWBOR, 2010, p. 1) [14].
Lundvall (2001) [28] explains that the relevance of tacit knowledge for economic success directly influences the aspects that foster innovation policies. "This is why innovation policies need to have a social dimension in which the quality of the exchange between people and organizations is important and in which the search for competence on the part of companies becomes a legitimate objective" (LUNDVALL, 2001, p. 203) [28].

The author also considers two factors as fundamental in the educational process linked to the knowledge

economy. The first of them would be the creation of innovation networks that include other companies and other subjects, competitors or customers, as a way to cooperate for the appropriation and propagation of knowledge. For him, this collective effort is necessary, since companies do not individually master all aspects of product design, or even processes and services (LUNDVALL, 2001) [28].

The other factor concerns the five areas that need special attention, in order to intensify the effectiveness of the practices of a learning knowledge economy, as explained below:

- The development of human resources: Private companies need to invest in training the skills of their employees through formal training and courses. Public initiative needs to train those unskilled workers. That is, public and private in search of professional improvement for individuals.
- New forms of organization: which intensify the exchange of knowledge and experiences between the different sectors of a company and society.
- The establishment of innovation networks: that relate to each other internally and externally, always seeking to update themselves in relation to innovations and avoid stagnation in the market.
- Assignment of a new role for the service sector: transformed into key parts for the innovation process, based on their analysis and results, and through mediation between customers and producers, in a process of knowledge sharing.
- Integrating research institutions and innovation systems: that is, promoting the effective engagement of universities in innovation processes (LUNDVALL, 2001) [28] .

In conclusion, it is clear that knowledge has become the main source of value creation, it is something that does not rival for being infinite, for not having reduced its stock (DOWBOR, 2010) [14]. The author also mentions examples of MIT's free access actions, which he did in exchange for visibility and image improvement in the market. However, for him:

> Education today needs to modernize quickly, as it manages an area, knowledge, where interests are increasingly fierce, in the countless MBAs, corporate colleges, distance education systems, integrated systems of privatized school management, and the broad industry of University Degree. New technologies and the knowledge economy are welcome, it is about ensuring their utilization and democratic use (DOWBOR, 2010, p. 6) [14].

Therefore, it is worth mentioning that, according to Lundvall (2001) [28], contributing to the training of workers in general, as well as promoting training in companies and educational institutions, should be the primary focus of innovation policies. Especially with regard to the improvement of people, the formation of networks and the new social and business configurations, in relation to sustainability and the environment, aspects that, currently, cannot be unrelated to the economic / political context.

2.4 The environment in the context of innovations

Andrade (2012) [2] has already pointed out that the economy and the environment are inseparable, since everything that is produced through economic activity and the full functioning of society comes from external environments, from natural systems. Therefore, it is natural that any study on economic theories

also consider in its theoretical framework the dimensions of sustainability and the impacts that human actions cause to the environment.

Thus, Cavalcanti (2010) [9] questions how much it would be acceptable to remove from natural systems in favor of economic processes, that is, how much it would be possible to extract from the environment so that there would be the least possible impact. Then, the author, when making an analogy with a boat that, when it exceeds the load limit, is full, mentions the term "optimal load", which in the interpretation for the environmental issue would be the use of natural resources to their maximum limit. However, thinking of a macroeconomics of the environment, still making an analogy to the boat, the carrying capacity would have an important role, in this case, the carrying capacity would be the limit of the environment in supporting human actions on it. Anyway, it is this limit that will guide the dynamics of sustainable development or sustainable growth (CAVALCANTI, 2010) [9].

Andrade (2012) [2] classifies the economy focused on sustainability in two phenomena, which will be delimited below. The neoclassical environmental economy arose due to pressure from current society, to the economic branches, to start considering ecological issues in their actions and decision-making processes, since it is the sector that most extracts and causes damage to the environment.

Also in this model, the ecosystem is passive and impartial, and It is only analyzed what are the harmful impacts caused by the economy. Its convenience revolves around people and not the condition of environmental exploitation. In other words, the ecosystem is only a supplier of the economic system, not taking into account that in the future, the risk of resource depletion would also be harmful to human beings (ANDRADE, 2012) [2].

> In this branch of neoclassical environmental theory, we seek to answer questions regarding the optimal pattern of use of these resources, what is the proper management of renewable resources and what is the optimal rate of depletion of non-renewable resources. Ultimately, the central question underlying the analytical structure of the natural resource economy is whether its finite character can become an obstacle to the expansion of the economic system (ANDRADE, 2012, p. 11) [2].

Another phenomenon, more recent than the neoclassical environmental theory, is Ecological Economics, which started from a meeting held in Barcelona, in 1987, which highlighted a criticism of the way neoclassical theory conducted solutions in defense of the environment, despite its enormous potential for doing so, "claiming that the disregard of the biophysical-ecological aspects of the economic system leads to a partial and necessarily reductionist analysis of the interfaces between economics and the environment" (ANDRADE, 2012, p. 3) [2]. Thus, the main argument of this new model would be that such a complex subject should be analyzed and studied from the perspective of several disciplines, and not only from science or ecology (ANDRADE, 2012) [2]. So:

> Being based on a biophysical-ecological analysis of the economic system, ecological economics combines concepts from the natural sciences (biology, ecology, thermodynamics) and the social sciences (economics, politics) with the aim of providing an integrated analysis of the interfaces between the economic system and the environment, overcoming the reductionist character present in neoclassical analyzes. Thus, it is considered that the ecological economy offers an analytical tool more consistent with the criteria of sustainability and with the preservation of life on the planet (ANDRADE, 2012, p. 27) [2].

For Cavalcanti (2010) [9]:

> When realizing, in both cases, the need to overcome the disciplinary narrowness that prevents an overview of the ecological-economic problem as a whole, EE appears without disciplinary dependence, be it on the economy or on the ecology, resulting, in reverse, in an attempt to integration of both. Their worldview would therefore have to be transdisciplinary, focusing on the relationship between ecosystems and economic systems in the broadest possible sense (CAVALCANTI, 2010, p. 60) [9].

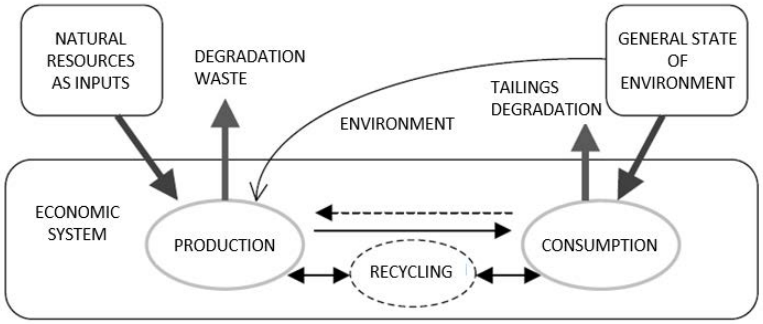
Cavalcanti (2010) [9] also points out that the intensification of the threat perception of the natural system was preponderant for the formulation of the ecological economy. For him, there is an endless struggle between the environment and the economy, which delimits new actions and attitudes that no longer take into account only financial issues.

It is also important to emphasize that this model is not completely opposed to the use of available natural resources, however, what "recriminates is the irresponsible use of these resources and the disregard for the finitude of the physical base that sustains the economic system" (ANDRADE, 2012, p. 21) [9]. In short:

> "[...] conventional economics excludes nature as an externality of the economic process; the environmental economy is concerned with giving nature a price, with the tendency to see it as an amenity (an idea implicit in the common notion of "green"); and ecological economics attributes to nature the condition of irreplaceable support for everything that society can do "(CAVALCANTI, 2010, p. 63) [9].

For Mueller (2007) [32], it is necessary to think about this relationship between economic system and natural system, the first being an apparatus of strong complexity, which is supported by the second. Both interact with each other, the economic system extracts natural resources from the environment, however, it returns only waste, as can be seen in the figure below.

Figure 1: Chain of the relationship between the Economic System and natural resources



Source: Mueller (2007) [32]

Therefore, it is undeniable that the growth of the economy and its global spread, whether by countries or by diverse sectors, have a huge impact on nature, even if they are essential aspects for the lifestyle and consumption patterns of today's society. (ANDRADE, 2012) [2]. Hence the need to create innovation policies that favor the environment, in an attempt to generate a balance between maintaining the contemporary / globalized lifestyle and reducing the impacts caused by it.

According to Corazza (2003) [10], it is an extremely important and difficult task for leaders to develop technologies that respect the environment, as well as the incentive, knowledge, evaluation, choice and adoption of them. Public authorities must move in this direction, aiming that it is finally possible to arrive at what the author calls “desirable situation”, which:

> [...] it involves a value judgment, because it implies establishing certain values or norms to guide actions and decision making, especially in the public sphere. In terms of environmental protection, it would therefore be necessary to resort to a normative approach. Even before answering questions such as "what should be done?", It would be necessary to look for an acceptable answer to the following: "which situation is desirable?". In other words, it would be necessary to establish a reference and a criterion (or a set of them) to assess the possible social states: it would be necessary to establish a normative framework (CORAZZA, 2003, p. 481) [10].

Lundvall (2001) [28] outlines what would be necessary to establish innovation policies that are socially and environmentally sustainable. The author states that there are three key elements for the success of environmental innovation:

- Determine criteria in relation to interactions between customers and producers, based on the development of specific markets and consumers for environmentally friendly products. In addition, the government can create measures to encourage companies to adopt other quality standards for their products and services.
- Choose institutions for an analysis of the most important parameters of the environment and encourage interdisciplinary training and research initiatives.
- Interconnect policies for the environment, innovation policies and economic policies (LUNDVALL, 2001) [28].

In conclusion, these measures and analyzes represent a major challenge to the planet's status quo, when it comes to pollution and environmental degradation. However, the development of non-polluting or more "environmentally friendly" innovations and techniques is still valid for industry and other sectors. Innovations considered social, which positively interfere in society's lifestyle, are configured as fundamental components in the dynamics of sustainable growth (LUNDVALL, 2001) [28], as it will be possible to observe in the topic that follows.

2.5 Social innovation

Before getting into the concept of Social Innovation, that matters most in the context of this work, it is important to briefly introduce how innovation is key to understanding the dynamics of the knowledge economy. For Lastres and Ferraz (1999) [24], technological innovations refer to the process of using knowledge to develop new modes of production and commercialization of goods or services. These innovations can also be organizational, as they interfere with company processes, such as logistics, supply, etc.

An example of the result of current innovation would be the diffusion of Information and Communication Technologies (ICTs), which are composed of a set of innovative technologies in the fields of computing, software engineering, telecommunications, among others, which have achieved a radical reduction in operational costs with the adoption of this type of tool (LASTRES AND FERRAZ, 1999) [24].

For Lastres (1999) [24] the performance in networks and systems can also be seen as a form of innovation, since it reproduces a new pattern of strategic organizational behavior, regardless of being a small, medium or large company. This new standard is based on cooperation and interaction between the elements, in order to make the "generation, acquisition and diffusion of knowledge and innovations" more effective (p. 189) [24]. Also for the author:

> Additionally, remember that the appropriation of knowledge and information has specificities that cannot be ignored, as they are intangible resources that can be used - even simultaneously - by several people, without problems of exhaustion. Contrary to what happens with material goods, the consumption of information and knowledge does not destroy them, just as its disposal generally leaves no material traces. Giving them away or selling them does not cause them to be lost (LASTRES, 1999 p. 190) [24].

However, it is worth considering that the constant investment in innovations also requires investing in education, that is, in training, stimulating continuous learning (LASTRES AND FERRAZ, 1999) [24]. In addition, Lastres (1999) [24] points out that not having enough knowledge to know how to use innovations and new technologies or not being able to put into practice what has been learned, turns out to be more harmful than not being able to access these resources, i.e, it is essential that before the learning process there is also the opportunity to use that knowledge that has been acquired.

Thus, Almeida (2006) [1] argues that the main function of an innovative system would be to develop,

transmit and make use of innovations. However, it also talks about the institutions of the third sector, considering them naturally without efficiency and with a limited capacity to innovate, which is the reason for the lack of interest of the science of politics in the government to invest in developing innovation policies, constituting, therefore, the impediment to the practice of the knowledge economy.

It happens a lot that economic issues and political interests are taken into account, leaving aside the social aspect and its importance in the innovation process. In other words, innovation is considered to be only those that confer economic advantages or profit in the face of the market, relegating those forms of non-profit organization that contribute to social aspects, such as cooperatives or associations. As is the case, for example, of companies that produce free software, which, according to Tigre and Marques (2009) [41] is:

> The main alternative for software users who do not want to be subject to the licensing conditions and technical restrictions imposed by proprietary software providers is free or open software. Business models based on this type of license assume that the value is in the service and not the product TIGER; MARQUES (2009, p. 562) [41].

This is also the case for third sector institutions, which are composed of private initiative organizations, which are not profitable and in addition provide services that are advantageous or beneficial to the public in general. According to Almeida (2006) [1]:

> The third sector arises, during the 19th century, as a result of a social movement against the situation of disadvantaged social classes, affected by the Industrial Revolution. In the twentieth century, after the golden age of world capitalism, its revival is observed, in the context of the crisis of the welfare state and Fordism. Contrary to the classic social economy, the new social economy, as some call it, is not intended to be an alternative to the capitalist system, but rather a complementary one. (2006, p. 62) [1].

However, the dominant theory does not recognize that the third sector can be a promoter of innovations, mainly because its central objective is not to generate profit. Other factors that lead to this devaluation also involve the fact that the institution belongs to a group, and not to an individual subject, as for example in the case of cooperatives; and the guarantee of goods and services that are usually not very profitable, underestimated by the market and the government (LÉVESQUE, 2005, p. 9) [25].

Almeida (2006) [1] also highlights other factors that represent the weakness and limits of innovation in the third sector:

> Firstly, social economy organizations cannot succeed in all sectors, especially in those cases that need strong capitalization. Second, its capacity to face different social problems has limits, since its principle of operation is often based on reciprocity. Third, there are highly bureaucratic organizations that have a weak capacity for change. Last but not least, innovative capacity is not always up to date. The creation phase is usually the moment to innovate, but in the following stages of diffusion and development, it often tends to become trivial (LÉVESQUE, 2005;

LÉVESQUE, 2006) [25] , [26].

Therefore, the potential for innovation in that sector, based on a social economy, is closely linked to its ability to sustain itself, still depending considerably on the public sector, although it is seeking more independence and other forms of financial aid (ALMEIDA, 2006) [1]. The OECD (Organization for Economic Cooperation and Development) defines that Social Innovation:

> [...] seeks new answers to economic and social problems, through the identification and distribution of new services that improve the quality of life of individuals and communities. This involves the design and implementation of new labor market integration processes, new skills, new jobs and new forms of participation. Social innovations thus contribute to the well-being of communities and individuals, whether consumers or producers. OECD (2003: 299) [35].

Therefore, social innovation has several forms of association, interaction and mobilization of people, still highly diversified, with companies linked to philanthropy, Free software, information vehicles, among others (ALMEIDA, 2006) [1]. This is mainly about the cooperative institutions that bring together workers who collect recyclable materials from Brazil, as will be discussed in the next chapter.

Finally, it is worth mentioning that social innovations help to mitigate the problems caused by technological innovations, contributing also to the new dynamics of society. For this reason, third sector companies are so important for the consolidation of the knowledge economy as they seek other alternatives and even innovative answers to social and economic problems (ALMEIDA, 2006) [1].

3. The knowledge economy in the context of recycling

The constant growth of capitalism and, consequently, of industrialization, caused a considerable increase in consumption, mainly of industrialized products that generate a huge amount of common waste and solid waste. Thinking beyond the environmental issue, it is also possible to notice how all these economic changes have also brought about profound transformations in social and labor relations, encouraging the appearance of new professional activities, indispensable in this specific context, as well as accentuating the fragility that already exists in these relationships.

This is the case of individuals involved in the recyclable material collector profession, an activity that emerged in the context mentioned above and also from the high unemployment rate in the formal sector, which, for Bosi (2008) [7], it leads workers, especially those with little study and qualification, to look for other possibilities to support themselves, finding this alternative in informal job, such as in recycling cooperatives, scrap dealers, garbage dumps. “It is, above all, about surviving and ensuring the family's daily life [...]” (SANTOS, 2008, p. 46) [36].

According to Lussari (2016) [30], this industry / market arose due to several factors, among them, the environmental factor, which focuses on the concern for the unrestrained use of natural resources,

encouraging raw materials to be reused in the production process. In addition, there was a great opportunity to make a profit from less expensive material and a less valued workforce. In this sense, the author also points out how recycling is constituted as an extremely ambiguous market, being, on the one hand, an environmentally correct practice, while, on the other hand, it fuels the profit possibilities of companies in this capitalist[2] model (LUSSARI, 2016) [30].

Therefore, it is concluded that the activity in question involves several subjects that differ according to the social and power relations that each one occupies in this context. Hence the importance of cooperatives for workers in this niche, since, for Silva (2017) [40], this organization may represent a possibility for the empowerment of waste pickers[3]. Also, according to Lussari (2016) [30], cooperatives promote strengthening and give voice to waste pickers, in front of politicians and those who are at the upper levels of the pyramid[4]. Other authors such as Costa & Chaves (2012) [12] and Bosi (2008) [7], citing Dagnino and Dagnino (2010) [13], also state about the visibility that cooperatives give to the collector's struggles, promoting representativeness before the public power and the application of labor rights.

Thus, it is possible to observe that the cooperative is basically the union of a group of people who perform a specific labor activity. Its main objectives would be the organization of the groups, the improvement in the work processes and the representation of these workers before the government, businessmen, possible customers, among others. Thus, cooperatives benefit the life of waste pickers, guaranteeing more quality of life and helping to reduce the marginal condition of waste pickers. However, it is also important to note that not all waste pickers benefit from this cooperativism. A considerable portion is still unnoticed and operating in extremely precarious conditions, in exchange for survival.

With this in mind, the focus of this chapter is to analyze the research work of Bunchaft and Oliveira Filho (2015) [34], which links the recycling industry to the knowledge economy, qualifying recycling activity as an empirical object in this area of research, due to the transformations brought about in the activity through the knowledge acquired in the aspects of organization, logistics and commercialization, observed mainly in those cooperatives that are already more advanced.

For researchers, knowing and understanding the knowledge levels of this group becomes essential for the development of public policies aimed at their social inclusion (BUNCHAFT; OLIVEIRA FILHO, 2015) [34]. The scorn of the waste picker does not only happen on the financial side, but also because of the lack of recognition of the activity as worthy or important, as well as being praised by doctors, lawyers, businessmen, etc. Informality, the exploitation of labor, the lack of conditions for waste pickers to move within social classes and the vulnerability of this portion of the population, gives them the tone of

[2] Who sees the work of the collector as a way to save on costs related to licenses, qualified professionals, planting large areas to obtain raw material.
[3] The formalized picker represents only 10% of this social group. In other words, 90% cannot even reach work in cooperatives.
[4] Working crowded in the physical space of a waste pickers' cooperative ideologically represents a right place of work, fixed, with headquarters, possibility of coexistence with other workers. Place to go and return, ideologically this is very important for the Brazilian worker. Mainly, the society that sees the worker as the one who "left home" to work. Who works at cooperative X, which is at that address.

marginality. When there are no possibilities for formal work, subjects are also denied access to education, health, representation, rights and, even, visibility, voice. And this often happens, even when the worker is cooperative.

Thus, Bunchaft and Oliveira Filho (2015) [34] sought to develop in their research, Integrated Knowledge Modules (MIC's) that articulated scientific and practical research, and could be replicated in different contexts (transport; sorting; pressing; marketing, organization, logistics, production etc.) with an assessment of physical, economic and market efficiencies, thus being transformed into a knowledge economy. For him, establishing these analytical bases should contribute to the identification of acquired knowledge and its dissemination, which serve for the development of new businesses and partnerships, including with the private sector.

The research established several parameters for the knowledge economy, relating them to the recycling industry. First, the levels of knowledge present in the recycling activity were identified, through technologies, innovations, new ideas related to the production processes, etc. In addition, the efficiency of the operation of these tools in the context of the referred activity was evaluated. Then, based on these data, Bunchaft and Oliveira Filho[5] (2015) [34] determined 4 levels, which he calls "Steps of acquired knowledge" (SK1, SK2, SK3 and SK4), according to the structural and productive organization of waste pickers' organizations recyclable materials. Of these 4 degrees, the latter is represented by groups that are not yet properly organized, as will be better described below:

a) Sk1 - Step of knowledge 1: High level of knowledge acquired

It consists of groups formally organized into associations or cooperatives, and which have all the necessary equipment for the optimization of work processes (presses, scales, trolleys, own warehouses, among others). They have the capacity to increase their physical structures and high potential to spread their acquired knowledge to other less prepared groups.

Its highest level of organization, provides efficiency in physical, economic and market, with a consequent pay higher and higher quality of life. They also have sanitary facilities, bathrooms and adequate levels of hygiene, as well as kitchens and cafeterias for the preparation and timing of meals. Some cooperatives of this level even have classrooms and computers, for training, literacy and other studies.

At this level, the institutions are already prepared to verticalize the production of recyclable materials. They have a work pattern, with equal and uniform equipment for workers, as can be seen in the images that follow:

[5] Prof. Dr. João Damásio and Antonio Bunchaft, friendship built over 14 years of work at the Center for Social and Environmental Studies - Pangea.

Figure 2: Photograph of the conveyor, trolleys and uniformed workers

Source: Bunchaft, Oliveira Filho and by the author (2015-2020).

Figure 3: Photograph of the equipment in a SK1 recycling warehouse

Source: By the author (2020).

b) SK2 - Step of knowledge 2: Medium level of knowledge acquired

It is made up of groups also formally organized into associations or cooperatives. However, with less equipment and needing financial support for the purchase of machinery and its growth. It has some acquired knowledge, being, however, direct beneficiaries of the spread of knowledge at the SK1 level.

At this level, the cooperatives are in an intermediate phase because of the lack of some equipment and knowledge so that they can increase production. In this case, it is necessary to reinforce the infrastructure, both physical and personnel, to expand the collection. As seen in the photos below, it has a rudimentary structure and little influenced by technology.

Figure 4: Photograph of a recycling truck, warehouse and materials

Source: Bunchaft, Oliveira Filho and by the author (2015-2020).

Figure 5: Photograph of a SK2 recycling warehouse

Source: Bunchaft and Oliveira Filho (2015).

c) SK3 - Step of knowledge 3: Low level of knowledge acquired

It is composed of groups still in the process of organization. They have little equipment, many belonging to the group itself, and they need financial assistance to acquire almost all the necessary equipment, in addition to their own warehouses. They have very little acquired knowledge and need a lot of support to get adequate training and new knowledge.

In general, they have difficulties including knowing where to look and requesting financing and technical support. For this reason, the formalization of its cooperative would mean inclusion, the rise to a higher level of knowledge, in addition to a slight departure from the conditions of vulnerability, marginality and invisibility. As seen in the photos below, the shed is not organized and has a precarious structure, which is also reflected in the work of the waste picker (Figures 6 and 7).

Figure 5: Photograph of SK3 recycling warehouse

Sourse: Bunchaft, Oliveira Filho and by the author (2015-2020).

Figure 6: Photograph of SK3 level worker with his trolleys

Source: By the author (2020).

d) SK4 - Step of knowledge 4: Very low level of knowledge acquired

It consists of disorganized groups or individual workers, who work on streets or dumps. They do not have any equipment, often working in extremely precarious conditions and selling their materials to middlemen and scrap dealers, who pay prices well below the market. They have only that basic knowledge related to the collection and selection of materials.

For the complete assembly of the physical infrastructure and purchase of equipment, they need financial support, which would also enable them to begin to acquire more knowledge. As in the case of the SK3 level, the formalization of a cooperative would mean inclusion and ascension to a higher level of knowledge, in addition to a slight departure from the condition of marginality.

Figure 7: Photograph of workers looking for recyclable materials in a "dump"

Source: By the author (2020).

Figure 8: Photograph of the picking work at a "dump" and on the streets

Source: Bunchaft, Oliveira Filho (2015).

After the establishment of these levels of knowledge, other types of analysis are also carried out, which are also important, of the work of BUNCHAFT, OLIVEIRA FILHO (2015) [34], such as the number of collectors and cooperatives and the level of knowledge in which they find themselves. As shown in the table below:

Table 1: Number of waste pickers and cooperatives

Knowledge Steps	No. of Waste Pickers	%	No. of Cooperatives	%	Pickers by cooperative
SK1	1.381	4 %	24	7 %	57.5
SK2	2.753	8 %	70	21 %	39.3
SK3	5.720	16 %	122	37 %	46.9
SK4	25.783	72 %	115	35 %	224.2
Total	30.131	100 %	331	100 %	91

Source: PANGEA / BUNCHAFT, OLIVEIRA FILHO (2015), J. op.cit. p.85.

Thus, according to the table, it is possible to state that only 7% of the cooperatives, 24 out of a total of 331, have knowledge and infrastructure adequate to the SK1 level, that is, it is an extremely small portion of the sample surveyed, which demonstrates that most waste pickers, even those who are already organized, still do not work under conditions considered ideal.

Considering a junction between the levels SK1 and SK2, which are the levels where the best knowledge and basic infrastructure are found, it is observed that the value of 28% (or 94 of a total of 331), remains much lower, compared to the others levels (SK3 and SK4), which together represent a total of 237 cooperatives, out of a total of 331 in the sample, or 72%. Therefore, it is concluded that the two groups that represent more cooperatives and, thus, more workers, are those where the levels of acquired knowledge are lower and the working conditions are more precarious and unequal.

These differences are even clearer, and better understood, when comparing the total number of waste pickers, which is 35,637, to the number of waste pickers belonging to the SK3 and SK4 groups, which is 31,503. In other words, there are 31,503 individuals working precariously and failing to see possibilities for improvement, also due to the lack of acquired knowledge.

About this, BUNCHAFT, OLIVEIRA FILHO (2015) [34] questions how to create public policies for this population, without promoting the maintenance of their structural conditions. In short, financial investments and the creation of new jobs are of no use unless there is a strong educational process that enables waste pickers to make a real change in their lives, in addition to independence, based on effective and lasting knowledge that can be practiced in the scavenging activity.

Other possible analyzes concern the region and the levels of knowledge in which the cooperatives of the sampled are located, as shown in the table below:

Table 2: Regional distribution of cooperatives, according to knowledge levels

Region	Total in the region	SK1	SK2	SK3	SK4
North	2	0	0	1	1
Midwest	25	3	6	8	8
North East	58	2	7	14	35
Southeast	112	14	47	35	16
South	47	6	10	22	9
Total	244	25	70	80	69

Source: PANGEA BUNCHAFT, OLIVEIRA FILHO (2015), J. op.cit. p.132 – Table 7.11

According to Table 2, it is observed that most of the cooperatives are in the Southeast, followed by the Northeast, South and Midwest. The North region has the fewest cooperatives (2), both of which belong to the SK3 and SK4 levels. This demonstrates a certain delay in the North region in relation to the knowledge needed to improve the work processes of a cooperative of waste pickers. It also points to a

deficiency in the region in relation to the treatment given to solid waste and recyclable materials.

The Southeast region has a total of 112 cooperatives, which mostly belong to the SK2 and SK3 levels, respectively. These data show that the region, despite already having a certain level of knowledge, still needs to make much progress in its dissemination, so that most cooperatives can achieve an ideal level (SK1) in recycling work.

In the Northeast region, which has a total of 58 cooperatives, most (35) are at the lowest level of knowledge acquired SK4, 14 at the SK3 level, 7 at the SK2 level and only 2 at the SK1 level. These data demonstrate, then, that the majority of waste pickers still work in precarious conditions, despite all the innovations and technologies that exist today. This decrease points to a deficiency in the region in terms of acquired knowledge and the potential dissemination of that knowledge, a fact that could, little by little, cause the cooperatives to climb the steps, so that they could reach the ideal level.

Almost the same can be seen in the South region, which has a total of 47 cooperatives and most (22) are at the SK3 level, with 9 at the SK4 level, 10 at the SK2 level and only 6 at the SK1 level. Data from the South region point to a slight improvement in the level of knowledge acquired, as there are 6 cooperatives at the SK1 level and most of them are in SK3, despite still having a low potential for disseminating the acquired knowledge.

Finally, the central-west region has only 25 cooperatives, and most of them (16) are at the lowest levels of knowledge acquired (SK3 and SK4), with 3 being at the SK2 level and only 3 at the SK1 level. These data point to a similarity in relation to the other regions, which demonstrate a lack in the dissemination of the acquired knowledge, since there are a large number of cooperatives at the lowest levels of this item.

Therefore, in general, it is concluded that, even with all the technological and innovative apparatus that already exists today, including in relation to the processes and the organization, there is a lack of sufficient knowledge, and the transmission of them, to be applied and carried out in the practice. What can be seen by the huge number of collectors and cooperatives that are still at the lowest levels of knowledge acquired.

Thus, after all this analysis, it is important to highlight how the research by Bunchaft and Oliveira Filho (2015) [34], specifically, Marketing Networks Uilmer, Cruz (2015) [33], is configured as a social rescue, according to the words of the author himself, since it represents the possibility of solving the problem of the lack of knowledge of one of the most excluded social groups in society. The idea is to be able to identify all the faults that need to be remedied, especially those related to the knowledge necessary to provide a healthier work environment and better quality of life for workers. Thus, the dissemination and sharing of knowledge applied in cooperatives that belong to the SK1 level, to cooperatives at other levels, would be the ideal way to transform the current paradigm of the scavenging activity in the recycling market.

Oliveira Filho et al. (2020) [34] still mention some parameters of knowledge that would be fundamental to acquire for there to be a change in this scenario, which are:

a) Knowledge economy applied to techniques for sorting recyclable materials: the production chain of recycling is defined as the set of substrings that operate on specific types of recyclable materials. According to Oliveira Filho et al. (2020) [33], these substrings deal with the diversity of plastics - PET (polyethylene terephthalate), HDPE (high density polyethylene), LDPE (low density polyethylene), PVC (vinyl polyethylene), PP (polypropylene), PS (thermoplastic) polystyrene) and plastic film, among others -, papers - white paper types 1, 2 and 3, magazine paper, newsprint, catalogs, cardboard etc. - ferrous scraps, styrofoam, aluminum, Tetra Pak (a mixture of aluminum and cardboard), among other solid wastes that are often found in the consumer market. In addition to this variety of recyclable materials, one cannot lose sight of the color variation of the waste. Each of them has a different productive purpose within the substrings[6].

Oliveira Filho et al. (2020) [33] state that, for each type and color of recyclable, there is a specific purchase price by the recycling industry. It reports to its supply chain based, as a rule, on intermediation structures, on the first step, and on the recyclable material collectors themselves, on the second step, which feed the entire production chain through their work of sorting the collected waste. However, according to the authors, it is essential to consider the so-called opportunity cost by sorting, that is, it is essential to take into account which recyclable is worth investing in a specialized sorting, since some add more value than others.

In this segment, it can be said that building systematic knowledge about the diversity of recyclable materials and their forms of sorting makes it possible to add value to the price practiced by the product. It is noteworthy that the surpluses generated in the commercialization stage of the recycling production chain - that is, between the collection carried out by the collectors and the sale to the intermediation structures, until they reach the industry - can exceed 500%[7]. Most waste pickers are not aware of this. It follows that a properly systematized knowledge about this technique can influence the increase in the per capita value of the material collected by the collectors without increasing production, increasing the income of this social segment. It allows a conscious and specialized sorting process, organized and efficient, according to the diversity of recyclable materials that exist, adding value and enabling the practice of better prices.

b) Knowledge economy applied to the identification and characterization of the players in the recycling process markets along the productive networks of recyclable materials: it addresses the different forms of production, appropriation of values, relative gains and characteristics of existing market structures along the chain. It also deals with “Commercialization Networks”, which incorporates

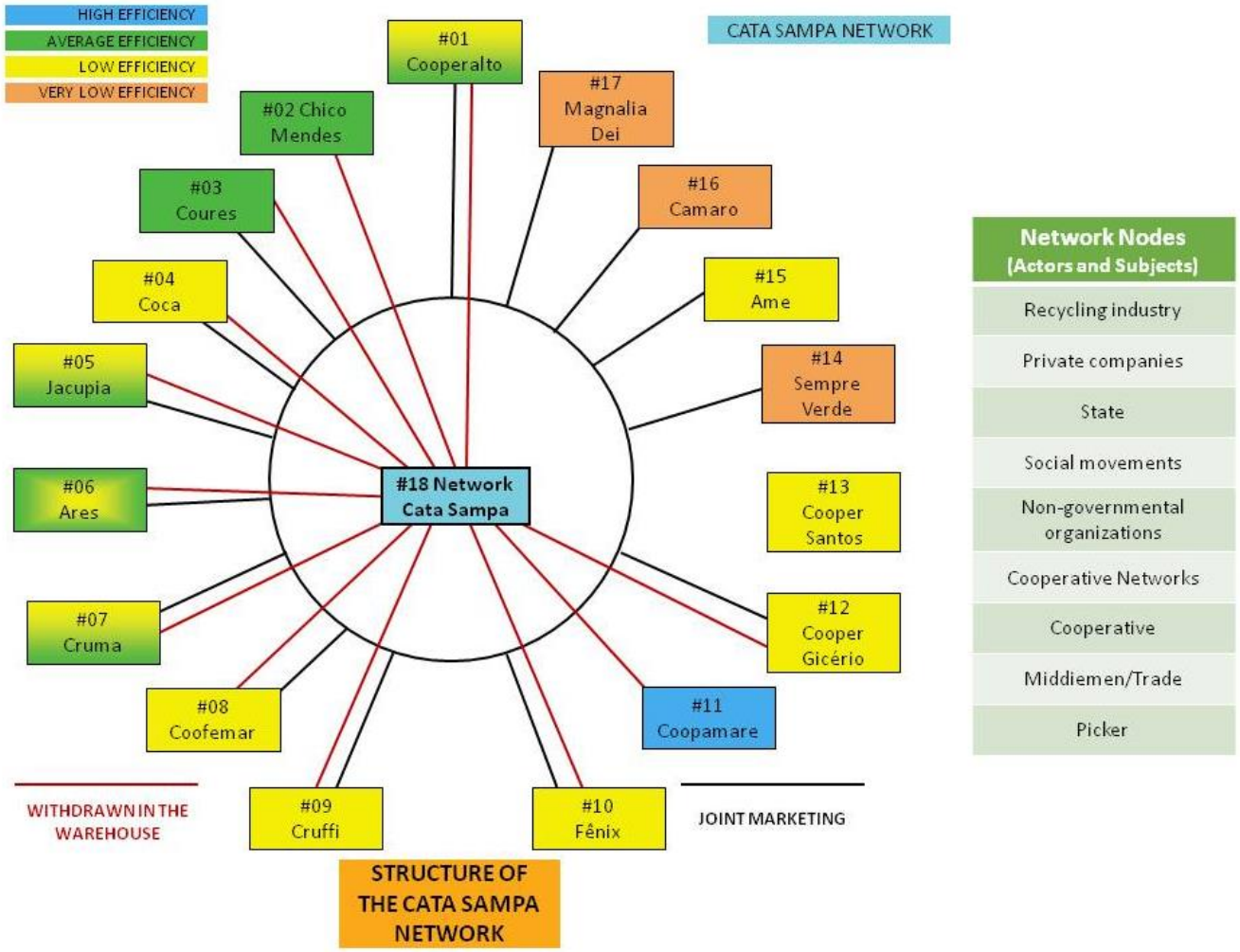
[6] As a demonstration, recycling white LDPE can result in a multitude of recycled products of different colors. On the other hand, only dark colored products can be derived from recycling dark colored LDPE. Obviously, the recycling of the first case adds significantly more value to the product than that of the second.

[7] The pickers' survival horizon implies the daily sale of the material, which prevents the formation of stock and reduces the price they could charge.

new organizational and logistical strategies, such as the practice of Joint Marketing, which allows some types of materials to be collected in several cooperatives that do not have a productive scale that allows better prices: the objective is to gather and, if necessary, stock up on recyclable materials until the necessary volume is obtained to meet demands at levels of commercialization higher than those that would be obtained by decentralized individual commercialization.

The following figure illustrates, with the example of the Cata Sampa Network, how a Marketing Network can be structured. The blue lines connected to the circle show the cooperatives that benefit from joint marketing. The red lines indicate that there is some participation by the respective cooperatives in the "withdrawals" from the processing of materials collected from large generators and fairs and events. The colors that fill the rectangles of each cooperative indicate their relative efficiencies.

Organization Chart 1: CATA SAMPA Marketing Network



Source: Oliveira Filho et al. (2020), adapted by the author.

In this sense, knowledge about how a marketing network is constituted allows for a more global analysis of the consumer market for recycled materials, being able to generate advantages through efficiency and the great potential for disseminating knowledge improving the standard of living of waste pickers from

institutions linked to these networks.

In addition to proper sorting, scale of production and regularity of supply are fundamental to being able to directly sell recyclable materials to the recycling industry. As Oliveira Filho et al. (2020) [33], such an industry cannot live with minute quantities and irregular supplies, under the risk of jeopardizing its production process.

For being disorganized economically, the waste pickers work, usually in isolation, rescuing the streets and dumps waste on which they operate, selling them by day and in small quantity for intermediation structures. Even though they organize themselves into cooperatives or associations, they continue to collect a very small volume of materials, which keeps them hostage to the intermediation.

In this sense, Oliveira Filho et al. (2020) [33] point to the so-called marketing networks, a recent phenomenon in Latin America, almost restricted to Brazil. These are unique networks, still experimental and, because of that, unknown among academics, which consist of a business strategy in the midst of poverty - a strategy that constitutes an intelligence center capable of articulating small, medium and large organizations of waste pickers with a view to a single and instantaneous marketing in order to achieve considerable monthly volumes and regular supply, thus succeeding in overcoming the intermediation structures, selling directly to the recycling industry. Such networks are also capable of analyzing the market on a regional and national basis, building an information system on current and future trends in the production chain, observing medium and long-term movements, allowing strategic positions by waste pickers.

Although they are an interesting strategy for the emancipation of the intermediation structures, the marketing networks are not yet able to build productive stocks to face the market's seasonality. It so happens that they do not have enough information to understand how the formation of stock occurs in the market by sub-chain, nor what are and how the categories of analysis that affect the formation and variation of the price over time operate[8].

In view of this, we can say that these networks lack a knowledge articulated with the empirical experience, perhaps even due to the fact that it has not yet been the target of so many studies. Building this knowledge can mean a shift in the positioning of waste pickers in the production chain, moving from mere individual suppliers to regional and national economic organizations that supply raw materials to the industry[9].

[8] The price of Nafta in the international market impacts on virgin PET resin, which, in certain situations, can be cheaper than recycled resin, however paradoxical this may be.

[9] The CATABAHIA Network, the object of research, is the first national network to introduce this strategy, being a benchmark for Brazil. In 2007 it was considered by the United Nations as one of the 50 best experiences of achieving the Millennium Development Goals, in the category of combating poverty. As an experience, it is an empirical knowledge that has been successful. Here an attempt is made to analyze the experience and systematize it together with a set of other techniques, with the aim of constituting a KIE (recycling equipment) that can be reproduced in other experiences in Latin America.

c) Knowledge economy applied to logistical techniques for the collection, processing and transportation of recyclable materials: as a rule, the recyclable material has little weight and a lot of volume. In this sense, paying to "load air" is very common in selective collection processes. Oliveira Filho et al. (2020) [33] state that the density in the distribution of collectable waste in a territory is due to three fundamental factors, namely the income of the community that inhabits the territory, the size of the local population and the presence of large companies in the surroundings. From this it can be said that the higher the income of the community, the more waste it will produce. Among these residues there will be a higher incidence of recyclable materials than of organic materials, and the added economic value per capita will also be higher. It is also possible to infer that the larger the local population, the greater the territorial density of existing waste, and that the more companies are established in the vicinity, the greater the density of waste concentrated in small territorial spaces.

The proper modeling of capturing recyclable materials through the distribution, within a territory, of a certain numerical set of warehouses strategically located until the arrival at a central warehouse consists of a type of empirical knowledge that, many times, is not systematized, either linked to scientific knowledge. In addition, the adequate modeling for a consortium between collection trolleys, by means of human traction, and trucks, with the intention of obtaining a larger volume within the lowest possible economic cost, is also seen as an empirical experience that does not systematize or aggregate to the scientific framework. This shows, as Oliveira Filho et al. (2020) [33], that the records of assembly of systems for capturing recyclable materials are erratic, considering, at once, the variables of weight, volume and irregularity of the waste in the territorial and income distribution. It also shows that the records of formulations of mathematical equations for logistical purposes are mistaken through computerized systems that take into account the same variables, managing to build mere models of intercropping between depository, warehouses, human traction and trucks.

Such issues affect the increase in costs for waste pickers, who often either suffer from inhumane collection systems or, when they have trucks, do not use them rationally. For this aspect, the aforementioned issues give rise to the need to build a structured knowledge on which models of arrangement of selective collection logistic circuits are economically sustainable and operationally viable for diversified situations, in which the variables have different intensity in each territory. Structured knowledge about the logistical processes in the selective collection, which are sustainable and viable in different situations such as differences in territory, time of year, materials, etc.

d) Knowledge economy applied to production verticalization techniques and the articulation of new energy and environmental opportunities: the value added to recyclables through production verticalization requires, as we have already mentioned, volume and regularity. From this it can be deduced that there are more chances of success in the aggregation in collectors' structures organized in commercialization networks[10]. However, it is not inopportune to ask in which substring more value is

[10] The CATABAHIA Network is implementing a plastic recycling industry that will also produce bleach bottles with the formulation of water, which will be marketed in the Wal-Mart chain of supermarkets across the country. This is an unprecedented feat for waste pickers who left the dump to become industrialists.

added and up to what level of verticalization it is worth reaching.

New windows of opportunities have opened in Brazil with biofuels. As Oliveira Filho et al. (2020) [33], cooking oil became an input for biodiesel plants. However, because it is a liquid waste, the logistical structure of adequate collection is not properly matured on a large scale. The levels of added value to cooking oil for sale with the Brazilian oil company (Petrobrás) are also not mature, because the whole process is very recent.

Petrobras is currently the fourth largest company in the Americas, having recently started an aggressive oil purchase strategy for waste pickers' cooperatives. However, it still does not know the market and its nuances. Although the collectors have the potential to collect organic waste that could be worked on a scale aiming at the construction of biodigesters for the production of compost and energy generation, these products could be commercialized or absorbed in the collectors' production plants. This is an expressive potential, on which pilot projects for the implementation of biodigesters already exist. The experience in biodigestor collector cooperatives is basically India and Brazil. Therefore, it is essential to accompany and articulate the experience with scientific knowledge[11].

This whole system of collecting recyclable materials, adding value and generating energy is perfectly quantifiable in terms of saved environmental resources, namely: water, trees, bauxite, iron, copper, aluminum, sand, etc. This process opens windows of opportunity to build a methodology for framing these experiences so that they receive resources from the Kyoto Protocol, which today, however, has only benefited large business organizations.

It adds additional value to recyclables through vertical production, with more chances of success in cooperatives and associations of waste pickers organized in networks for the sale of recyclable materials. In addition, it seeks to link this process to issues of sustainability and energy generation.

Regarding education, it is important to consider the knowledge economy, in the scope of recycling, not only in those processes that cause improvements and financial profits, but also in the changes that this knowledge causes in the personal life of the collectors and how it influences in all their decisions from day to day, including attempts to “improve your life” or “raise” the levels of knowledge steps. An example of this would be the participation of waste pickers in the electoral process through voting.

What is observed is that those workers less organized and with a lower level of knowledge, end up voting for populist candidates and with empty promises, representatives of parties that respond to the interests of the elite and of big businessmen, including those involved in recycling. On the other hand, more organized workers who have higher levels of knowledge, end up reflecting on their conditions with more awareness, better observing those candidates who really intend to fight for the needs of their class.

[11] The CATABAHIA Network has been assembling a biodigester to generate energy that will be directed to the plastic industry of the network itself. This is an innovative experience in the world, with full use of organic and recyclable waste.

Finally, it is worth stating, then, that knowledge, when acquired, provides an increase in the collectors' income, in addition to improvements in quality of life and working conditions, with the acquisition of new equipment, adequate and hygienic environment, use of uniforms, training, education etc. All of this turns recycling workers into protagonists in decision-making and administrative processes, further reducing their condition as invisible and marginal. However, still according to the words of Oliveira Filho et al. (2020) [33], the knowledge acquired only has value when it is disseminated to those who do not have it, as would be the case of the dissemination of knowledge from cooperatives SK1 and SK2 to those SK3 and SK4.

4. Conclusion

It was possible to observe, from the reflections proposed in this research, how globalization caused great changes in the relationships that exist between man and work, science and the environment. In the beginning, what prevailed were material and financial assets, related to profit, in a gross way. However, over time, it was observed that there are other points that are so important and that they could also provide profit and improvements in the processes of the institutions. It is the case of an appreciation of knowledge and experience, which came into force in the main contemporary management and labor practices.

It was sought to understand, in the light of the researcher and philosopher Peter F. Drucker, how the "Knowledge Economy" defends that the most important asset of an institution is knowledge. This knowledge includes innovations, technology, science, formal knowledge, experience, that is, everything that can create more effective ways of operating in today's markets.

In addition, the recycling industry was related to this concept, determining 4 levels of knowledge steps and demonstrating how the knowledge acquired in relation to logistics, organization, equipment marketing - observed mainly in those cooperatives that are already more advanced - it can be promordial in improving the quality of life and work, in addition to better earnings, for cooperatives and waste pickers.

In this sense, it is stated how this work was fundamental to reflect on what was asked in the question problem: How does the knowledge economy relate and positively influence work activities such as the collection of recyclable materials?; when it was understood that knowledge, represented by technologies, new equipment and process improvements, is essential to improve the work of recyclable material collectors, such as the cooperatives belonging to SK1 and SK2, which have equipment for the processing of collected material, in addition to more standardized and organized processes, as already mentioned. As well as the problem question, the general objective and the specific objectives were also achieved, in this same perspective.

It is concluded, then, that the collectors of recyclable materials are part of a large number of Brazilians

whose work occurs in the condition of informality and social exclusion and rights. That is why the discussion addressed here is so fundamental, as it is believed that this study can integrate a rich material for reflection on the condition of recycling workers, who are so important, both for society and for the environment, but even so, they continue to be extremely devalued socially and financially. Finally, here it was also possible to systematize the activity of scavenging, on the steps of knowledge, in order to encourage new possibilities to improve and value these subjects, so that they can get rid of this marginal condition.

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Appendix


THEORETICAL AND METHODOLOGICAL CONTRIBUTIONS OF THE KNOWLEDGE ECONOMY: The applicable "steps" in Brazilian recycling
SK1
SK2
Uilmer Rodrigues
Ricardo Alexandrino Garcia
SK3
SK4

BAYESIAN REGULARIZERS OF ARTIFICIAL NEURAL NETWORKS APPLIED TO THE RELIABILITY FORECAST OF INTERNAL COMBUSTION MACHINES IN THE SHORT-TERM.

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Abstract

Predictive as well as preventive maintenance are tools of maintenance programs that aim to increase or maintain the life expectancy of an equipment through computational techniques and tools. Bearing in mind that the power generation industry has a high maintenance rate with machines and / or electric generators stopped, this research aims to develop a computational model for predicting the Reliability Key Performance Indicator (KPI) to identify how available the equipment will be in a time span of 22 days, for this the methodology to be used will be based on analyzes and tests of artificial neural network (ANN) architectures using the Bayesian Regularizers training algorithm, alternating the transfer functions in the layers hidden to find the best state of convergence and the minimum Root Mean Square Error (RMSE) value calculated between the real and simulated outputs. According to the results obtained by the training, validation and test steps, the algorithm presented a RMSE rate of 0.0000104202 and a 99.9% correlation between the real and simulated values, thus the model is able to identify which machine will have the greatest efficiency and less efficiency within the defined time span.

Keywords: Reliability, RNA, Bayesian Regularizers, UTE;

1. Introduction

One of the elements that cause financial impacts in the sectors of commerce and industry is the maintenance of electric machines and / or generators (CORRÊA, 2020; SALLES *et. al.,* 2020; RUIZ-HERNÁNDEZ *et. al.,* 2020) that require large workforce for carrying out energy supply procedures and not having work breaks. Among the concerns of this sector, the supply of energy stands out (SÁNCHEZ *et. al.,* 2020), as occurs in companies of essential services such as hospitals, clinics and supermarkets causing eventual irreversible damage or even loss of life in the case of hospitals when there is a lack of energy supply (CHINI *et. al.,* 2020).

For this, the other types of maintenance become trivial to guarantee the functioning of the equipment, among which qualified professionals who adapt or adopt methodologies of different procedures to perform in the necessary environment (AGNESE, 2020) perform the methods of prevention, prediction and correction. One of the performance indicators used in maintenance management according to NBR-5462 is Reliability, which refers to the probability of proper functioning within a certain period of the elements involved in the production chain.

One of the methods used to identify faults in electric generators that includes internal combustion machines is the vibration analysis (ROCHA, *et. al.,* 2020; ZINGONI, 2020), the method consists of monitoring the target machine by defining the measurement ranges and parameters used for data collection. However, with the advancement of science and technology, computational tools gain space in these scenarios in order to optimize and improve the quality with which the processes are performed, but what stands out most in these procedures is the appropriate use of computational intelligence techniques (SOUZA, 2020; ABDULRAHMAN *et. al.,* 2020; BAROROH *et. al.,* 2020) to guarantee, through mathematical models disseminated in academia and science, the results presented by the tool.

With this, studies with Machine Learning, Deep Learning, Pattern Recognition, Data Processing, Pattern

Classification, Optimization Techniques (RIGHETTO, 2020; ABDULRAHMAN *et. al.,* 2020; BAROROH *et. al.,* 2020) and many others are growing as the demands for complexity in these scenarios increase. An example that contemplates the scenario of maintenance of machines with the use of AI (Artificial Intelligence) is the detection of failures (CARDOSO, 2020; ARUNTHAVANATHAN *et. al.,* 2020).

Therefore, the use of these elements becomes more evident and tends to raise the level of complexity according to the need that companies find to adapt these methods or tools to the scenario used and obtain satisfactory results. With this, the present research demonstrates a focus on the scenario of maintenance of machines when using the group of electric generators of Thermoelectric Power Plants as study object, the study and implementation of the Artificial Neural Network Technique for Prediction of the Group's Reliability Index of engines.

2 Literature Review

2.1 Predictive maintenance

Predictive maintenance (HAN *et. al.,* 2021; SILVA *et. al.,* 2019) becomes a necessary method since it is possible to prevent the stoppage of machines in a production process through indicators offered by monitoring systems, identify the small irregularities that can evolve to large failures early and thus allow for correction (AYVAZ and ALPAY, 2021; TIAN, LIU and SHU, 2021). Some methods for performing equipment-monitoring diagnostics are used in the literature (SCHWENDEMANN, AMJAD AND SIKORA, 2021; MANHERTZ and BERECZKY, 2021; LUGHOFER and SAYED-MOUCHAWEH, 2019), such as:

Vibration Analysis: Through analysis of machines excited by dynamic efforts, vibration sensors at defined points in the machine, the vibration registers are captured (FONSECA-JUNIOR *et. al.,* 2015). According to the extent to which the components of an equipment start to fail, the frequency and amplitude of vibration begin to change and with the analysis of the spectrum applied to the system it is possible to identify whether any component has its integrity compromised (MORO, 2020; YU, FENG and LIANG, 2021).

Thermography: This method is based on the detection of infrared radiation emitted naturally by bodies with temperature proportional to the intensity emitted from the equipment, with this, it is possible to identify regions or points where the temperature is altered and obtain information about the state of the machine (MEIßNER *et. al.,* 2021; LUGHOFER and SAYED-MOUCHAWEH, 2019; FONSECA-JUNIOR *et. al.,* 2015).

Cracks analysis: Uses magnetic particle test methods, deviate from their trajectory when finding a superficial or subsurface discontinued, this allows to identify points of non-conformity and apply the necessary repairs (CHEN *et. al.,* 2021; LUGHOFER and SAYED-MOUCHAWEH, 2019).

Thickness measurement: This method uses ultrasound as a non-destructive test, commonly used in industries to detect discontinuities in the entire volume of the material, the process consists of making the ultrasonic wave emitted by a transducer travel through the analyzed material, with this being verified the echoes received back, so it is possible to identify internal flaws or thicknesses (EL-ADAWY *et. al.,* 2021; LUGHOFER and SAYED-MOUCHAWEH, 2019).

2.2 Reliability in maintenance

According to NBR 5462, reliability is the possibility for an item, equipment, machine or system to perform its function within a certain period of time within a project, what is expected with the method is to analyze the degree of confidence of the equipment and with this determines metrics of use or maintenance techniques that act in the continuous improvement of the equipment (LU *et. al.,* 2021).

This measurement is commonly made based on a history of equipment performance and its estimate of future operation, which can be measured: Increased machine life, reduced maintenance costs, improved operational performance, agility and consistency of the teams techniques (ZOU *et. al.,* 2021; LUGHOFER and SAYED-MOUCHAWEH, 2019). The reliability parameter to be calculated from this historical observation can be expressed by equation 1:

$$\lambda_i^x = \frac{N_{fi}}{t_i^x . n} \tag{1}$$

Where N_{fi} is the number of failures before the i-th point of failure, t_i^x is the failure time of the ith point of failure for subsystem x, and n is the number of failures of the subsystem (BAI *et. al.,* 2020). The failure rate for each failure point of subsystem x can be expressed by equation 2:

$$\lambda^x = [\lambda_1^x, \lambda_2^x, \lambda_3^x \dots \lambda_i^x, \dots \lambda_{n-1}^x, \lambda_n^x]^t \tag{2}$$

For Bai et. al. (2020) in relation to fault investigation techniques, one of the most used is the bathtub curve, in which it is possible to analyze the equipment's useful life, a series of combinatorial radial basis functions for RBF are used to approximate functions complex or difficult calculations, expressed by equation 3.

$$\hat{y}(x) = \sum_{i=1}^{n} \beta_i f(\|x - x_i\|) = f(x)^T \beta \tag{3}$$

Where $\hat{y}(x)$ is the prediction response vector, x, β is the radial base coefficient vector β_i is the i-th component $\beta, f(x)$ is the RBF vector $f(\|x - x_i\|)$ is the i-th component of $f(x), r = \|x - x_i\|$ is the Euclidean distance between two vectors (LUGHOFER and SAYED-MOUCHAWEH, 2019; BAI *et. al.,* 2020). The same equation can be rewritten for the failure rate equation being expressed by equation 4:

$$\hat{\lambda}^x(t) = \sum_{i=1}^{n} \beta_i f(\|x - x_i\|) = f(x)^T \beta \tag{4}$$

Where $\hat{\lambda}^x(t)$ is the failure rate of subsystem x at time t. The unit's reliability is defined as its cumulative probability of success, thus the reliability function $R(t)$ is given by equation 5:

$$R(t) = \frac{n_s(t)}{n_s(t) + n_f(t)} = \frac{n_s(t)}{n_0} \tag{5}$$

The distribution function $F(t)$ is the complement of $R(t)$ expressed by equation 6:

$$R(t) = 1 - F(t) = 1 - \int_0^t f(u)du = \int_t^{+\infty} f(u)du \tag{6}$$

Thus, the reliability function indicates the probability that an item / equipment will be successful in its operation, characterized by the absence of failures in a period of time (LUGHOFER and SAYED-MOUCHAWEH, 2019; BAI *et. al.,* 2020). In order to measure reliability by means of probabilistic calculations, it is necessary to design a future scenario. However, it is necessary to have a survey of the average time between equipment failures, equipment failure rate and to know in advance what will be projected for the reliability calculation, in this case. if the number of projection days (SOLTANALI *et. al.,*

2021).

2.3 Bayesian regularizers in machine learning

The Bayesian inference can also be used to select the best structures or hypotheses $H = \{H_1, H_2, \dots, H_k\}$. According to Barbosa and Ferreira (2020) with the Bayes rule, the a posteriori probability distribution $p = (H_h|Y)$ of the H_h hypothesis is given by, expressed by equation 7:

$$p = (H_h|Y) = \frac{p = (H_h|Y)\ \mathrm{p}(H_h)}{p(Y)} \tag{7}$$

Where:

$p(Y)$ = is a normalization factor

H_h = a priori equiprobable;

$p(H_h|Y)$ = model evaluator

The a priori probability $p(Y)$ starts from the premise that weights should initially assume values close to zero in order to avoid training saturation in analogy to the normalization applied to the input and output signals (FERREIRA and BARBOSA, 2020; FERREIRA, DE SOUZA and DO COUTTO FILHO, 2020). To define a probability, let δ_k be the output of the k-th output neuron of the Multilayer Perceptron (MLP), the equation x represents the weights that connect the hidden layer neurons to the k-th output neuron, expressed by equation 8.

$$\delta_k = \emptyset_{saida}\left\{\sum_{j=1}^{m} \varpi_{kj}\phi_{oculta}\left(\sum_{i=1}^{n} w_{ji}x_i + b_j\right) + b_k\right\} \tag{8}$$

The bias of this neuron, $b_k \in \mathbb{R}$ o bias of the k-th output neuron, $\emptyset_{oculta}(.): \mathbb{R} \longrightarrow \mathbb{R}$ the sigmoidal function of activation of the neurons of the hidden layer and $\emptyset_{saida}(.): \mathbb{R} \longrightarrow \mathbb{R}$ the function of activation of neurons in the output layer. Thus, the vector $\underline{w} \in \mathbb{R}^m$, $\underline{w} = [\underline{w_s'}\ \underline{w_1'} \dots \underline{w_j'}\ b\ b_1 \dots b_j]^t$ training without the need for a validation set (FERREIRA and BARBOSA, 2020; FERREIRA, DE SOUZA and DO COUTTO FILHO, 2020).

The principle of maximizing the evidence applied to the parameters $\underline{w}$ giving rise to the functional $S(\underline{w})$ to be minimized for estimation of $\underline{w}$ applied the hypotheses $H = \{H_1, H_2, \dots, H_k\}$ to calculate ln $p = (H_h|Y)$ is also applied to the hyperparameters $\alpha_i\ e\ \beta$ giving rise to an iterative algorithm (LEOCÁDIO and FERREIRA, 2012). For Leocádio and Ferreira (2012) the Bayesian inference based on maximizing the evidence applied to the development of MLPs can be summarized by the algorithm:

Step 1: specify the minimum number (N_{min}) and the maximum number (N_{max}) of neurons in the hidden layer and make the number of neurons $m = N_{min}$;

Step 2: manipulate proof variables in a n-dimensional vector of inputs. In cases of binary inputs (n + 2), if they are continuous (n + 1);

Step 3: do l =0 and initialize $\underline{w}(l) = [\underline{w}_1(l), \dots, \underline{w}_{n+3}(l)]^t, \underline{\alpha}(l) = [\underline{\alpha}_1(l), \dots, \underline{\alpha}_{n+3}(l)]^t\ e\ \beta(l)$.

Step 4: Using error back propagation, minimize $s(\underline{w}) = \frac{\beta}{2}\sum_{j=1}^{n}[d_j - f(\underline{x}_j, \underline{w})]^2 + \frac{1}{2}\sum_{i=1}^{n+3}\alpha_i \sum_{l=1}^{M} w_{il}^2$ about $\underline{w}(l)$ to obtain $\underline{w}(l+1)$.

Step 5: Calculate $\alpha_i(l+1), \beta(l+1)\ e\ \gamma_i(l+1)$;

Step 6: Do l = l + 1 and return to step 4 until convergence. After convergence, proceed to the next step.

Step 7: Separate the hyperparameters $\alpha_1's$ related to continuous inputs and the hyperparameters $\alpha_j's$ into binary inputs into two subsets.

Step 8: For each list, select the entries with $\alpha_i < \alpha_{ref}$ represents the hyperparameter associated with the proof variable.

Step 9: Repeat steps 4 to 6 using only the entries selected in steps 8, with n answering for the number of entries selected to obtain the trained model H_m

Step 10: Calculate the logarithm of the evidence for the hypotheses (number of neurons in the hidden layer) H_m.

Step 11: If $m = N_{max}$ go to step 12, otherwise do m = m + 1 and return to step 2.

Step 12: select the hypothesis H_k with more evidence ln $p(\underline{Y}|H_h)$ to make the predictions.

Each RNA model has characteristics and purposes, it is worth noting that the use of these models depends on the architecture and the learning process that must be balanced with a training algorithm. Learning occurs when the neural network reaches a generalized solution to a class of problems (CABEZA *et. al.,* 2018). Among the ways to learn a neural network there are those that consist of: error correction, competition, Hebrew models and learning machines (ARABI BULAGHI *et. al.,* 2020).

However, this alone is not enough to have the best neural network model, this is due to the various nonlinear applications, the activation functions do this intuitively by creating learning models that relate dependent and independent variables. Some examples of the activation function are shown in table 1.

Table 1: Activation functions.

Initials	Function	Expression
Sigmoide	Sigmoide	$\sigma = \frac{1}{1+e^x}$
TanH	Hyperbolic Tangent	$tanh(x) = 2\sigma(2x) - 1$ $tanh'(x) = 1 - tanh^2(x)$
ReLU	Rectified Linear Unit	$ReLU(x) = \max\{0, x\}, sendo \begin{cases} 1, se\ x \geq 0 \\ 0, c.c \end{cases}$
ELU	Exponential Linear Unit	$ELU(x,\alpha) = \begin{cases} x, se\ x \geq 0 \\ \alpha(e^x - 1), se\ c.c \end{cases}$ $ELU'(x,\alpha) = \begin{cases} 1, se\ x \geq 0 \\ ELU(x,\alpha) + \alpha, se\ c.c \end{cases}$
Leaky ReLU	Leaked Rectified Linear Unit	$LeakyReLU(x,\alpha) = \max\{\alpha x, x\}$ $LeakyReLU'(x,\alpha) = \begin{cases} 1, se\ x \geq 0 \\ \alpha, se\ c.c \end{cases}$

Depending on the number of iterations that have been defined for a neural network, the combination of these methods can reduce the prediction time or increase if not used correctly.

3. Materials and methods

In order to carry out this research, it was necessary to use a database containing the main failures of a group

of internal combustion engines provided with vibration analysis in Thermoelectric Plants. The analysis period consists of January to December 2019, the data set includes date, time, downtime, system that failed, subsystem that was affected and description of the failure. Figure 1 illustrates a flow with the stages of development.

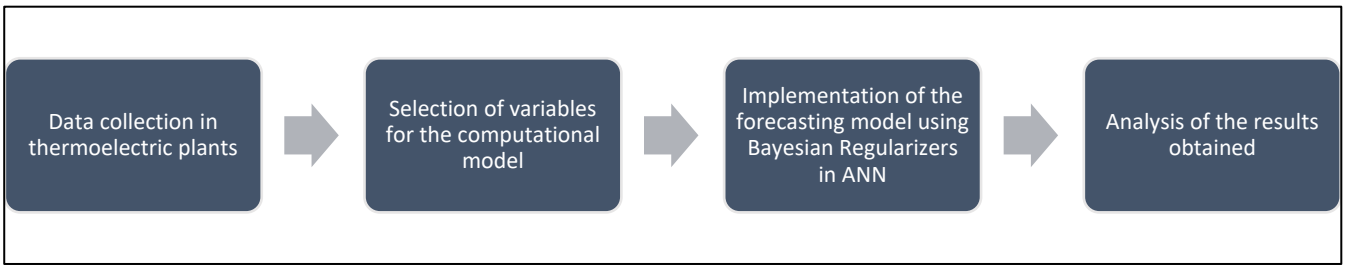

Figure 1: Development stages.

3.1 Step 1: Data collection in thermoelectric plants

For data collection, a survey of failures in internal combustion machines in thermoelectric plants was carried out in a period from January to December 2019. Table 2 shows the days analyzed during the period.

Table 2: Distribution of analyzes by month.

Month	Days analyzed	Operating hours
Janeiro	9	216
Fevereiro	26	624
Março	29	696
Abril	29	696
Maio	29	696
Junho	27	648
Julho	29	696
Agosto	27	648
Setembro	28	672
Outubro	21	504
Novembro	26	624
Dezembro	16	384
Total	**296**	**7104**

According to the analysis of the monthly samples they vary in an average of 24 days, where the hours of operation of the group of engines is given by equation 9:

$$HO = 24 * DA \quad (9)$$

Where:

HO = Hours of operation;

DA = Days analyzed;

24 = hours of the day;

The machines that were analyzed in that time are 4-stroke internal combustion engines, from Wartisila NSD

Corporation, model 18V46, with a nominal power of 15.75 MW, efficiency of 42.3%, length of 13.58m, width 5,347m, height of 5,488m and weight of 237 tons.

3.2 Step 2: Selection of variables for the computational model

The set of data provided by the vibration analysis allowed a table to be produced with the main variables that will be used in the forecasting model, where each one has importance and dependence for the calculation of Reliability, being:

1. **Total downtime**: total downtime of the machines per month;
2. **Total frequency**: number of occurrences of the machines per month;
3. **Days analyzed**: Number of days analyzed to provide failure data;
4. **Hours of operation**: total time of operation without considering failures;
5. **MTBF**: average time between failures;
6. **MTTR**: average repair time;
7. **Failure rate**: instantaneous failure rate within a period of time.

Finally, the **Reliability** output variable defined by a forecast time function to estimate this key performance indicator on a percentage scale.

3.3 Step 3: Implementation of the forecasting model using Bayesian Regularizers in ANN

For simulations of the computational model using the Bayesian Regularizers training algorithm in the learning process of the Neural Network, 5 input and 1 output variables were used. The network learning process is divided into 3 stages: training, validation and testing, where the data are separated by 70%, 15% and 15% respectively.

The machine that will generate the results provided by the simulations has the following configurations: 16GB of RAM, core i5 generation 10 processor with 2.50 GHz, 64-bit platform and 500GB SSD. Table 2 presents the configuration data of the neural network that were used to simulate the reliability of the motor group of the thermoelectric plants considering the Bayesian regularization.

Table 3: Configuration of the Bayesian model of RNA.

ALG	FC1	FC2	NC1	NC2	Epoch
Bayesian Regularization	Sigmoide	Sigmoide	24	50	24

Where:

ALG = Algorithm used;

FC1 = Layer 1 transfer function;

FC2 = Layer 2 transfer function;

NC1 = Number of neurons in layer 1;

NC2 = Number of neurons in layer 2;

Times = Number of iterations for the convergence of the algorithm;

MSE = Mean Square Error;

RMSE = Square Root of the Average Error

3.4 Step 4: Analysis of the results

The step for choosing the best configuration for the Bayesian regularization algorithm is an analysis of the lowest mean square error, where each network model is trained and a filter is made to identify the one with the lowest EMQ index. For each iteration performed, a network performance validation is performed, where a function is called that is responsible for simulating the network test result with the output vector, according to equation 10:

$$EQM = \sqrt{\frac{\sum_{i=1}^{n}(ra_i - rs_i)^2}{n}} \quad (10)$$

Where:
NDE = Mean Square Error;
n = number of elements of the output vector;
ra = target result;
rs = simulated result
Figure 2 illustrates the steps to obtain the best RNA model based on the minimum mean square error.

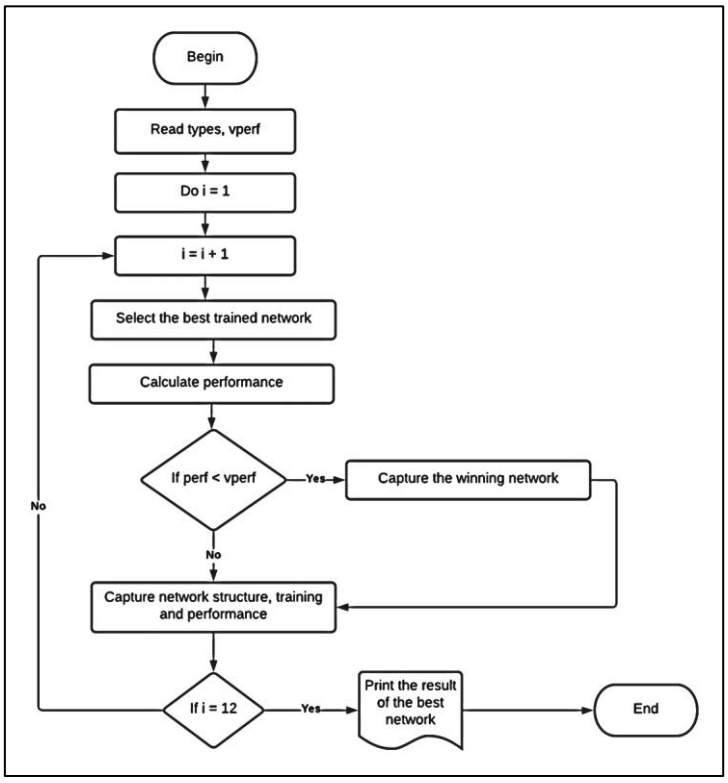

Figure 2: Best RNA selection algorithm.

For the evaluation of the winning Bayesian regularizer model, the configurations are alternated according to the need for neurons and the transfer function to escape the gradient explosion, thus obtaining better results of approximation of function.

4. Results and discussions

To find the data set necessary to feed the RNA input nxp matrix, some elements were pre-processed and the model was adjusted to a point where it was measurable, for example, in the case of considering an estimated assessment of the reliability of a group of 20 engines within a Thermoelectric Plant it was necessary to group the Total Downtime and the Total Frequency Time.

Table 4 presents the pre-processed data set for RNA in a period from January to December 2019, grouping the 20 TTP engines. These data are provided from the vibration analysis where the stop time calculation is performed for each equipment that failed, at the end of each month an accounting is made and grouped.

Table 4: TTP nxp array.

MOTOR	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
1	0,00	3,0	2,37	0,00	1,92	0,00	0,00	7,30	1,8	2,68	0,0	1,3	**20,32**
2	0,00	0,0	0,45	8,98	0,85	3,87	6,33	1,30	0,0	0,70	9,3	0,0	**31,78**
3	0,00	5,9	9,52	0,00	5,20	0,00	0,45	0,70	0,0	0,00	0,0	0,9	**22,60**
4	4,13	7,4	2,60	20,53	2,85	3,43	1,17	4,35	2,0	0,00	1,8	0,0	**50,18**
5	0,00	0,0	1,98	0,00	0,00	0,00	0,65	0,00	0,0	0,00	0,0	2,1	**4,75**
6	0,00	7,8	0,00	1,92	2,52	4,97	0,00	0,00	4,5	5,10	3,2	1,0	**30,98**
7	0,00	0,0	0,00	0,45	3,43	3,00	3,20	0,00	5,0	0,00	0,5	1,9	**17,35**
8	8,92	0,0	0,00	0,00	0,00	0,70	0,00	6,85	0,0	4,52	0,0	0,0	**20,98**
9	0,00	2,2	1,92	1,08	1,92	0,00	0,45	0,00	1,9	2,13	2,7	0,0	**14,18**
10	0,00	0,0	2,00	3,30	1,80	3,93	0,00	1,45	0,0	1,60	1,4	2,2	**17,75**
11	7,37	1,5	2,00	0,00	0,00	0,00	6,25	7,92	1,3	0,00	7,8	0,9	**35,05**
12	3,43	3,9	0,00	0,85	9,35	7,85	0,00	1,98	0,0	0,00	0,0	0,0	**27,32**
13	0,00	2,0	12,38	3,25	0,00	2,93	6,85	0,00	1,3	0,00	2,0	7,4	**38,10**
14	14,15	0,8	0,00	0,00	3,92	6,10	0,00	1,75	5,8	3,67	0,9	3,3	**40,27**
15	0,00	0,0	0,00	0,00	2,23	2,00	7,00	12,03	0,0	3,20	0,0	1,5	**28,00**
16	3,85	1,5	0,85	8,95	1,33	0,00	0,70	1,75	5,2	1,53	0,7	0,0	**26,33**
17	0,00	3,5	5,00	1,92	5,62	4,10	2,00	0,63	0,0	1,75	6,2	0,0	**30,70**
18	0,00	1,9	0,00	5,85	0,45	0,00	0,85	3,95	0,0	1,98	0,0	0,0	**14,93**
19	0,00	1,0	12,82	2,73	4,10	0,00	3,20	3,08	2,4	0,00	0,0	0,0	**29,32**
20	2,93	0,1	1,72	11,08	1,75	5,17	0,45	1,92	2,6	0,00	1,9	6,7	**36,30**

Table 5 shows the pre-processed set of TF for RNA for a period from January to December 2019, grouping the 20 engines. The set represents the amount of frequency that the equipment failed during the month being grouped by engine, while table 6 shows the total downtime on a decimal hour scale.

Table 5: TF nxp array.

MOTOR	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
1	0	1,0	2,00	0,00	1,00	0,00	0,00	2,00	1,0	2,00	0,0	1,0	**10**
2	0	0,0	1,00	3,00	1,00	3,00	4,00	1,00	0,0	1,00	3,0	0,0	**17**
3	0	2,0	2,00	0,00	2,00	0,00	1,00	1,00	0,0	0,00	0,0	1,0	**9**
4	1	2,0	2,00	3,00	2,00	2,00	1,00	3,00	1,0	0,00	1,0	0,0	**18**
5	0	0,0	1,00	0,00	0,00	0,00	1,00	0,00	0,0	0,00	0,0	2,0	**4**
6	0	3,0	0,00	1,00	2,00	4,00	0,00	0,00	3,0	2,00	1,0	1,0	**17**
7	0	0,0	0,00	1,00	2,00	3,00	0,00	0,00	2,0	0,00	1,0	1,0	**10**
8	1	0,0	0,00	0,00	0,00	1,00	0,00	1,00	0,0	1,00	0,0	0,0	**4**
9	0	2,0	1,00	2,00	1,00	0,00	1,00	0,00	1,0	1,00	2,0	0,0	**11**
10	0	0,0	2,00	2,00	3,00	3,00	0,00	1,00	0,0	2,00	1,0	1,0	**15**
11	2	1,0	1,00	0,00	0,00	0,00	3,00	2,00	1,0	0,00	4,0	1,0	**15**
12	3	1,0	0,00	1,00	3,00	4,00	0,00	1,00	0,0	0,00	0,0	0,0	**13**
13	0	2,0	2,00	1,00	0,00	2,00	1,00	0,00	1,0	0,00	1,0	5,0	**15**
14	1	1,0	0,00	0,00	2,00	2,00	0,00	1,00	2,0	3,00	1,0	1,0	**14**
15	0	0,0	0,00	0,00	1,00	1,00	3,00	4,00	0,0	1,00	0,0	1,0	**11**
16	1	1,0	1,00	2,00	2,00	0,00	1,00	1,00	2,0	1,00	1,0	0,0	**13**
17	0	2,0	2,00	1,00	3,00	1,00	1,00	1,00	0,0	2,00	4,0	0,0	**17**
18	0	1,0	0,00	2,00	1,00	0,00	1,00	2,00	0,0	1,00	0,0	0,0	**8**
19	0	1,0	2,00	2,00	1,00	0,00	1,00	2,00	1,0	0,00	0,0	0,0	**10**
20	1	1,0	2,00	3,00	1,00	2,00	1,00	1,00	2,0	0,00	1,0	2,0	**17**

4.1 Architecture, training and validation of Bayesian Regularization

Figure 3 illustrates the winning configuration for the RNA model with the Bayesian Regularization training algorithm.

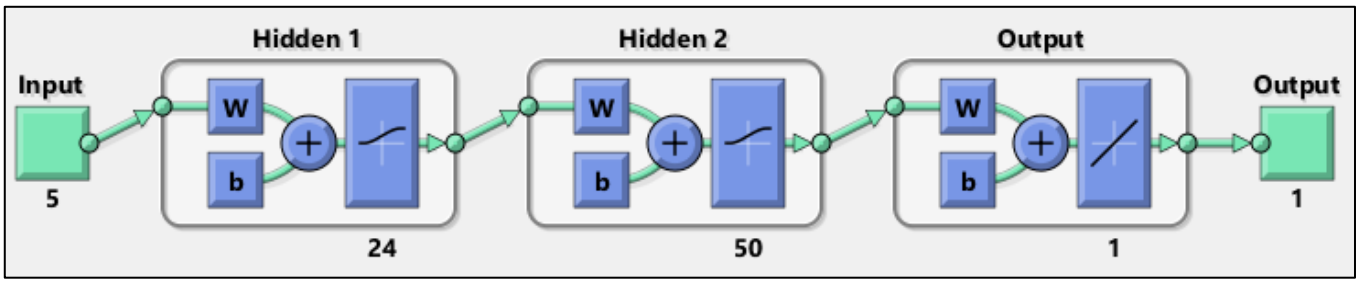

Figure 3: Winning RNA architecture.

It is worth noting that the input layer has 5 neurons referring to the input variables and 1 output neuron which refers to the Reliability forecast result. Table 6 shows the values obtained using the best RNA selection algorithm.

Table 6: Result of the best ANN using Bayesian Regularization.

FC1	FC2	NC1	NC2	Épocas	MSE	RMSE	MAPE
Sigmoide	Sigmoide	24	50	24	0.0000000001	0.0000104202	0.0000372952

According to the results of tests carried out, the winning network model obtained a rate of 0.0000104202 of RMSE and a configuration of 5 neurons in the input layer, 24 in the first intermediate layer, 50 in the second intermediate layer and 1 in the output layer, the it even reaches its state of convergence at the time 24 of 1000 using the Sigmoide transfer function in the input and intermediate layers. Figure 4 illustrates the best training performance of the network where the mean quadratic error obtained from the training step is 0.0000104202 or 1.029e-10.

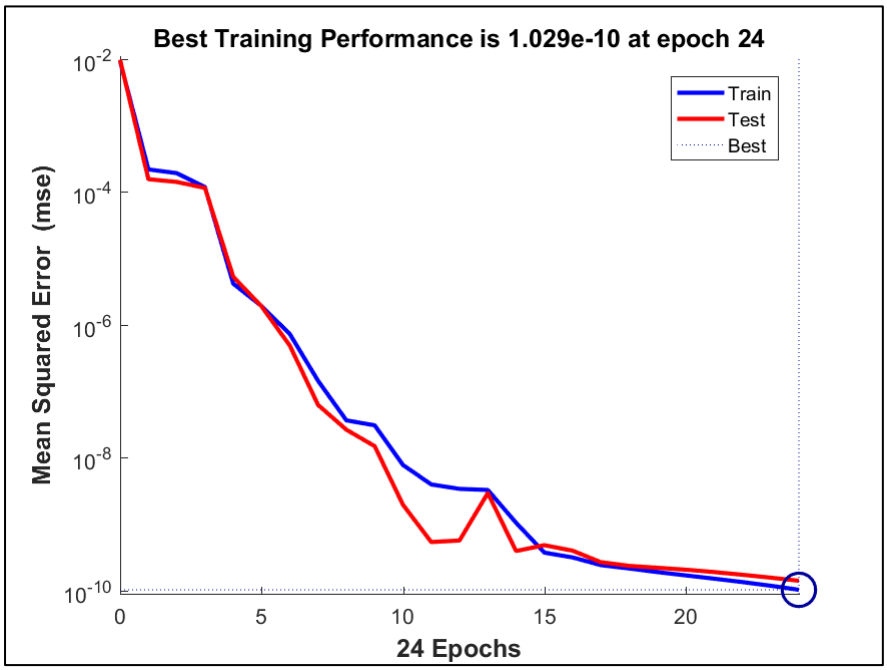

Figure 4: Graph of the best training performance.

To prove the effectiveness of the network through a statistical error analysis, figure x illustrates the error results from the smallest to the largest obtained through the training, test and validation steps, where the smallest error is achieved in the Zero Error marking line.

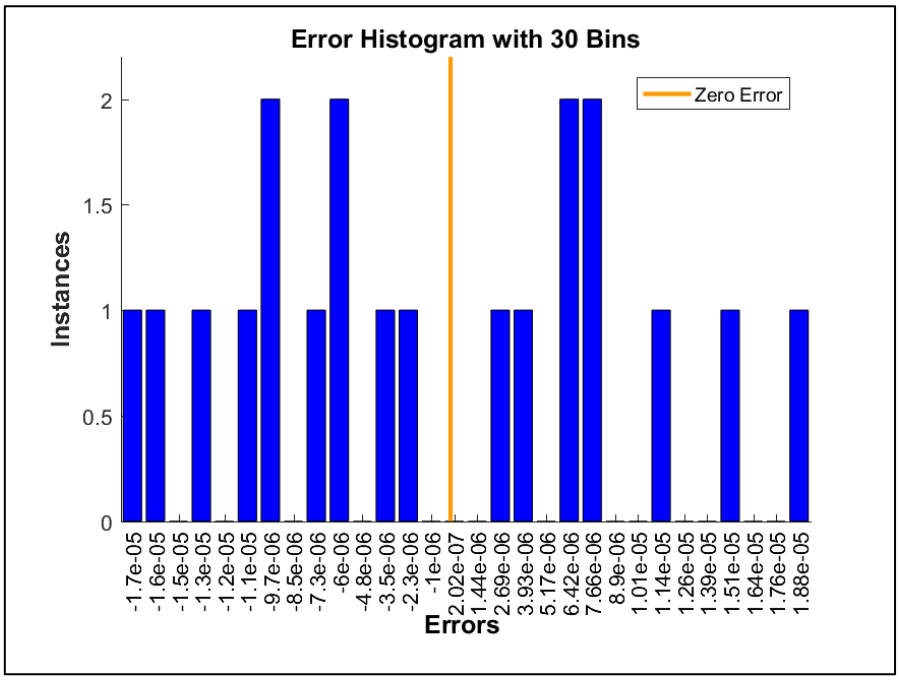

Figure 5: Histogram of error performance.

4.2 Network simulation applied to the engine group Reliability forecast

The simulation was performed by the numerical calculation software known as MatLab 2016a where it was possible to simulate the real data and then compare it with the simulated data from the network. Table 7 presents the results obtained from the calculated model.

Table 7: Calculated Model Results.

Motor	Calculated reliability %	Calculated failure %
1	24,70140556	75,29859444
2	24,72584755	75,27415245
3	24,69794165	75,30205835
4	24,72949717	75,27050283
5	24,68052799	75,31947201
6	24,72562121	75,27437879
7	24,70145604	75,29854396
8	24,68055314	75,31944686
9	24,70488315	75,29511685
10	24,71875172	75,28124828
11	24,71877582	75,28122418
12	24,71193255	75,28806745
13	24,71884821	75,28115179
14	24,71544435	75,28455565
15	24,70499279	75,29500721

16	24,71188414	75,28811586
17	24,72579987	75,27420013
18	24,69449831	75,30550169
19	24,70138317	75,29861683
20	24,72582587	75,27417413

The simulation was carried out with the previously validated configurations of the Bayesian Regularization algorithm to predict the probability of operation of the motor group in a time span of 22 days. Table 8 presents the relative data of predicted reliability and predicted failure.

Table 8: Results of the Predicted Model.

Motor	Expected reliability %	Predicted failure %
1	24,70140556	75,29859444
2	24,72584755	75,27415245
3	24,69794165	75,30205835
4	24,72949717	75,27050283
5	24,68052799	75,31947201
6	24,72562121	75,27437879
7	24,70145604	75,29854396
8	24,68055314	75,31944686
9	24,70488315	75,29511685
10	24,71875172	75,28124828
11	24,71877582	75,28122418
12	24,71193255	75,28806745
13	24,71884821	75,28115179
14	24,71544435	75,28455565
15	24,70499279	75,29500721
16	24,71188414	75,28811586
17	24,72579987	75,27420013
18	24,69449831	75,30550169
19	24,70138317	75,29861683
20	24,72582587	75,27417413

According to figure 6, it is possible to compare the calculated and predicted models where the correlation between them is given by 0.0000104202 of mean square error and 99.9% correlation. According to the results obtained from the predicted model, the engine with the highest failure rate is number 4 with 75.28% and the engine with the lowest failure rate is number 5 with a rate of 75.32 %.

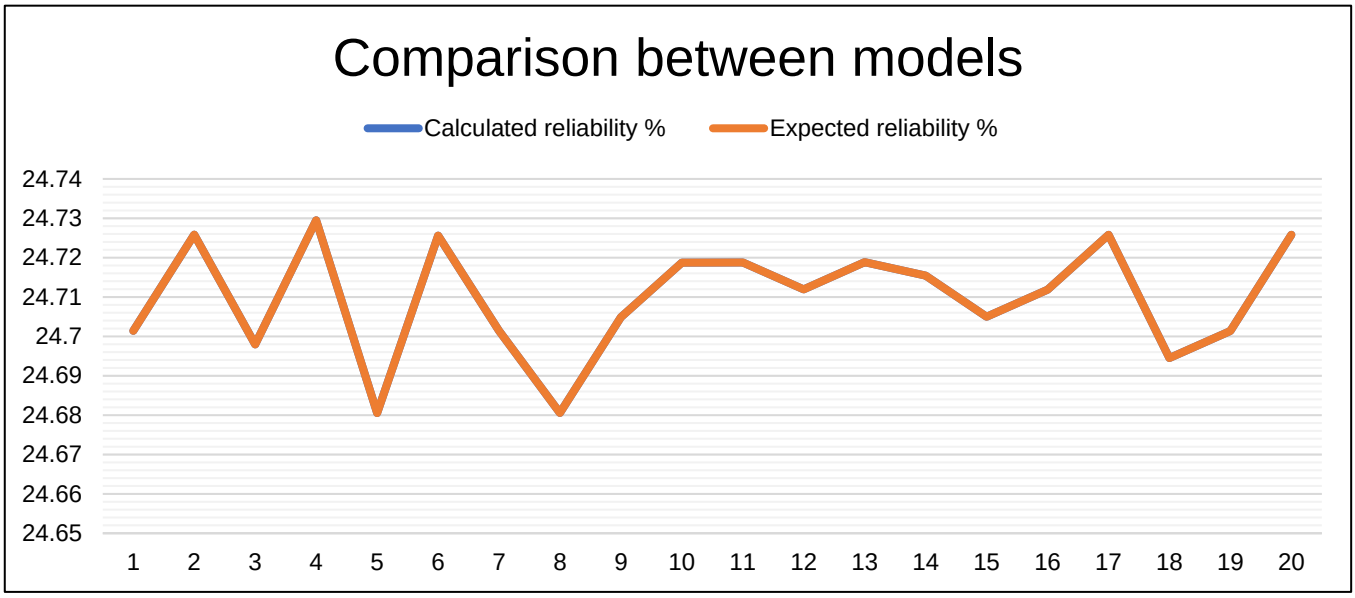

Figure 6: Comparative chart between models.

5. Conclusion

During the research it was possible to identify new research possibilities, considering that in addition to the variables raised (Total Downtime, Total Frequency, Total Occurrences, Average Time Between Failures, Failure Rate, Total Days and Reliability) for the model could be added to increase the consistency and accuracy of the network.

With this, new methodologies can be applied as is the case with Self-Organizing Maps (SOM) for classification of patterns, in this way, it would be possible to determine fault characteristics and determine the probability of new events, or even the use of the supervised approach. considering other fault identification characteristics.

Among the models of RNA architectures applied for prediction and analysis of the reliability KPI, the Bayesian Regularizers with the configurations of 5 neurons in the input layer, 24 in the first hidden layer, proved to be able and accurate to work with the proposed data. 50 in the second hidden layer and 1 in the output layer, presenting a rate of 0.0000104202 of RMSE, accurately estimating the reliability of the motor group. When comparing the results between the calculated and predicted models, it is possible to identify the similarity in the 22-day projection, according to the predicted model, it was possible to achieve a 99.9% hit rate.

6. Acknowledgement

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Safety profile, antimicrobial and antibiofilm activities of a nanostructured lipid carrier containing oil and butter from *Astrocaryum vulgare: in vitro* studies

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Abstract

Ethnopharmacological relevance: *Tucumã (Astrocaryum vulgare)is a fruit native to the Amazon region. Extracts from the peel and pulp are thought of as promising treatments for bacterial infections. The primary constituents of Tucumã oil and butter possess unsaturated carbon chains that are susceptible to oxidation by light or heat. The oils have high volatility and low aqueous solubility that limits their use without a vehicle. Nanotechnology refers to techniques to solve these problems. Nanostructured lipid carriers (NLC), for example, protect fixed oils degradation by heat or light, as well as from oxidation and evaporation, ensuring greater stability and function, thereby prolonging the useful life of the final product.* ***Study objectives:*** *The objective of this study was to evaluate the hemolytic, cytotoxic, antimicrobial and antibiofilm properties of an NLC containing Tucumã butter and oil soasto improve the solubility and photosensitivity of the compounds, generating better pharmacological efficacy.* ***Materials and methods:*** *The NLC was assessed for stability for 60 days. The cytotoxicity of nanoparticles in peripheral blood mononucleated cells was determined in culture using assays for cell viability, DNA damage, oxidative metabolism and damage to human erythrocytes. Antimicrobial activity was determined using the broth microdilution technique and antibiofilm activity according to standardized protocols.* ***Results:*** *The Tucumã NLC remained stable throughout the evaluated period, with pH between 5.22–5.35, monodisperse distribution (PDI<0.3) and average particle size of 170.7 ± 3nm. Cytotoxicity studies revealed that the NLC is safe and modulates inflammatory processes, demonstrated by increased cell viability and nitric oxide levels. There was low hemolytic activity of the NLC against human erythrocytes atmost concentrations*

tested. ***Conclusion:*** *Taken together, the data suggest that NLC containing Tucumã oil and butter showed antimicrobial and antibiofilm activity against organisms that cause morbidity and mortality in humans. They may be alternative solutions to public health problems related to bacterial infections.*

Keywords: Microorganisms; Infections; Nanoparticles; Tucumã.

1. Introduction

Bacterial infections are one of the main causes of chronic diseases and mortality, causing economic losses for patients and public health systems. Each year in the United States, at least 2.8 million people are infected with antibiotic-resistant bacteria, with at least 35,000 deaths (CDC, 2019). Based on the incidence of antibiotic-resistant infections in 2014, each infection would cost $ 1,383 to be properly treated, resulting in national health care costs for the adult population of approximately 2.8 billion per year (CDC, 2019). Antibiotics have been the preferred treatment method because antimicrobial agents kill microorganisms or stop their growth. Nevertheless, several studies have provided direct evidence that the widespread use of antibiotics leads to the emergence of multidrug-resistant bacterial strains (KNETSCH and KOOLE, 2011; PORSE et al., 2020), now considered a significant health problem worldwide (TARSILLO and PRIEFER, 2020).

Antibacterial agents based on herbal products have aroused growing interest because of their technological, economic, nutritional, and bactericidal activities(SUTILLI et al., 2018; JOSHI, 2018).These herbs include Tucumã (*Astrocaryum vulgare*) (HOVORKOVÁ et al., 2018),a fruit native to the Amazon region that is widely used as an anti-inflammatory and antioxidant (BONY et al., 2012).Recent studies have revealed its potential use as a hypoglycemic and antioxidant in a model of diabetes induced by alloxan (BALDISSERA et al., 2017). In the particular interest of the present study, Hovorková et al. (2018) studied the antibacterial activity of Tucumã against gram-positive and commensal pathogenic bacteria in the intestine, revealing that Tucumã is a promising herbal product for use as an antibacterial agent. Jobim et al. (2014) tested extracts of pulp and bark from Tucumã (*Astrocaryum aculeatum*) against 37 microorganisms and found significant antibacterial activity against three important gram-positive bacteria and antifungal activity against *C. albicans*. The antimicrobial mechanism of action of Tucumã appeared to involve redox imbalance that interrupts the growth of microorganisms and/or causes increased mortality. This effect has some specificity for each microorganism involving the role of different chemical compounds found in Tucumã extracts.

Even with good biological activity, oils in generation can undergo oxidation, with consequent loss of biological function. In this context, nanotechnology may provide an important alternative, because substances on the nanometer scale have different properties from those on the macrometric scale (FREIRE et al., 2018). In addition, nanoparticles (NPs) increase the retention of a drug in the particle, increasing the release time and controlling the release of the molecule. Nanostructured lipid carriers (NLC) protect fixed oils against degradation by heat and light, oxidation and evaporation, ensuring greater stability and function, consequently prolonging the useful life of the final product (PIRAN et al., 2017). We believe that nanotechnology can improve the antimicrobial activity of Tucumã oil and prevent its activity from being

reduced.

Most antimicrobial resistance mechanisms are irrelevant to NPs, because NPs are in direct contact with the bacterial cell wall, without the need to penetrate the cell. This shows that NPs are less likely to promote resistance in bacteria than are antibiotics. In addition, in view of the serious health concern associated with antimicrobial resistance, new approaches to inhibit microbial growth and the biofilms formed by them have been studied. The usefulness of nanomaterials for the efficient administration of antibacterials and the development of anti-biofilm agents is a promising strategy to overcome the resistance of microorganisms to antimicrobials (LOPES et al., 2019; WANG et al., 2017).

2. Materials and methods

2.1 Acquisition of Tucumã oil and butter

Tucumã oil and butter were purchased commercially from Amazon oil Industry - (Pará, Brazil).

2.1.1 Characterization of Tucumã oil and butter

The oil was previously characterized by Baldissera et al. (2017) using the gas chromatography method. The major components were oleic (368.7 mg/g) and palmitic acid (198.23 mg/g).

Tucumã butter was characterized using the method of Hartman and Lago (1973). A total of 20 mg of lipids from 1 mL of 0.4 M KOH methanolic solution were added in a test tube and vortexed for 1 min. The samples were kept in a water bath for 10 minutes at the boiling point and subsequently cooled to room temperature. Then, 3 mL of1 M H_2SO_4 methanolic solution were added and vortexed and kept in a water bath for 10 min. After cooling, 2 ml of hexane was added and centrifuged at 1050*g* for 5 min. Finally, the hexane with the fatty acid methyl esters (FAME) was subjected to chromatographic analysis. For FAME determination, a gas chromatograph model 3400CX was equipped with a flame ionization detector (Varian, Palo Alto, CA). A microliter of samples was injected into an injector without division, operated in split mode (20:1) at 250 °C. Hydrogen was used as a carrier gas at a constant pressure of 30 psi. The FAMEs were separated using an HP-88 chromatography column (100 m × 0.25 mm × 0.20 μm thick film, Agilent, J & W, Folson, CA, USA). The initial oven temperature was programmed at 50 °C for 1 min and increased to 185 °C, at a rate of 15 °C/min. Then, increasing to 195 °C, at a rate of 0.5 °C/min, and finally up to 230 °C, increasing by 15 °C/min, and maintained for 5 min at isothermal. The detector temperature was kept constant at 250 °C. FAME compounds were identified by comparing the experimental retention time with those of the authentic standard (FAME Mix-37, Sigma Aldrich, St. Louis, MO). The results were presented as a percentage of each FA identified in the lipid fraction, considering the equivalent factor of the chain size from FAME to FID and the conversion factor of the ester in the respective acid, according to Visentainer and Franco (2006).

2.2 Preparation and characterization of the Nanostructured Lipid Carrier

The NLC containing the Tucumã oil and butter was prepared using a method developed by pre-formulation tests using Ultra Turrax® equipment and characterized according to pH, polydispersion index (PDI), size and zeta potential. The diameter and PDI determinations of the nanoparticles were carried out through

dynamic light scattering; the zeta potential was measured using electrophoresis (Zetasizer® nano-Zs model ZEN 3600, Malvern), the determination of the pH of the nanoparticles was performed in pH-meter. The formulation was prepared at n = 3 and maintained under various temperature and storage conditions (refrigerator at 28ºC, oven at 40ºC, room temperature with exposure to light and room temperature in a dark place) over60 days.

2.3 Biocompatibility Parameters

2.3.1 Hemolytic activity

The hemolytic assay was determined according to Souza Filho et al. (2019) with modifications. Blood was added with 1x PBS solution (1:1 v/v) and centrifuged for 15 minutes at 168*g*. The supernatants were discarded, and this procedure was repeated three times. Subsequently, in microtubes containing 1mL of 1x PBS at different pHs (pH 7.2 simulating cases of sepsis due to metabolic acidosis; pH 7.4 simulating the normal pH of the organism and pH 7.5 simulating alkalemia), 50µL of red blood cells were added washed and 10µL were taken. As controls, we used the following: negative control (NC) (erythrocytes + 0.9% sodium chloride); positive control (PC) (erythrocytes + distilled water); surfactants (TS) (erythrocytes + mixture of surfactants, Tween® 60 + Spam 60®, in the same concentrations as treatments with NLC). The tubes were incubated at 37 °C at room temperature, under rotation, for 1 hour. After the microtubes were centrifuged for 15 minutes at 168*g*, 200µL of the supernatants were transferred to 96-well plates and were read in the ELISA reader at 540nm. The results were expressed as a percentage of the positive control.

2.3.2 Coagulation test

This assay was performed according to Souza Filho et al. (2019). Whole blood was collected in citrate tubes and centrifuged for 10 minutes at 1050*g.* Then, 225 µL of plasma were separated into wells along with 25 µL of NLC treatments and incubated at 37 °C for 30 minutes. Two independent experiments were carried out in duplicate with different donors. Subsequently, a properly calibrated Quick Timer II (Drake) coagulometer was read, according to the manufacturer's recommendations for tests for TP hemostasis (Labtest - lot: 4008) and TTPa hemostasis (Labtest - lot: 4006). As a reference we used the interval between 25 and 35 seconds for the normal value of TTPa, while the baseline values of TP used the interval between 11 and 15 seconds, according to authors (SALVADOR-MORALES et al., 2009; ADAMSON et al., 1993).

2.4 Cytotoxicity evaluation

2.4.1 Cell culture and treatments

Peripheral blood mononuclear cells (PBMCs) derived from whole blood samples discarded from healthy adults were obtained from the Clinical Analysis Laboratory of the Franciscan University (LEAC-UFN) (experimental protocol approved by the UFN Ethics Committee on Human Beings) (CAAE número: 31211214.4.0000.5306) with absence of identification data.

Blood samples were processed for PBMC separation using procedure based on the difference in density gradient using the Ficoll Histopaque-1077VR reagent (Sigma-Aldrich). After the blood was disposed of in the reagent (1:1 v/v), the samples were centrifuged for 30 minutes at room temperature. PBMCs were distributed in 96-well plates containing RPMI 1640 cell medium (Sigma-Aldrich) containing 10% fetal

bovine serum and supplemented with 1% antibiotics. The cells were grown at $2x10^5$cells ml^{-1}per well (BOTTON et al. 2015). Then, the cells were exposed to each compound tested for the efficacy protocol described in this research, in the same concentrations for 24 h, to evaluate its effect on cell modulation through different colorimetric and fluorometric assays. All treatments and trials were carried out in at least triplicate to ensure coherent statistical analysis; hydrogen peroxide (H_2O_2) at 200 µM was used as a positive control for all tests.

2.4.2 Cell viability measurements

After the treatment period, cell viability was assessed. The first assay performed was MTT (3-(4,5-dimethylthiazol-2yl)-2,5-diphenyl tetrazoline bromide) using the protocol according to Mossman (1983), when completing the incubation time of the cells with the treatment were 20µL of the MTT solution (0.01M and pH 7.4) was added at a concentration of 5mg/mL diluted in PBS (1X phosphate buffer). The plates that received the MTT solution were protected from light and kept at 37 °C, in an oven with 5% CO_2, which was homogenized and incubated for 2 h. After incubation, the supernatants were removed from the wells and the cells resuspended in 150µL of dimethyl sulfoxide (DMSO). Absorbance was determined in an ELISA reader at 560nm.

The determination of cell viability was complemented by the quantification of free DNA in the medium using the DNA-PicoGreen® reagent (Invitrogen, Life Technologies). DNA-PicoGreen® reagent was incubated for 5 min together with the sample dark 96-well plates, and fluorescence reading was performed on the spectrofluorometer at 480nm (excitation) and 520nm (emission) (SAGRILLO et al., 2015).

2.4.3 Quantification of total levels of reactive oxygen species

The total ROS levels were measured by fluorescence according to the technique described by Esposti (2002) using wavelengths of 488 nm (excitation) and 525 nm (emission). The results were expressed as% of the negative control.

2.4.4 Determination of nitric oxide (NO) levels

NO levels were measured according to the technique described by Choi et al. (2012). For this, 50µL of cell culture supernatant and 50µL of Griess reagent were added to96-well plates. The plates were maintained at room temperature for 15 min and the reading was performed spectrophotometrically at 540nm. The results were expressed in percentages in relation to the negative control.

2.5 Evaluation of the antimicrobial activity of the Nanostructured Lipid Carrier

The sensitivity tests for determining the minimum inhibitory concentration (MIC) of the different microorganisms tested were determined using the broth microdilution method according to the protocol M07-A8 approved by the *Clinical and Laboratory Standards Institute* (CLSI).

The bacterial strains of *Klebsiella pneumoniae, Escherichia coli, Proteus mirabilis, Staphylococcus aureus, Staphylococcus epidermidis, Streptococcus agalactiae, Streptococcus mutans, Enterococcus faecalis* and methicillin-resistant *Staphylococcus aureus* (MRSA) used in this study are clinical isolates from inmates at the Santa Maria University Hospital who were previously identified by gender-specific phenotypic

methods. These microorganisms are part of the collection of strains of the Microbiology Laboratory of the Franciscan University, Santa Maria - RS. The strains of *Aeromonas hydrophila* and *Pseudomonas aeruginosa* were provided by the Microbiology and Pathology Laboratory of the Federal University of Santa Maria - UFSM, Santa Maria - RS, Brazil.

MIC was determined to assess the NLC's antimicrobial activity against the microorganisms tested. In this sense, the bacterial samples were cultured on Mueller–Hinton agar (MH), and the colonies were inoculated in 5 mL of sterile saline, the absorbance was controlled until a transmittance of 0.5 was obtained on the MacFarland scale (1 x $10^6$to 5 x 10^6cellsper mL), then a 1:10 dilution in MH broth was performed resulting in a concentration of 10^4cells per mL.

After inoculum preparation, MIC was performed in 96-well polystyrene plates. The tests were performed in triplicate where, first, 100µL of MH broth were distributed in each well. A 100µL aliquot of the NLC solution containing Tucumã butter and oil was added to the first well and, after homogenization, transferred to the second, and so on until the twelfth well. Once the serial dilutions were made, the following dilutions were obtained: 25000, 12500, 6250, 3125, 1562.5, 781.25, 390.6, 195.3, 97.65, 48.8,24.41, and 12.2µg/mL.Soon after, the microorganisms were inoculated, where 10 µL of the standardized inoculum was then added to each well of the microdilution plate. After pipetting, the plates were incubated at 37 ºC for 48 h. The plates were read by adding 20µL of a 1% solution of the 2,3,5-triphenyl tetrazolium chloride dye (Vetec®), in order to assist in the MIC development. As a negative control (-) three wells were used with the MH broth and, as a positive control (+), three wells were used with the MH broth and the bacterial inoculum and as a surfactant control (TS) three wells with a mixture of surfactants, Tween® 60 + Spam 60®, in the same concentrations as NLC treatments.

2.6 Interference of the Nanostructured Lipid Carrier in the formation of biofilm

To assess the interference capacity of the NLC on the biofilm in formation of *K. pneumoniae, E.coli, P. aeruginosa, S.aureus, S. epidermidis*, *S.agalactiae*, methicillin-resistant *S.aureus* (MRSA) and *A.hydrophila*, one amount of each bacterial isolate was cultured in sterile petri dishes with MH Agar and incubated at 37ºC for 24 h. Then the colonies were suspended in sterile 0.85% saline to prepare the inoculum. Cell density was adjusted in a spectrophotometer in order to obtain a transmittance equivalent to the 0.5 tube on the McFarland scale(1 x 10^6 a 5 x 10^6 cells/mL) at a wavelength of 630nm.

In 96-well plates of sterile polystyrene, 90µL of brain–heart infusion (BHI) broth supplemented with 1% glucose was added and then 20µL of the inoculum of each microorganism in each well and 90µL of the NLC solution were dispensed to test the antibiofilm activity of the nanoparticles. For the negative control, only broth was added, and for the positive control, the culture medium plus the solution containing the microorganisms was added. For the surfactant control (TS), the medium and the mixture of surfactants, Tween® 60 + Spam, was added. 60®, in the same concentrations as NLC treatments. After pipetting, the plates were incubated at 37ºC for 48 h. After this period, the samples were washed with 200µL of distilled water, three times. Then, the biofilm was fixed with 150µL of methane for 20min, after the plates were emptied and the wells were stained with 150µL of gentian violet for 15min and again washed with 200µL of distilled water. Subsequently, 150µL of 95% ethanol was added to dilute the crystals. Finally, the OD (optical density) was determined in a microplate reader, measured at 570nm (STEPANOVI et al. 2007).

2.7 Statistical analysis

The results of hemolysis and cytotoxicity were presented as a percentage of the untreated control group (negative control). The analyses were performed using one-way bilateral analysis of variance (ANOVA) followed by Dunnett's post hoc test. Values with $p < 0.05$ were considered statistically significant. The data were expressed as mean ± standard deviation. The graphs were prepared using GraphPadPrism version 5.01 (GraphPad Software, La Jolla, CA, USA).

The OD readings obtained in the biofilm formation assay were recorded as mean ± standard deviation (SD) and bilateral one-way ANOVA followed by Dunnett's post hoc test. Values with $p < 0.05$ were considered statistically significant. The graphs were prepared using GraphPadPrism version 5.01 (GraphPad Software, La Jolla, CA, USA).

3. Results

3.1 Characterization of Tucumã butter

The determination of the concentration of fatty acids is shown in Table 1. The analysis of Tucumã butter by gas chromatography identified 12 fatty acids, the majority of which was lauric acid (41.95 mg/g), myristic acid (28.08 mg/g) and oleic acid (10.07 mg/g).

Table 1. Determination of fatty acid composition in tucumã butter (*Astrocaryum vulgare*) by gas chromatography.

Fattyacid	mg of fatty acid/g of tucumã butter
Ácido capróico (C6:0)	0,07
Ácido caprílico (C8:0)	1,77
Ácido cáprico (C10:0)	1,89
Ácido undecanóico (C11:0)	0,07
Ácido láurico (C12:0)	41,94
Ácido isomerístico (C13:0)	0,10
Ácido mirístico (C14:0)	28,3
Ácido palmítico (C16:0)	9,03
Ácido esteárico (C18:0)	2,55
Ácido oléico (C18:1cis)	10,07
Ácido linoléico (C18:2cis)	2,64
Ácido γ-linolênico (C18:3n6)	0,03

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3.2 Preparation and characterization of the Nanostructured Lipid Carrier

The prepared formulation had a monodispersed distribution of particles showing PDI value of 0.256 ± 2, average size of 170.7 ± 3nm, zeta potential of -18.2 ± 2 and pH of 5.22–5.35. When evaluating the NLC formulations under various conditions of temperature and storage, there were no significant changes in the stability of the formulations over 60 days in any of the conditions of storage and temperature that they were

exposed to. The formulations stored in the refrigerator at -4ºC, showed a PDI value of 0.252 ± 2, average size of 168.9 ± 3nm, zeta potential of -18.8 ± 2 and pH of 5.32–5.55. The formulations stored in an oven at 40ºC showed a PDI value of 0.255 ± 2, an average size of 165.9 ± 3nm, zeta potential of -18.6 ± 2 and pH of 5.42–5.53. When stored at room temperature in a dark environment, the formulations showed a PDI value of 0.257 ± 2, average size of 171.3 ± 3nm, zeta potential of -18.4 ± 2 and pH of 5.37–5.43.In a clear environment, PDI value was0.254 ± 2, average size was171.8 ± 3nm, zeta potential was-18.0 ± 2 and pH was5.39–5.45.The formulations maintained in a clear environment and at room temperature underwent a color change.

3.3 Biocompatibility Parameters

3.3.1 Hemolytic activity

Hemolytic activity was significantly higher in the treatment with 12500 µg/mL NLC with pH 7.2 (acidosis) compared to the NC group, while it was significantly higher in the treatment with 25000 µg/mL NLC with pH 7.4 (physiological) compared to the NC group. There was no significant difference between groups treated with NLC in relation to hemolytic activity at pH 7.5 (alkalosis) (Figure 1).

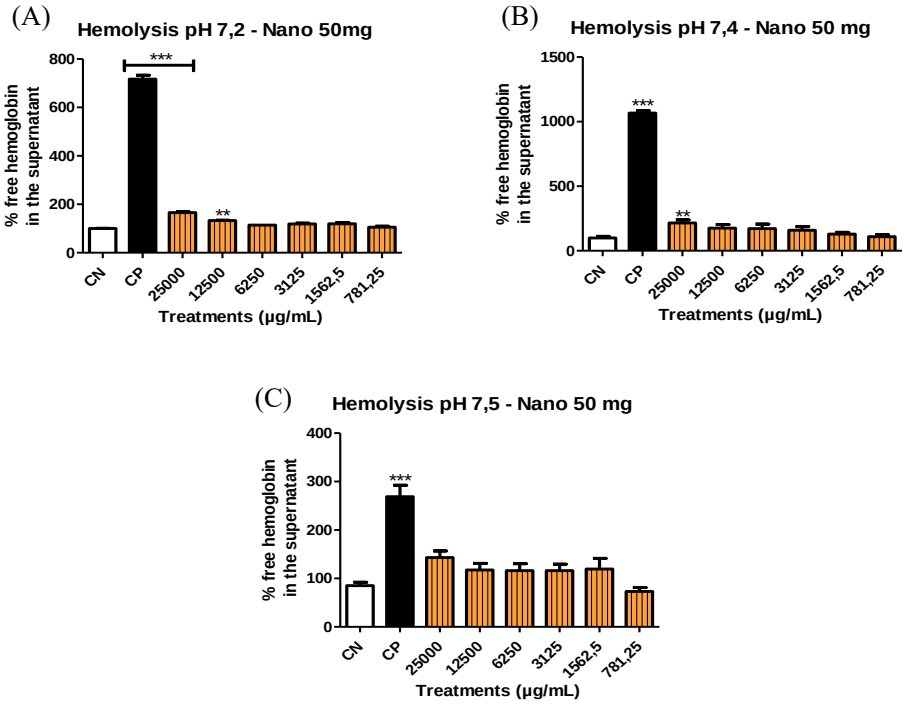

Figure 1. Results of hemolysis at different concentrations of the Nanostructured Lipid Carrier (NLC) at different pHs. (A) Results of hemolysis at pH 7.2 simulating cases of metabolic acidosis. (B) Hemolysis results at pH 7.4 simulating cases of physiological pH. (C) Hemolysis results at pH 7.5 simulating cases of metabolic alkalosis. Note: Results expressed as a percentage of positive control (100%). Values with p <0.05 were considered statistically significant.

3.3.2 Coagulation test

The results of the coagulation tests are related to the type and concentration of treatments, as can be seen in Figure 2A (TP) and 2B (TTPa). Where for the TP test there were no results outside the biological range.

In the TTPa test at treatment concentrations of 781.25 µg/mL and 12.2 µg/mL. The results were below the biological range.

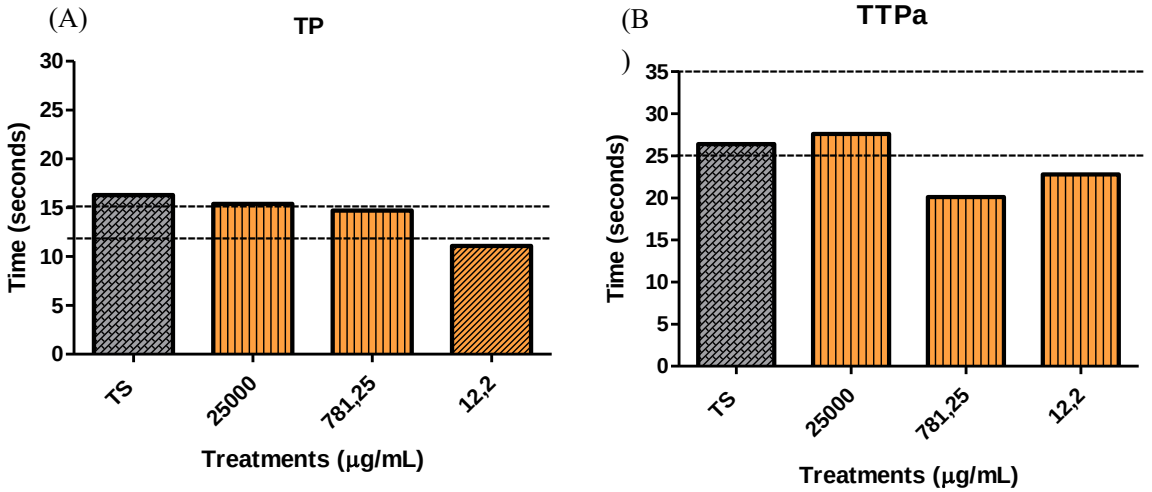

Figure 2. Results of coagulation tests at different concentrations of the Nanostructured Lipid Carrier (NLC). (A) prothrombin time (TP) results. (B) results from partially activated thromboplastin time (TTPa). The dotted limits correspond to the expected physiological times for healthy donors (between 12 and 15 seconds for PT and 25 and 35 seconds for TTPa). Values expressed as mean ± standard deviation (SD).

3.4 Cytotoxicity evaluation

3.4.1 Cell viability measurements

Cell viability was significantly higher in the treatment with 25000 µg/mL NLC than in the NC group (Figure 3A). Figure 3B shows the results for detecting double-stranded DNA damage in the cell culture supernatant, where no DNA damage was observed in any of the tested concentrations.

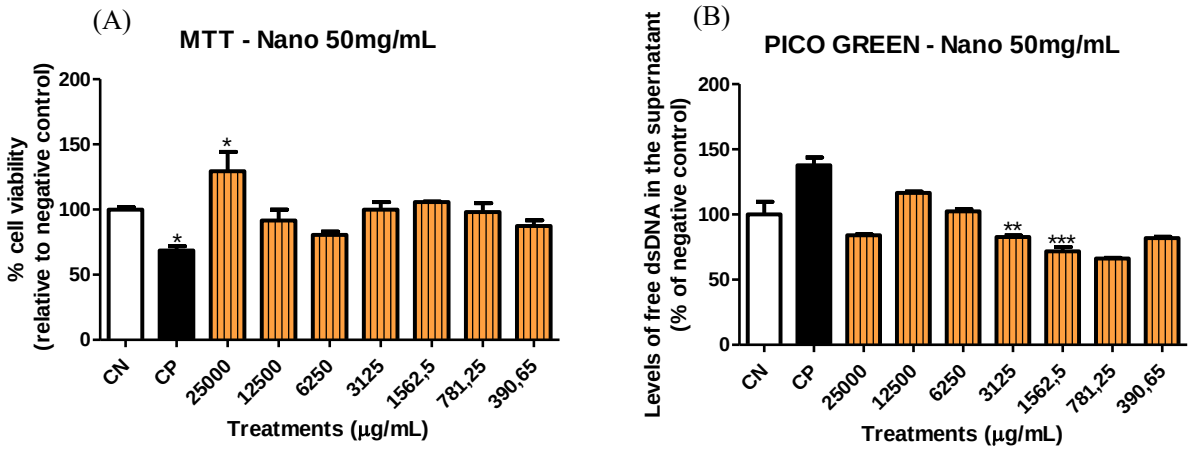

Figure 3. (A) MTT assay (3-(4,5-dimethylthiazol-2yl)-2,5-diphenyl tetrazoline bromide) after 24h incubation. (B) Quantification quantity of free dsDNA after 24h of treatment. The data are presented as% of the untreated control group (CN). Values with $p < 0.05$ were considered statistically significant.

3.4.2 Quantification of total levels of reactive oxygen species

Treatments with 6250 µg/mL and 3125 µg/mL NLC showed a significant increase in DCF production compared to the NC group (Figure 4).

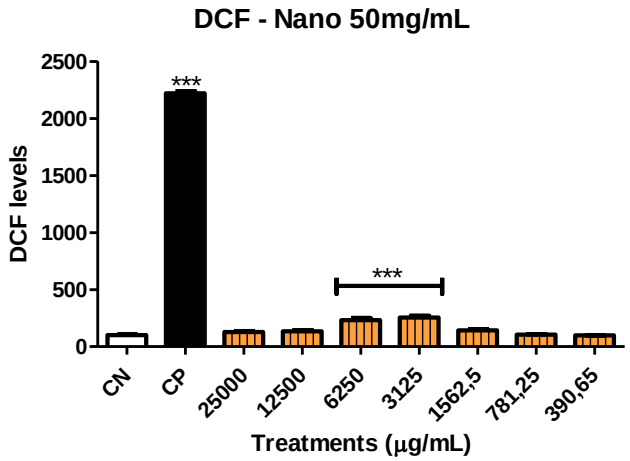

Figure 4. 2 ', 7'-dichlorofluorescein diacetate (DCF) assay with 24h incubation. The data are presented as% of the untreated control group (CN). Values with p <0.05 were considered statistically significant.

3.4.3 Determination of nitric oxide levels

ON levels were significantly higher in the treatment with 25000 µg/mL NLC than in the NC group (Figure 5).

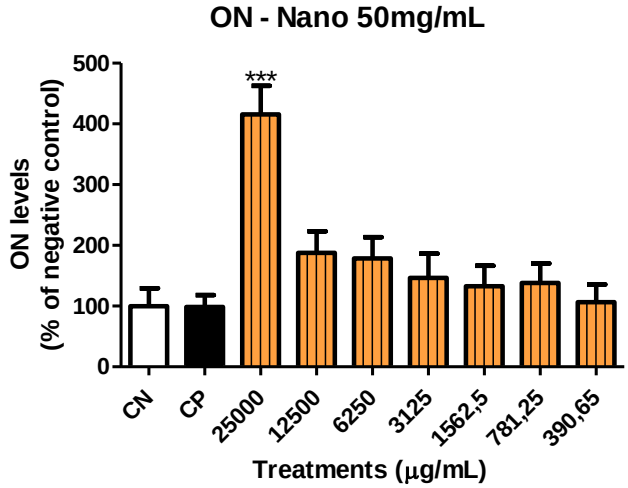

Figure 5. Nitric oxide (NO) assay with 24h incubation. The data are presented as% of the untreated control group (CN). Values with p <0.05 were considered statistically significant.

3.5 In vitro evaluation of the antimicrobial activity of the Nanostructured Lipid Carrier

The NLC containing Tucumã oil and butter showed antimicrobial activity in vitro against ten microorganisms of broad clinical importance to humans. The results also indicate that there was a greater antibacterial efficiency for gram-negative bacteria than for gram-positive bacteria (Table 2).

Table 2. Minimum Inhibitory Concentration (MIC) of the Nanostructured Lipid Carrier (CLN) containing Tucumã oil and butter *Astrocaryum vulgare.*

MICROORGANISMS	MIC(µg/mL)
Staphylococcus aureus	12500
Staphylococcus aureus resistente a Meticilina (MRSA)	12500
Staphylococcusepidermidis	3125
Streptococcus mutans	---
Streptococcus agalactiae	6250
Enterococcusfaecalis	6250
Klebsiellapneumoniae	12500
Escherichia coli	12500
Pseudomonasaeruginosa	25000
Aeromonashydrophila	25000

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3.6 Interference of the Nanostructured Lipid Carrier in the formation of biofilm

The biofilm formation for *A.hydrophila*, *E.coli*, *K.pneumoniae*, *S.agalactiae* and were significantly lower at concentrations of 25,000, 12500 and 6250 µg/mL NLC compared to that of PC. By contrast, biofilm formation for *S. epidermidis* and *S.aureus* was significantly lower at concentrations of 25000 and 12500µg/mL NLC compared to PC (Figure 6).

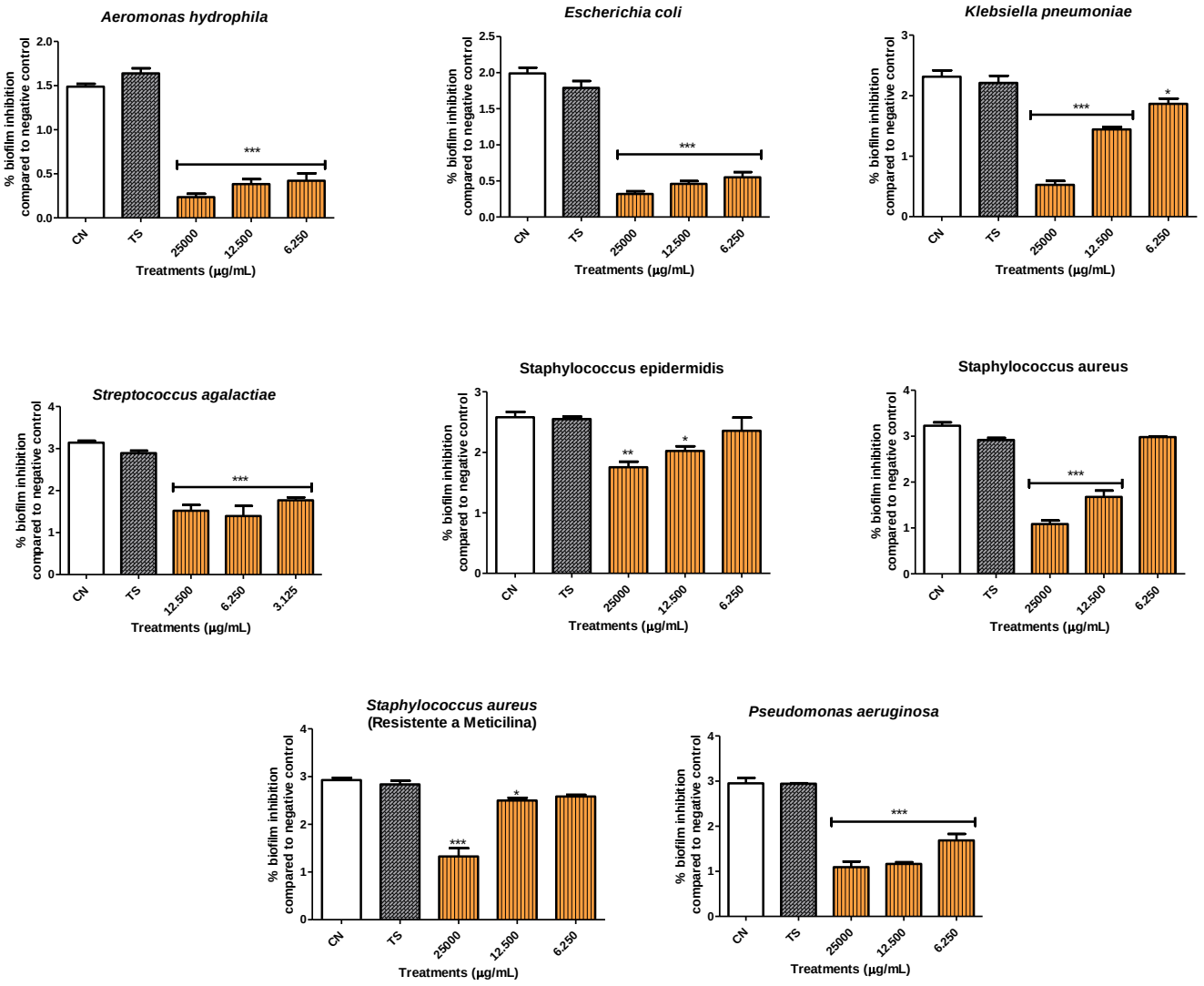

Figure 6. Effect of different concentrations of the Nanostructured Lipid Carrier (NLC) on the biofilm inhibition of different microorganisms. Significant difference between the tested concentration and the positive control (CP). Values with $p < 0.05$ were considered statistically significant.

4. Discussion

We observed for the first time that a nanoformulation of Tucumã oil in the form of NLC showed potent antimicrobial and anti-biofilm activities against various gram-positive and gram-negative bacteria that are human and animal pathogens. Our findings reveal that this formulation has morphological characteristics and an adequate safety profile, which makes this formulation an alternative to combat these pathogens.

A complete characterization of NLC is important, considering the influence of such parameters in terms of biological effects, because the physical-chemical analysis provides important information about the stability of these types of nanoformulation over time (GIORDANI et al., 2014). Particle size is an important attribute of lipid nanocarriers, affecting stability, encapsulation efficiency, drug release profile, biodistribution, mucus adhesion, and cell uptake. A rapid increase in particle size, for example, indicates low stability of the colloidal system (BAHARI and HAMISHEHK, 2016). For a particle to be considered

nanometric, it is necessary that at least one of its dimensions is less than 1000 nm and that this changes its nature properties. Thus, the results found for the sizes of the produced nanoparticles agree with the criteria established in the literature, suggesting adequate stability and better therapeutic efficacy. The results of the characterization of the nanoparticles suggestadequate homogeneity: all formulations must be monodispersed (PDI <0.3) and diameter less than 300 nm. The numerical value of the PDI varies from 0.0 (for a perfectly uniform sample in relation to the particle size) to 1.0 (for a highly polydispersed sample with various particle size populations). Values of 0.2 and below are generally considered acceptable in practice for nanoparticles based on material polymers. In drug delivery applications using lipid-based carriers, such as liposomes and nanoliposomes formulations, a PDI of 0.3 and below is considered acceptable and indicates a homogeneous population of phospholipid vesicles (CHEN et al. 2011). In this study, the polydispersity index was low (<0.3) for all dispersions obtained, indicating the formation of monodispersed systems.

The stability studies of the Nanostructured Lipid Carrier (NLC) showed that it remained stable for the period of 60 days in all established temperature and storage conditions. There were no visible trends in sedimentation, phase separation or aggregation over time. The average particle size, PDI, zeta potential and pH are considered good indicators of stability of suspended nanoparticles (BERNARDI et al., 2011).Considering that the zeta potential reflects the electrostatic repulsion between the particles, and that the standard value of the zeta potential is equal to or greater than +/- 30mV, it is associated with stable solutions, it can be said that the prepared formulation was stable. In addition, high values of polydispersity index indicate heterogeneity in the diameter of the suspended particles; variations in polydispersity values as a function of time indicate the formation of particle populations with diameters that did not initially exist, which may be due to particle aggregation or breaking/degradation (MACHADO et al., 2019). The characterization and stability results obtained demonstrate that the NLC was successfully developed, remaining stable for a substantial period of time in all temperature and storage conditions to which it was exposed. In order for nanoformulations to be used efficiently in technological and biomedical applications, they must be able to remain stable for a long period of time, without losing their properties or structural changes.

The hemolysis assay is useful to determine cytotoxic activity and may be related to direct damage to the erythrocyte cell membrane (ALENCAR et al., 2015). For this reason, we performed this test in three conditions (physiological, acidosis, and alkalosis) to see if NLC were capable of causing damage to erythrocytes. We found that the highest concentrations of NLC (12500 µg/mL in the condition of acidosis; 25000 µg/mL in physiological conditions) caused hemolysis in the erythrocytes, suggesting a possible cytotoxic effect when applied in high concentrations. To the best of our knowledge, there are no reports on the hemolytic effects of NLC; however, that effect can be explained by one of its major compounds, i.e., oleic acid. Hoque et al. (2013) found that high concentrations of oleic acid caused hemolysis in human and goat erythrocytes. According to what was observed in the present study, where only the two highest concentrations of NLC have hemolytic effect, we believe that the high amount of oleic acid present in Tucumã oil and butter may be responsible for the hemolytic action of NLC. Ashokraja et al. (2017) suggested that the observed hemolysis properties of synthesized NPs can be essentially attributed to their size, surface chemistry, and physicochemical properties. Nevertheless, according to these authors, the

hemolytic process involves the denaturation of cells through the physical-chemical interaction between NPs and the cell surface. Red blood cells do not have cellular organelles and the structure of red blood cells is maintained by few membrane proteins, phospholipids and carbohydrates in their cell membrane. In such physiological conditions, red blood cell senescence occurs due to physical-chemical changes in its membrane. More molecules of the NLC are being released at pH 7.2 and 7.4 than the NLC at pH 7.5, as blood pH variation can also lead to hypertonic condition causing hemolysis. Likewise, the main cause of the higher hemolysis properties of the NLC may be due to the interactions of reactive species with the cell surface or due to changes in pH (ASHOKRAJA et al., 2017).

Nevertheless, nanoparticles can have longer systemic circulation times. This prolonged time of circulation in the blood stream increases the duration of contact with these blood components, including the coagulation system, potentially amplifying the activation of the coagulation cascade. The results of the coagulation tests showed normal TP activities, in all concentrations tested with TP values within the biological range, and abnormal TPPa values, below the biological range, in the two lowest concentrations tested, but without statistical significance. According to Zare-Zardini et al. (2018), one of the most important things about coagulation is the idea of the intrinsic and extrinsic arms of the coagulation cascade and the way they interact during coagulation in the body. For a potent application of any compound, an investigation of its effect on blood clotting is necessary. The results demonstrated that the NLC does not interfere in the extrinsic and intrinsic clotting pathways. However, as changes in the TTPa test were observed, we did not rule out interactions with intrinsic coagulation factors such as factors VIII, IX, XI, XII, and pre-kallikrein protein. For these reasons, different methods of analysis must be performed to confirm and better understand our findings.

To investigate the safety profile of this formulation, we performed MTT assays and measured changes in double-stranded DNA. In the MTT assay, no concentration was able to reduce the cellular viability of PBMCs after 24 h of culture, suggesting that this treatment does not have cytotoxic effects for mononuclear cells such as lymphocytes and monocytes. These results agree with those of Sagrillo et al. (2015), who reported that Tucumã fruit extracts did not have cytotoxic effects and reduced the toxic effects of human lymphocytes exposed to hydrogen peroxide. Furthermore, we did not detect the presence of double-stranded DNA damage in any of the tested concentrations.

To identify possible mechanisms of action associated with these few cytotoxic effects of the highest concentrations of NLC, we evaluated the production of ROS and nitric oxide, two important mediators of oxidative and inflammatory damage related to cytotoxic effects (Baldissera et al., 2017). According to these authors, the production of reactive species are among the main causes of DNA damage. These species react with various DNA components to produce DNA damage, modifying bases, inducing interconnection between chains and intra-chains, and promoting chromosomal abnormalities. In the present study, a significant increase in the production of ROS (6250 and 3125 μg/mL) and NO (25000μg/mL) was observed compared to the negative control, suggesting that the production of ROS and NO may be involved in these cytotoxic effects found in red blood cells and PBMC exposed to NLC for 24 h. Although it has caused some negative effects, a recent study by Baldissera et al. (2017) found that Tucumã oil reduced oxidative damage in the brain of diabetic mice, which reveals its potent antioxidant action. On the other hand, β-carotene, another main constituent of Tucumã oil and butter prevented cell damage and decreased levels of

DCF (BESTWICK and MILNE, 1999). Another important constituent of both oil and Tucumã butter is tocopherol, an excellent inhibitor of lipid peroxidation, which acts as a hydrogen donor for the peroxyl radical, interrupting the radical chain reaction (BARREIROS and DAVDI, 2006). It is important to note that the cytotoxic effects of NLC may be due to its constituents, because the literature reports the absence of toxic effects of Tucumã oil.

The results related to antimicrobial activity are important, because these microorganisms isolated in hospital environments can colonize and adhere to the surfaces of medical instruments and implants. Because they are already resistant to various drugs, the ability to adhere can effectively reduce antimicrobial options and can further worsen infections. The main reason why NPs are being considered as an alternative to antimicrobials is that they can effectively prevent microbial resistance to drugs in certain cases. The rampant use of antibiotics has led to the emergence of several risks to public health, including the emergence of superbugs that do not respond to any antibioticand an existing epidemic against which the medication has no defense. The search for new effective antibacterial materials is significant for combating drug resistance, and NPs are being established as a promising approach to solving this problem (WANG et al., 2017).Rossato et al. (2019) showed that Tucumã-free oil showed antimicrobial activity against 5 microorganisms. *A.vulgare* oil is rich in lipids, carotenes, fibers and tocopherol, providing the fruit with high energy and nutritive content. Probably, the antimicrobial effect of Tucumã oil may be associated with its chemical composition, which includes several types of polyphenol molecules and fatty acids. Still, according to Rossato et al. (2019) polyphenols are secondary metabolites produced by higher plants, which play several essential roles in the physiology of plants that have potential healthy properties in the human body, mainly as antioxidants, anti-inflammatories, anti-allergens, and antimicrobials. This suggests that low uptake of free oil may limit its effectiveness, and that lipid encapsulation can help the active ingredients achieve their goals. Piran et al. (2017) demonstrated that NLC's increase the retention of a drug in the particle increased the release time and reduced the amount of drug needed to produce therapeutic action. According to these authors, this proficiency can be used to control the release of essential oils to improve the efficiency and reduce the quantity and toxicity of the essential oils used. By controlling the release of the drug molecule, the nanocarriers also protect essential oils against possible thermal or photoelectric degradation, oxidation or evaporation, which guarantees greater stability, flavor and function, consequently prolonging the useful life of the final product. According to Hu and Kwon (2011) most types of NP can overcome at least one of the common resistance mechanisms of microorganisms (including the interruption of bacterial membranes and the prevention of biofilm formation). These effects are the result of the bactericidal mode of NPs, which is based on their specific physicochemical properties. Unlike traditional antibiotics, NPs have dimensions <100 nm. The irexceptionally small size results in properties such as greater interaction with the cells due to greater area-to-surface ratiosand versatile and controllable application. According to Mühling et al. (2009),NPs cross the bacterial membrane and gather along the metabolic pathway, influencing the shape and function of the cell membrane. Then, NPs interact with the basic components of the bacterial cell, including DNA, lysosomes, ribosomes, and enzymes, leading to oxidative stress, disturbances of the electrolyte balance, inhibition of enzymes, heterogeneous changes, changes in the permeability of the cell membrane, deactivation of proteins, and changes in expression genes, all of which can be considered possible

mechanisms of action of nanoparticles against bacteria. According to Karimi et al. (2018) NLC systems allow the transfer of antibacterial extracts through the cell membrane layer. They acts carrier agents, bringing concentrations of compounds within the aqueous phase to microorganisms. According to these authors, there are “holes” in the cell membranes of the bacteria that act as component transfer areas, and smaller nanoparticles can be more easily inserted into the cavities and release their bioactive compounds, also contributing to the improvement of the antimicrobial activity of the nanoformulations. Finally, Mokarizadeh et al. (2017) found that lipid-based nanocarriers can protect essential oils against thermal or photoelectric degradation, increasing product stability and consequently, prolonging the life of the final product, in addition to not affecting the appearance, texture, or the taste of the product. The use of such delivery systems can increase the concentration of antimicrobials in areas in which microorganisms are preferentially located and can potentially increase the passive mechanisms of cell absorption that affect the stability of the lipid membrane and, as a result, increase antibacterial activity.

Comparing the MICs and the concentrations capable of inhibiting bacterial biofilm, we observed that the NLCs containing Tucumã oil and butter inhibited the formation of biofilm in concentrations lower than the MICs in most of the tested microorganisms. This suggests inhibition of biofilm formation of the microorganism in the sessile form (adhered to solid surfaces), not only in the inhibition of bacterial growth in the planktonic form (microorganisms in suspension and dispersed in the aqueous medium). Size of a NP can greatly affect its antibacterial activity. In addition to the rupture of bacterial membranes, the prevention of biofilm formation is an important mechanism becausebiofilms play fundamental roles in the development of bacterial resistance. The unique structure and composition of bacterial biofilms provides shelter or protection for embedded microorganisms, helping them to protect themselves from most antibiotics. In addition, bacterial biofilms are "a breeding ground" for frequent resistance mutations and the exchange and alteration of these mutations between bacterial cells. Studies have shown that many NPs can prevent or overcome biofilm formation (PEULEN and WILKINSON, 2011).Most bacteria exist in the form of biofilms, usually containing several species that interact with each other and with the environment. Biofilms are specifically microbial aggregates that depend on a solid surface and extracellular products, including extracellular polymeric substances (EPSs) (WANG et al., 2017). Astudy by Alalaiwe et al. (2019) using the biofilm, demonstrated that oxacillin-loaded nanoparticles penetrated the EPS, eradicating the MRSA biofilm more effectively than the individual treatment. According to these authors, extracellular DNA plays a fundamental role in the production of biofilm, acting as a chelator of cationic molecules. The interaction between EPS and nanoparticles with lipids can cause strong affinity and disintegration of the biofilm.

5. Conclusion

The Tucumã nanostructured lipid carrier was successfully developed by the homogenization method using Ultra Turrax. It remained stable for a considerable period of time. Cytotoxicity studies demonstrated that the nanoparticle suspension is safe because no concentration reduced cellular viability of PBMCs or caused double-stranded DNA damage, in addition to having low NLC hemolytic activity against human erythrocytes in most concentrations tested and few toxic effects at high concentrations. The NLC-

containing Tucumã oil and butter showed antimicrobial and antibiofilm activity against important agents that cause human morbidity and mortality Our findings suggest that this treatment, in nanostructured form, may be a potential alternative therapeutic agent for the elimination of bacteria and biofilms.

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An Analysis of the Geothermal Energy of Surface Water in Fátima do Sul, Mato Grosso do Sul, Brazil with an Emphasis on the Climatization of Buildings Environments

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Abstract

Investment in unrenewable energy sources has grown at a rapid pace during the beginning of the 21st century, and they may be exhausted by the middle of this century if this rhythm of consumption is maintained. Sustainable solutions have become a priority and the use of Geothermal Energy from Surface Water has attracted interest as a source of clean and renewable energy which can be used to climatize constructed environments. This article analyzes the surface water of a reservoir located in Fátima do Sul, Mato Grosso do Sul determining its temperature at depths of 0.3 to 1.5 meters (1 to 5 feet) using our own method which employs an *Arduino Mega 2560 R3, a free electronic hardware prototype with a single board. The results demonstrate an inverse relationship between the variation in the water's temperature*

and an increase in depth, or in other words, there are smaller variations in temperature at greater depths. This fact gives these waters the capacity to store heat, and thus it can be employed in heating and cooling constructed environments.

Keywords: Geothermal energy with low enthalpy; Geothermal heat pumps; Water as a source of heat exchange.

1. Introduction

Recently the issue of sustainability has received great attention around the world in all areas of knowledge. Energy efficiency is among the main alternatives that are being prioritized given the variety of energy sources employed in climatizing constructed environments (Hughes, 2008; Raposo & Pinheiro, 2015), which for the most part still uses non-renewable energy for this purpose.

In Brazil, 53.9% of the energy matrix consists of non-renewable sources of energy. This total is even more of a concern when we look at the world stage, where this number surges to 86.1% (Empresa de Pesquisa Energética [EPE], 2020). This exacerbated use of non-renewable sources of energy has led to concern about its possible scarcity, as well as the effect of the greenhouse gases that they release into the atmosphere which aggravate climate change (Kanbur et al., 2001; Pereira, Horn & Dos Santos, 2010; Ferreira, Vieira, Da Silva & Da Cruz, 2017; Omido, Barboza & Moreira Júnior, 2017).

It is known that practically half of the world's oil reserves have already been used up, and if we continue at the same pace of consumption the rest will be used up in 50 years. Natural gas, for example, will last for 60 years, while coal which still has unexplored reserves, may last 250 years (Goldemberg & Lucon, 2007). In addition, between 2030 and 2050, the mean world temperature may rise by 1.5ºC (2.7°F) if we continue at the same rate of consumption (Intergovernmental Panel on Climate Change [IPCC], 2018).

Under this scenario, surface geothermal energy, a clean and renewable source of energy, has been attracting greater attention. This way of obtaining energy is being employed by various countries with different climates, but it has not been used widely in Brazil, mainly due to an absence of information and studies which demonstrate the viability of its use in this country (Fonseca, Casalini, Tucci & Battisti, 2014).

2. Surface Geothermal Energy

Geothermal energy, in its literal sense, is energy that is stored underground in the form of heat that comes from underground movements of the Earth's water, its nucleus and mantle, and mainly solar radiation which can be converted into electricity or thermal energy (Barbier, 2002; Ferreira, 2013). According to Trillo and Angulo (2008), geothermal energy has attracted a lot of attention, given that it can be used for a variety of purposes and is also considered one of the largest existing sources of renewable energy.

Geothermal energy can be divided into four categories in terms of its enthalpy, each of which has its respective use:

Text Table 1 - Classification and Utilization of Geothermal Energy

Geothermal Energy		
Enthalpy	*Temperature (°C)*	*Utilization*
High Enthalpy	≥ 150	Generating electricity through water vapor
Medium Enthalpy	90 ≤ T < 150	Generating electricity
Low Enthalpy	30 ≤ T < 90	Used for thermal purposes in direct and indirect ways
Very Low Enthalpy	T < 30	Used for geothermal heat pumps

Source: Adapted from Trillo and Angulo (2008).

According to Text Table 1, high and medium enthalpy geothermal energy are used to produce electricity, since they have greater geothermal potential precisely due to the fact that they are obtained at great depths under the ground, and thus require geothermal plants for their extraction. Unlike these forms, very low enthalpy energy is used to heat and cool constructed environments for recreational and leisure purposes, given that it has less geothermal potential because it is extracted from depths close to the surface, and thus requires a ground source heat pump (GSHP) for its extraction.

The extraction of very low enthalpy geothermal energy through ground source heat pumps (GSHP) is one of the most efficient ways of climatizing constructed environments. It consists of a heat exchanger, a pipe system, and a heat pump which is responsible for transferring the thermal energy from the circuit to the pipes (Self, Reddy & Rosen, 2013).

Heat pumps, known as thermal machines, transfer heat from a cool source to a warm source through vapor compression cycles. Their importance comes from their wide range of applications, which includes in this context, the transfer of heat between buildings and the outside environment, or in other words, the heating and cooling of the constructed environment (Naicker, 2015).

The vapor compression cycle consists of a change in its physical state to a liquid which is found inside the heat pump in the evaporator and condenser compartments, as can be seen in Figure 1. Normally a refrigerant liquid is selected in accordance with the type of GSHP being used (Self et al., 2013).

Figure 1 - Vapor Compression Cycle.
Source: Adapted from the Efficient House (2021).

Figure 1 highlights the heating of a constructed environment in which the heat pump used to climatize the environment functions in the following manner (Self et al., 2013):

I. The refrigerant liquid in the first circuit removes the heat from the external environment (a heat source which could be water, the ground, or the air), transporting it to the evaporator where the first energy exchange takes place, which transforms the refrigerant liquid in the heat pump into low pressure vapor (evaporation);

II. The vapor passes through a compression process within the compressor, which increases its pressure producing high temperature and high pressure vapor;

III. This vapor, in turn, is transported to the condenser, where it is cooled and condensed (condensation), producing a high temperature and high pressure liquid;

IV. The refrigerant liquid in the secondary circuit, installed in the constructed environment, captures the heat of the high temperature and high pressure vapor, sending it to the constructed environment that we wish to heat (diffusion of heat);

V. Finally, the refrigerant liquid in the heat pump circuit is submitted to an expansion process in the expansion valve, reducing the pressure which results in a low temperature and low pressure liquid, making it possible to restart the entire vapor compression cycle.

The efficiency of a heat pump is represented by the coefficient of performance (COP), which takes into consideration the quotient between the quantity of heat produced by the heat pump and the quantity of electricity needed for this process. This performance mainly depends on the configuration and size of the adopted system, the ground's characteristics, and climatic conditions, which can present values between 3 and 6 (Lopes, 2014).

In this sense, the capture of surface geothermal energy can be accomplished through an open or closed GSHP system (European Geothermal Energy Council [EGEC], 2015). Open GSHP systems work directly with underground water (the water table) or surface water (a lake, lagoon, river or creek), in accordance with Figure 2.

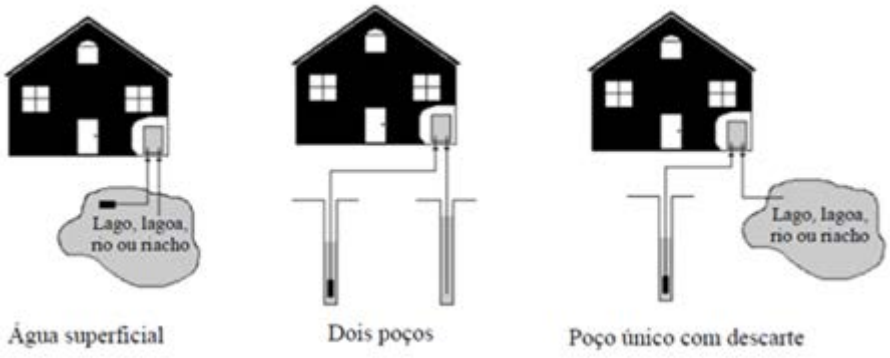

Figure 2 - Open Circuit System.
Source: Adapted from Swenka (2008).

In these open circuit systems, the water is extracted by the primary circuit, and then passes through the heat pump, and can be disposed of in the source itself, as we can see in Figure 2 for "*surface water*" in which the water is extracted from a lake (lagoon, river or creek) and returned to the same environment. In

addition, water can also be disposed of in another location distinct from where the water is extracted as we can see in Figure 2 for "*two wells*" and "*single well with a disposal*", where the water is extracted from a well and sent to another well or to a lake (lagoon, river or creek) respectively. This is a system with a low implementation cost, but requires greater attention in terms of the water quality and system maintenance (Swenka, 2008).

In closed GSHP systems, the transfer of heat occurs by passing the refrigerant liquid through a pipe system installed underground or underwater. This heat transfer which goes from the ground (or the water) to the edifice, or from the edifice to the ground (or water), depends on the season (Swenka, 2008; Ramalho et al., 2014). According to Brandl (2006), in closed systems, pipes can be installed vertically or horizontally, as can be seen in Figures 3 and 4.

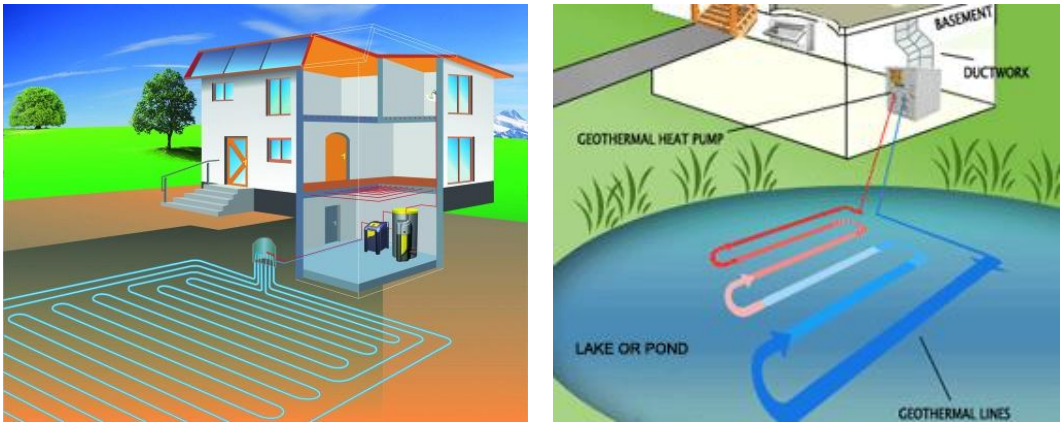

Figure 3 - Horizontal Closed Circuit Systems in the Ground and in the Water.
Source: Biomass Geothermal Energy (2017) and Ingram's (2021).

A horizontal closed system (Figure 3) normally is installed in places which have a large amount of space available (Rio, 2011) with a depth between 1.2 and 2.0 meters (4 to 6.5 feet) (Sanner, 2006). The advantage of this system is its low cost installation (Marzbanrad, Sharifzadegan & Kahraman, 2007).

Figure 4 - Vertical Closed Circuit Systems in the Ground and in the Water.
Source: Rodríguez (2015) and Geo Journal (2009).

A vertical closed circuit system (Figure 4) is required when there is not that much space available. Thus, the advantage of this system is the space needed for the installation, which is much smaller compared to the horizontal system. On the other hand, the installation of a ground system is expensive, because there's the need to make holes (Rio, 2011), while a surface water installation is less expensive.

This article seeks to trace the profile of water in a reservoir located on a private property in Fátima do Sul, Mato Grosso do Sul to provide a base for the installation of auxiliary climatization systems which employ surface water as a source/dissipator of heat. The intent is to contribute to the widespread utilization of surface geothermal energy using the installation of heat pumps, since in Brazil these systems are predominantly used for tourism and recreation.

3. Methodology

This study was developed in the city of Fátima do Sul, Mato Grosso do Sul, Brazil, located in the Greater Dourados region, specifically at the coordinates of 22º 22' 26" S and 54º 30' 50" W (Figure 5). Fátima do Sul is 248 km (154 miles) from the state capital Campo Grande and its altitude is 352 meters (1,155 feet). It has a tropical climate characterized by a rainy summer and a dry winter, with average annual precipitation ranging from 1500 to 1700 millimeters (59 to 67 inches), and an average annual temperature which varies from 22ºC to 24°C (71.6°F to 75.2°F) (Instituto Nacional de Meteorologia [INMET], 2020).

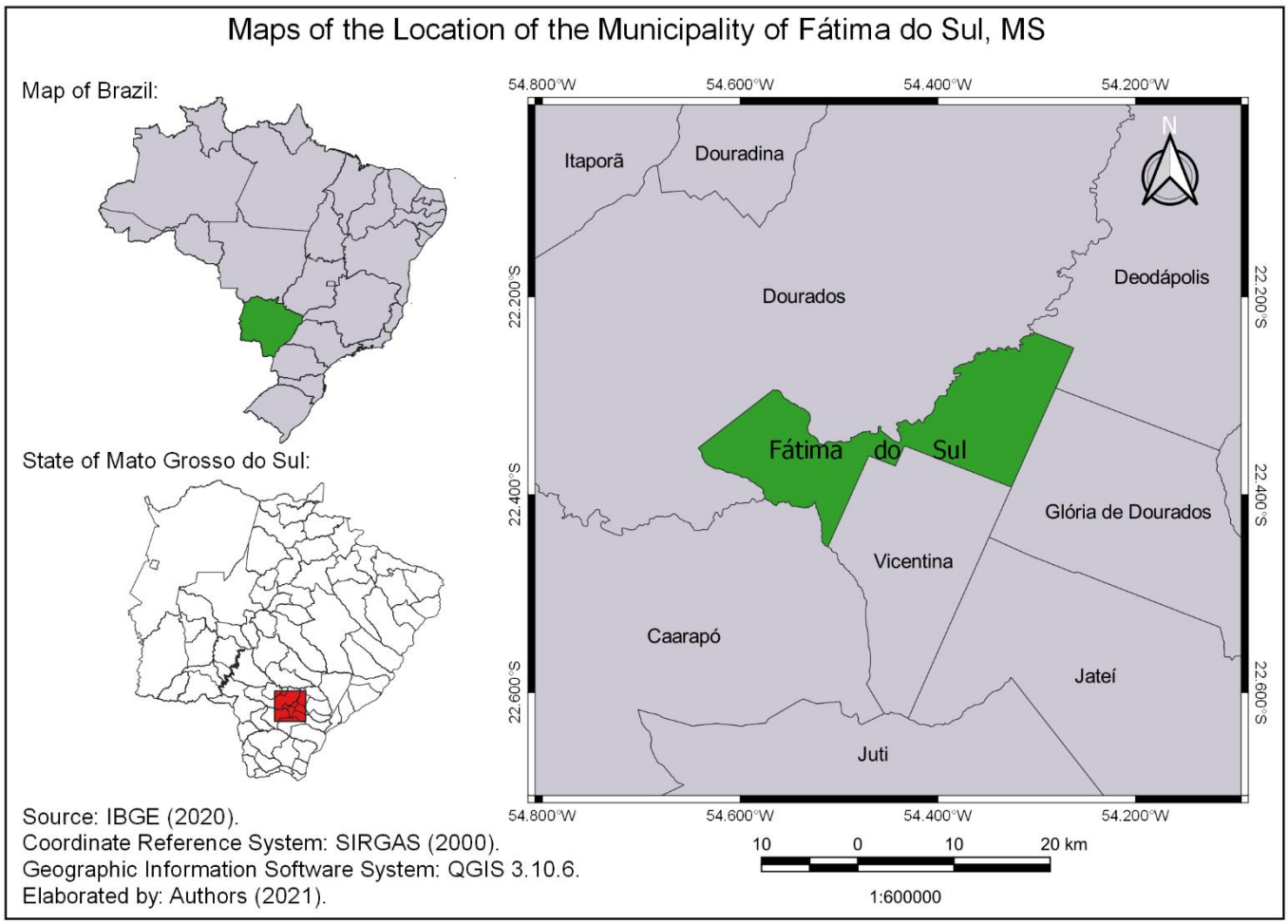

Figure 5 - Location of Fátima do Sul, Mato Grosso do Sul.

Source: The authors (2021).

The predominant soil is Red Oxisol (84.98%), and there is also a portion of Haplic Gley (15.02%) (Brazilian Institute of Geography and Statistics - Environmental Information Database [IBGE-BDIA], 2020), as can be seen in Figure 6.

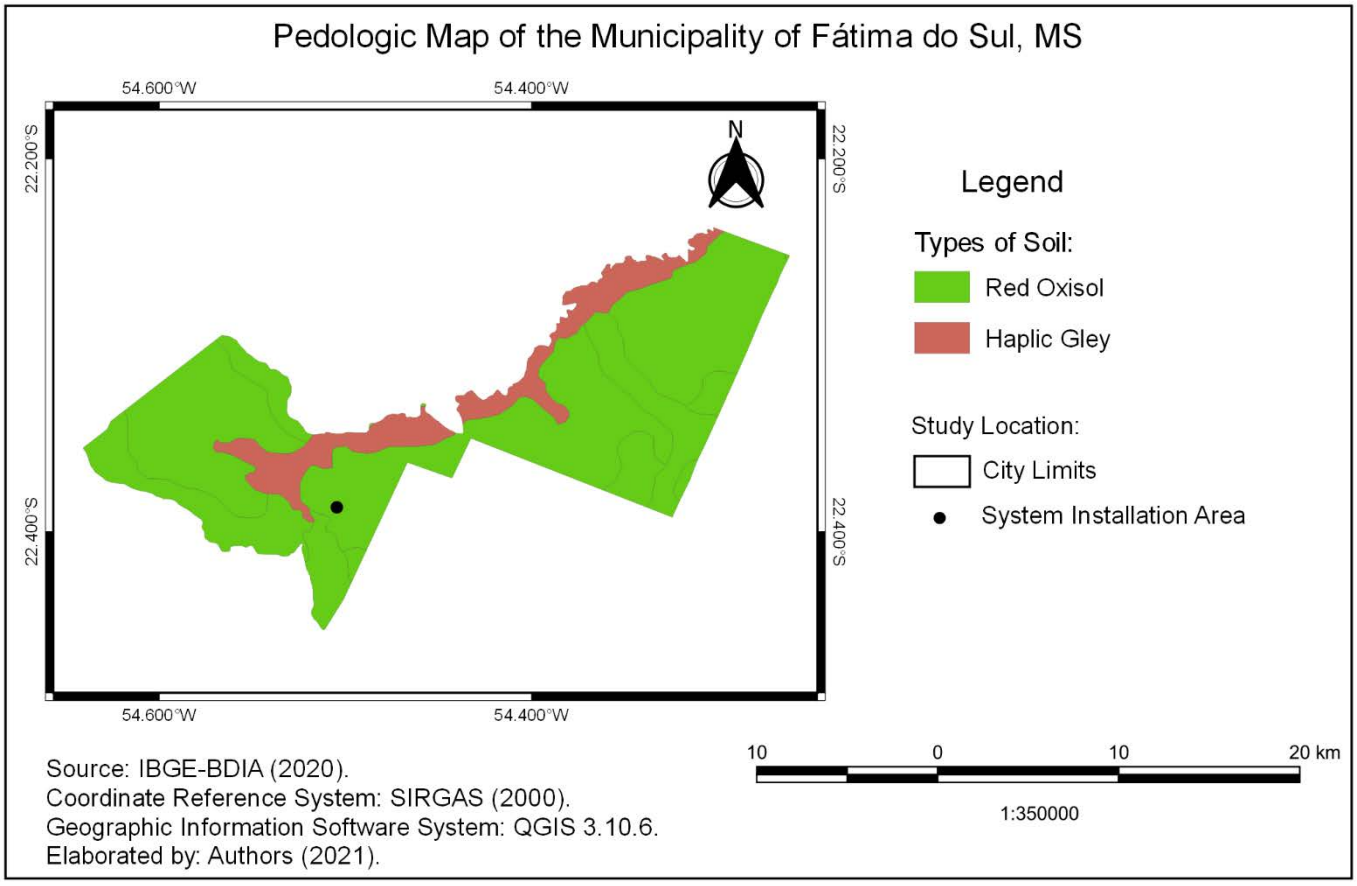

Figure 6 - Map of the Types of Soil in Fátima do Sul, Mato Grosso do Sul.
Source: The authors (2021).

The setting up and installation of the device responsible for collecting and storing ambient temperature readings at different depths in the reservoir was performed on June 30, 2018. The reservoir where the study took place is on a private property located at Avenida 9 de Julho n° 3181, where the type of soil is classified as Red Oxisol (Figure 6).

Water temperature data (from the reservoir) had to be acquired through digital sensors and later was correlated with the ambient temperature to analyze the thermal behavior of the water, and we opted to use the quantitative method described by Pereira, Shitsuka, Parreira & Shistsuka (2018).

To monitor the water temperature, we installed two DS18B20 temperature sensors at different depths. The first, which was closer to the center of the reservoir, was taken at a depth of 1.5 meters (5 feet), and the second, close to the edge of the reservoir, was taken at a depth of 0.3 meters (1 foot). A third temperature sensor was installed next to a shed to take the ambient temperature reading. In Figure 7 you can observe the temperature collection points on the property.

Figure 7 - The Property and the Location of the Temperature Sensors.
Source: Google Earth Image (2018).

The data acquisition and storage device consists of a waterproof DS18B20 temperature sensor, a Mega 2560 R3 Arduino board with a USB cable, a 9V power supply, an 830-point prototyping board with jumper cables, a Cat E6 ethernet cable, and 3 modules: DHT22, RTC DS3231 and the Micro SD Card (with a capacity of 8 gigabytes). The first of these items is responsible for collecting the ambient temperature and humidity readings in a shed, and the second supplies the exact date and time of the temperature readings, while the third stores all of the data in text files. This equipment was connected to electricity in the shed which was protected from the elements as depicted in Figure 8.

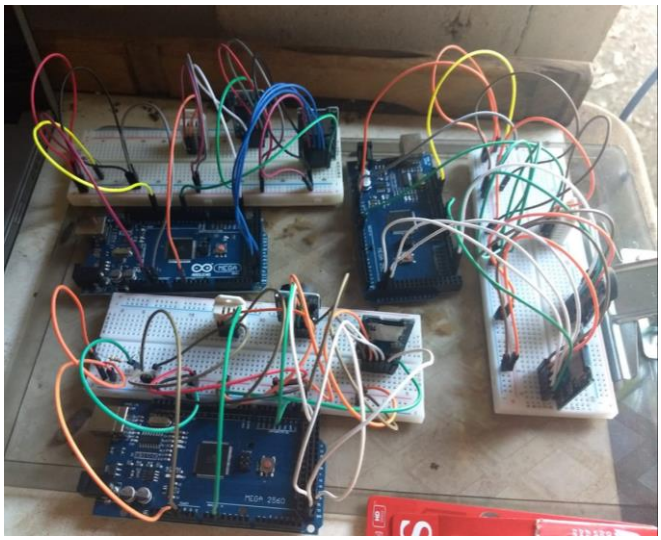

Figure 8 - Data Acquisition and Storage Device.
Source: The authors (2021).

According to Martinazzo and Orlando (2016), DS18B20 digital sensors coupled with the Arduino are more reliable and efficient than analog sensors (Termistor and LM35). The DS18B20 temperature sensors were obtained from the factory with just 1 meter of cable and thus they required a Cat E6 ethernet extension cable of the necessary length.

The necessary extension cables were approximately 100 meters long from the data acquisition and storage device (located in the shed) to the DS18B20 temperature sensor (located in the reservoir). This length of the extension cable increased the resistance of the Cat E6 cable, which in turn would compromise the transport of the data collected from the temperature sensors to the Arduino prototyping board, which

thus made it impossible to feed information from three sensors to a single board. Thus, we decided to use three Arduino boards, or in other words, a board for each sensor, as illustrated in Figure 8.

In order to keep the temperature sensors more stable physically and guarantee the collection of the temperature data at the initially defined depths (0.0m, 0.30m and 1.50m), we had to make sensor tips. These tips were made up of ¾" PVC pipes 25 cm (10 inches) in length and ¾" PVC caps fixed with adhesive tape and isolated with silicone, as shown in Figure 9.

Figure 9 - DS18B20 Temperature Sensor Tips.
Source: The authors (2021).

Next the DS18B20 temperature sensor was installed near the device shed to collect ambient temperature data (Figure 10-a). Then two temperature sensors were positioned inside the reservoir, one at a depth of 0.30 m (1 foot) (Figure 10-b) and the other at a depth of 1.50 m (5 feet) (Figure 10-c) with the help of weights to keep them submerged.

(a) (b) (c)

Figure 10 - DS18B20 Temperature Sensors Placed on the Property.
Source: The authors (2021).

After it was installed, the system collected temperature data continually every 20 minutes and stored it in the Micro SD cards. To maintain greater control over measurement errors and possible sensor problems, the data was collected weekly. The data was then analyzed using the OriginPro 8 software package.

4. Results and discussion

The collection and storage device for the ambient temperature and the temperature readings at various depths in the reservoir (0.0 m, 0.30m (1 foot) and 1.50m (5 feet)) continued to operate for a period of four months from June 30, 2018 through October 30, 2018. The behavior of the reservoir temperature compared to the ambient temperature can be observed in Figure 11.

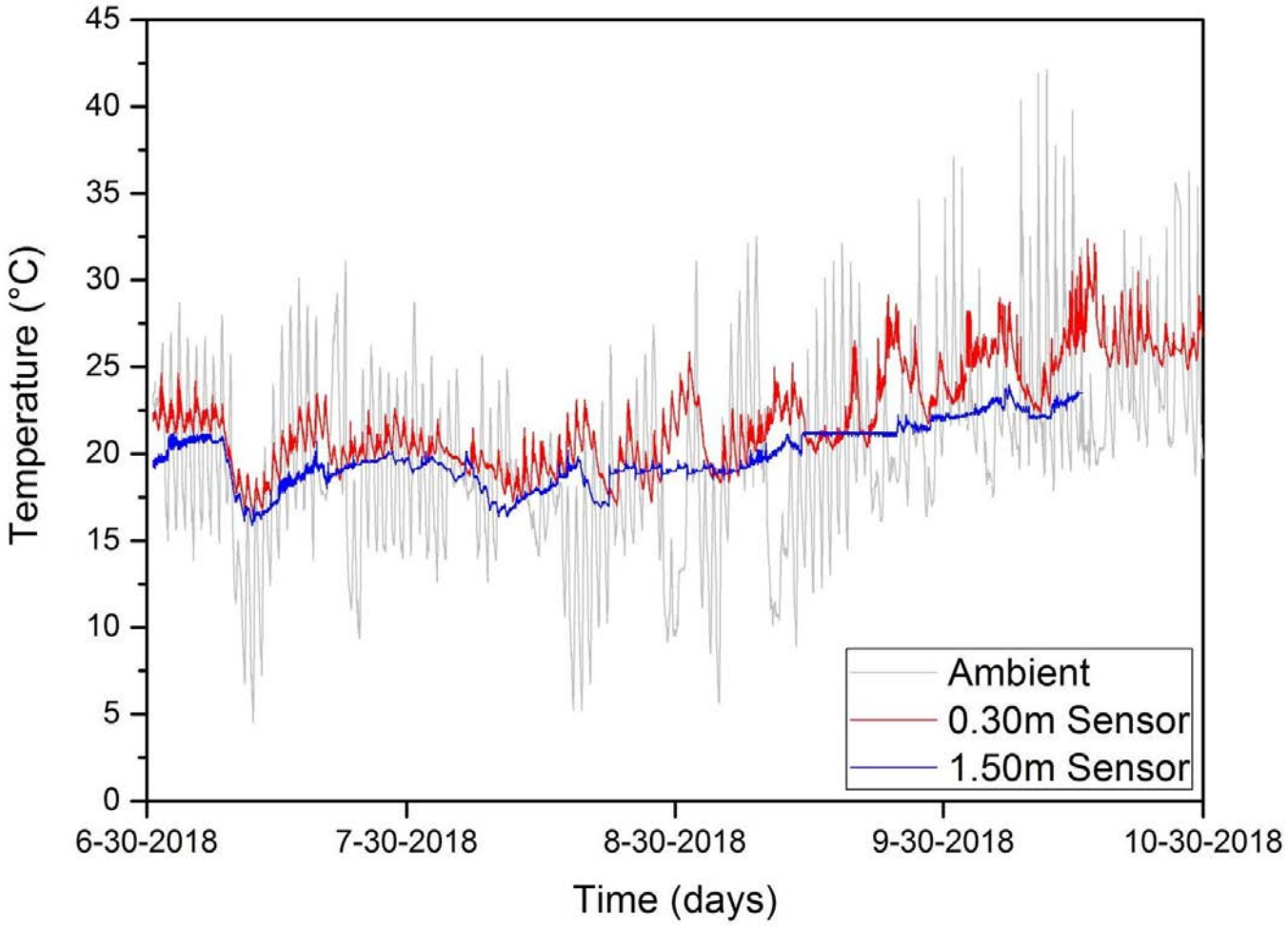

Figure 11 - Ambient and Water Temperatures of the Reservoir in Fátima do Sul, Mato Grosso do Sul. Source: The authors (2021).

The collection period lasted almost the entire winter (83 days) and included the beginning of spring (37 days), as can be observed in Figure 9, in which the ambient temperature reached minimum values close to 5 degrees Celsius (41°F) and later rose constantly reaching a temperature close to 20 degrees Celsius (68°F).

The behavior of the ambient temperature is reflected in the behavior of the water temperature, and it is possible to perceive from the graphic analysis (Figure 9) that the water temperature at 0.30m (1 foot) is more sensitive to the ambient temperature compared to the water temperature at 1.5m (5 feet), given that the thermal amplitude is greater at a depth of 0.30 meters. In this way, as we go deeper in the reservoir the water assumes a more and more constant temperature, confirming a low variation in the water temperature due to its high specific heat.

In Table 1, we can observe the thermal amplitude for the three depths analyzed over four months in this study.

Table 1 - Thermal Amplitude during the Measurements

	TMAXIMUM (ºC)	*TMINIMUM (ºC)*	*Thermal Amplitude (ºC)*
0.0m Sensor	42.13	4.50	37.63
0.3m Sensor	32.38	16.38	16.00
1.5m Sensor	24.00	15.88	8.12

Source: The authors (2021).

In Table 1, note that the thermal amplitude of the ambient reading was 37.63ºC, while at depths of 0.30m and 1.50m this amplitude was 16.00ºC and 8.12ºC, respectively. Thus, the diminution of thermal amplitude with increased depth in surface water is confirmed, revealing its capacity for thermal storage.

In Table 2 we may observe two extreme moments in relation to the ambient temperature during the analyzed period. The first was a cold day (7/12) and the second was a warm day (10/11), and we examine both in terms of the water temperature at 0.30m and 1.50m.

Table 2 - Ambient Temperature Extremes during the Measurements.

Date	*Time*	*Temperature (°C)*		
		0.0m Sensor	*0.30m Sensor*	*1.50m Sensor*
7/12/18	6:17 am	4.50	16.63	16.25
10/11/18	10:53 pm	42.13	24.13	22.13

Source: The authors (2021).

At both times, according to Table 2, we may perceive that independent of the conditions of extreme cold or warmth, the temperature at 0.30 meters and 1.50 meters in depth remained less severe, again revealing the thermal storage capacity of water. Thus, for July 12, 2018 which presented cooler temperatures, the water could be used as a source of warmth to heat constructed environments. On October

11, 2018, on the other hand, the water could be used as a cold source that could be exchanged with heat to cool these environments.

Another important aspect is the verification of the temperatures during a single day at different times. Table 3 shows the variation in the data for September 1, 2018.

Table 3 - Temperature Extremes during a Single Day under Observation

Date	*Time*	*Temperature (°C)*		
		0.0m Sensor	*0.30m Sensor*	*1.50m Sensor*
9/1/18	11:04 am	31.13	22.88	19.00
9/1/18	11:44 pm	13.00	22.13	19.00

Source: The authors (2021).

At both times, according to Table 3, we may perceive that during one day the temperature at the depths of 0.30m and 1.50m remained practically constant. Even though the ambient temperature varied by 18.13°C in a single day, the variations in temperature at the depths of 0.30m and 1.50m were 0.75°C and 0°C, respectively, revealing a lower thermal amplitude in the reservoir as depth increases. Figure 12 depicts the daily thermal behavior of the water.

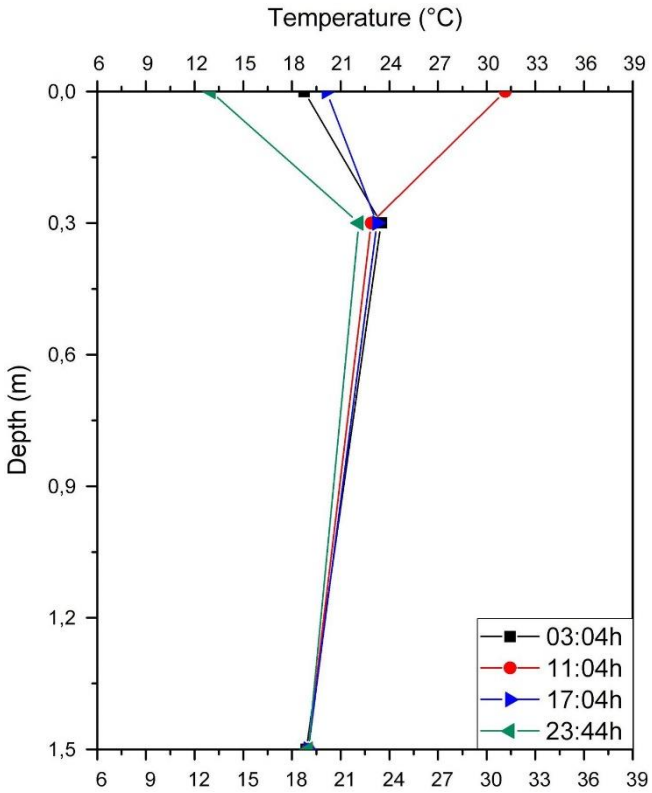

Figure 12 - Daily Thermal Behavior of the Reservoir Water.

Source: The authors (2021).

In this sense, analyzing graphically the daily change in temperature of the water at depths of 0.30m and 1.50m at 3:04 am, 11:04 am, 5:04 pm and 11:44 pm (Figure 12), it is possible to note greater thermal stability with increasing depth independent of the fact that the ambient temperature (0.0m) experiences an elevated thermal oscillation.

These results corroborate studies conducted by Márquez, Bohórquez & Melgar (2016), Omido, Barboza, Sanches & Sanches, (2018), Omido, Barboza, Sanches & Sanches, (2019), Sanches, Sanches, and Omido, Barboza, & Jordan, (2020), which display the possibility of using surface geothermal energy to support the climatization of constructed environments.

5. Conclusion

This evaluation of the potential utilization of Geothermal Energy from surface water in a reservoir located in Fátima do Sul, Mato Grosso do Sul makes it possible to conclude that water temperature tends to be more and more constant (has a lower thermal amplitude) as depth increases in the reservoir, or in other words, they are inversely proportional.

The difference between the ambient temperature and the underwater temperature reveals the possibility of using the energy stored in the water as a form of heat to run a heat pump to climatize constructed environments, or in other words, during winter the water can be a source of heat, and in summer it can dissipate heat.

Future studies should employ greater proximity between the data acquisition and storage mechanism and the location where the sensors are installed so that just one Arduino prototyping board will be necessary.

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THE POWER OF INNOVATION ON PERFORMANCE AND SOCIO-ENVIRONMENTAL SUSTAINABILITY

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Abstract

Purpose: *This study has analyzed the relationship between process and organizational innovation, performance in product, market and technical innovation and social environmental sustainability.*

Design/methodology/approach: *The data was collected in industrial companies using a questionnaire with a Likert scale and a structural equation model was used to estimate the parameters.*

Findings: *The results indicated that process and organizational innovation mediated by performance in product, market and technical innovation, influence social and environmental sustainability.*

Practical implications: *According to the investigated managers, the practical contributions point to the need of considering innovation elements to achieve a good performance. Subsequently points out that better performing organizations favor practices to seek the global sustainability of the enterprises.*

Originality/value: *The model used in this study, is broader than that applied in previous studies when considering the dimensions of innovation, performance and sustainability concurrently. Thus, it suggests the understanding, by the interested parties, about organizational performance as an influence of good socio-environmental sustainability practices.*

Keywords: innovation; performance; sustainability.

1. Introduction

Innovation promotes the development of countries and companies (Kahn, 2018; Gunday *et al*., 2011) and often increases the concern about social inequality and the finitude of natural resources. This happens because innovation promotes alternative ways of using resources that are harmful to the environment (Bocken *et al*., 2019; Silvestre and Tîrca, 2019).

A favorable scenario is created in companies that combine knowledge, technology, and sustainability in the innovation of products and services (Gunday *et al*., 2011; Tidd and Bessant, 2015). Innovations need to add socio-environmental factors to the economic interests, seeking to achieve in practice the full and inseparable integration between innovation and sustainability (Nidumolu *et al*., 2013; Albareda and Hajikhani, 2019).

Sustainability-oriented innovation (SOI) presents multiple ways to link a sustainable individual leadership and the entrepreneurship to other levels of organizational transformation, leading the transition systems towards a sustainable development. The challenge is turned into business opportunities for those seeking innovative and sustainable solutions (Bocken *et al*., 2019).

Companies that develop products, services and processes with socio-environmental concerns improve economic, environmental, and social performance (Nidumolu *et al*., 2013; Kneipp *et al*., 2018; Albareda and Hajikhani, 2019). Innovations that include the optimization of raw materials, use of recyclable materials and components with low environmental impact provide efficiency in the use of natural resources and cost reduction for companies, which promotes greater economic and environmental results (Lin *et al*. , 2013; Ramadani *et al*., 2019).

Process innovation affects the economic performance of companies and when combined with environmental sustainability practices, improves environmental performance by reducing the waste of water, energy, and raw materials. An example is the implementation of software that supports production and transport and reduces the waste of fossil fuels (González-García *et al*., 2012; Kneip *et al*., 2018).

Organizational and marketing innovation combined with socio-environmental practices have the potential to improve economic, social, and environmental performance. The new techniques for promoting products with returnable and biodegradable packaging enhance sustainable actions and improve the company's relationship with its stakeholders, which helps to open new markets (Nidumolu *et al*., 2013; Guerrero-Villegas *et al*., 2018).

Despite the great interest of innovation in the promulgation of sustainable practices, a known stimulus factor is the economic performance. In this scenario, companies that seek sustainability-oriented innovation need to prioritize the economic performance so that the resources in innovation are sufficient. In this context the objective of the investigation is to analyze the relationship between process and organizational innovation, performance in product, market and technical innovation and social environmental sustainability.

In large corporations, sustainability-oriented innovation has already been discussed since the late 1980s. However, in the last decades, Micro, Small and Medium companies have been the target of studies due to their representativeness in the world market and their flexibility to adapt, what makes them major contributors to sustainable development (Klewitz and Hansen, 2014).

Considering the context suggested by Klewitz and Hansen (2014), industrial companies in the Chapecó region were investigated. The region choice is justified by the economic relevance that the Chapecó region represents for the state of Santa Catarina. Also, according to SEBRAE (2013), the Western macro-region occupies the 4th place in the formation of the state GDP and Chapecó is its main city. The SEBRAE (2013) survey points out that 98.90% of the companies in the region are micro and small.

A challenge for managers is to find a way to make the company more sustainable considering the Triple Bottom Line (TBL) aspects. There is an imaginary trade-off between the adoption of sustainability practices and the company's profitability, or the need to give up the company's competitiveness to make it sustainable (Nidumolu *et al*., 2013; Adams *et al*., 2016). Also, many managers have not yet developed the conditions or do not have the capabilities to make their business more sustainable from a socio-environmental point of view (Adams *et al*., 2016).

This study's development justificative is presenting an empirical evidence that innovation combined with economic performance can improve socio-environmental practices. The approach of the study fills a literature gap on Sustainability-oriented innovation (SOI) related to small and medium-sized companies. The results of the study can be of academic and managerial interest. When seeking innovation, managers tend to increase economic performance, what leads to more financial resources that could be applied in socio-environmental practices, promoting an improvement in the company's image, for example. The originality of the research is in the breadth of considering simultaneously organizational and process innovation, economic performance, and sustainable practices in the environmental and social dimensions. This contribution helps to supply the observation made by Das (2017) that when considering the aspects of innovation most studies consider only the economic performance.

2. Theoretical Background and Hypothesis

The theoretical foundation of the study discusses the relationship between innovation and sustainability, innovation and performance, performance and sustainability and innovation, performance, and sustainability.

2.1 Process and Organizational Innovation (POI) and Social and Environmental Sustainability (SES)

The Oslo Manual defines that innovation can develop and improve processes in production activities, product delivery time and production support. The concept of organizational innovation includes the quality and efficiency improvement in the development of tasks, caused by organizational communication, learning capacity and the use of technologies by the team (OECD, 2018).

The proper approach of process and organizational innovation (POI) has the potential to improve performance in the environmental dimension of companies as new or improved products or services can reduce the emission of polluting gases and the use of harmful materials to the environment. Companies that invest in this type of innovation not only improve their environmental indicators, but also leverage their market share (Lin *et al*., 2013; Huang and Li, 2017).

The literature on Sustainability-oriented innovation (SOI) addresses five key objectives for discussion: strategic, operational, organizational, collaborative (including stakeholders) and systemic

changes in innovation (Albareda and Hajikhani, 2019). There is a growing concern and interaction between business management and research in the Sustainability-oriented innovation (SOI) area, managers are making changes towards this type of innovation while exploring new business models and creating or "co-creating" sustainable products and/or services (Albareda and Hajikhani, 2019).

According to González-García *et al*. (2012), eco-innovation in products can be a way to reduce the environmental impact of companies by developing an ecological product design. However, it will only occur if the design has ways to reuse residues, optimize raw materials and reduce energy use (González-García *et al*., 2012; Kneipp *et al*., 2018).

In general, Sustainability-oriented innovation (SOI) constantly seeks processes that improve the economic, social, and environmental aspects involved in creating value. It is suggested that in the future the "Innovation for Sustainability" research field will no longer be necessary, considering that every innovation will be in accordance with the Triple Bottom Line (Bocken *et al*., 2019).

In a qualitative study that analyzed the innovation processes combined with the sustainability practices of Brazilian multinationals, Marcon *et al*. (2017) the results suggested that companies have invested in actions to raise awareness about the importance of caring about the environment among suppliers, customers, and the community. The study highlights the
Natura case, a company that invests in innovation centers and finances research on biodiversity, agronomy and sustainability, and there are other cases that focus on communication strategies for more sustainable and conscious consumption.

To meet the research's objective with the background of the previous literature, the following research hypothesis is presented:

H_1: Process and organizational innovation has a positive and significant relation with social and environmental sustainability.

2.2 Process and Organizational Innovation (POI) and Product, Market, and Technical Innovation Performance (PMTIP)

Innovation is vital for the survival, growth, and competitive advantage of companies (Teece, 2010). According to the OECD (2018) the PMTIP is defined as a welfare or service that is significantly different from the products or services previously marketed by the company.

Tuan *et al*. (2016) found evidence that some types of innovation are more important to improve innovation's performance and this one can improve the performance of the company. Therefore, companies should concentrate their efforts on POI, as they have a positive influence on product, market and technical innovation performance.

In the sequence, Lee *et al*. (2019) found evidence that in low-tech industries the process innovation only has a positive effect in the organization's performance when moderated by organizational innovation. That shows that companies that are more opened to organizational changes tend to get better results from process innovation.

Gunday *et al*. (2011) discuss that in general innovation brings noticeable changes in the performance of companies. When analyzing manufacturing companies, they suggest that managers should focus their

efforts on product and process innovations to achieve sustainable development. Therefore, managers should develop a clear innovation strategy that helps to understand the impact of R&D, innovation itself and of the entrepreneurship in the company's performance (Ramadani *et al*., 2019).

An innovative company is one that has implemented new products or processes over time and requires conditions of novelty and use. It implies that activities that collaborate with the innovation process are successful if a product innovation was obtained (Amabile *et al*., 1996; OECD, 2018). Furthermore, innovation is considered an antecedent in the organization's performance. Research indicate that performance is influenced by innovation (Calantone *et al*., 2002; Chapman, 2006; Likar *et al*., 2014; Nambisan, 2013; Nybakk and Jenssen, 2012; Oke *et al*., 2012).

H_2: Process and organizational innovation has a positive and significant relation with product, market, and technical innovation performance.

2.3 Product, Market, and Technical Innovation Performance (PMTIP) and Social and Environmental Sustainability (SES)

Companies that are concerned about sustainability tend to develop governance mechanisms for socio-environmental issues that prioritize stakeholder engagement. To achieve that, companies have developed strategies that benefit the environment and the society by adopting practices such as reports, internal and external communication, analysis of non-financial indicators about employees and the establishment of socio-environmental standards in the selection of suppliers (Eccles *et al*., 2014).

Zhu *et al*. (2016) saw that Chinese state-owned companies that implemented improvements in job security, political responsibility and human rights achieved better social and financial performance. They certificated that these practices brought a positive image to the companies' brand and a greater employee satisfaction at work.

Agudo-Valiente *et al*. (2015) found out a positive relation between the way companies generate interaction and communication with stakeholders and the performance in corporate social responsibility. The establishment of communication channels with the different stakeholders allows the company to identify those demands that can improve the performance of social practices by concentrating efforts on what is important for customers, employees, and the community.

Zhang *et al*. (2019), when analyzing Chinese governmental companies, stated that patents for environmentally friendly products are positively associated with organizational performance. In addition to that, the company's ability to adopt environmental practices focused on reducing the energy consumption and the pollution, as well as the establishment of partnerships with suppliers and other institutions to implement those practices, has a positive impact in market performance.

Annunziata *et al*. (2018) and Gomes *et al*. (2013) say that companies tend to integrate corporate sustainability practices with organizational performance. Despite the model expressed in studies, in which socio-environmental practices influence performance, this study points out that performance influences socio-environmental practices.

We understand performance is made of several dimensions, and unlike financial measures, non-financial measures can provide strategic information, such as some projections to prevent, anticipate and

influence future results, constituting trend indicators. It does not mean that financial measures should be abandoned, but when it comes to evaluating strategies, it is necessary to complement them with non-financial measures (Bititci *et al*., 1997; Gomes *et al*., 2013).

H_3: Performance in product, market and technical innovation has a positive and significant relation with social and environmental sustainability.

2.4 Process and Organizational Innovation (POI), Product, Market, and Technical Innovation Performance (PMTIP) and Social and Environmental Sustainability (SES)

Process innovation makes a positive change in the environmental sustainability of companies as it leads to a higher level of engagement with environmental practices, due to the fact that the company seeks, through these sustainability practices, to stand out in the market (Moyano-Fuentes *et al*., 2017). In the literature there is evidence that an organization's innovation capacity is a key resource to acquire competitive advantages by improving its performance in the Triple Bottom Line aspects (Nidumolu *et al*., 2013; Muhamad *et al*., 2014).

In addition, studies indicate that companies that invest in Sustainability-oriented innovation (SOI) processes achieve superior financial performance. That is a consequence from the fact that companies that try to develop processes, products or services that harm less the environment, for example, improve their image, reputation and legitimacy with stakeholders (Aguilera-Caracuel; Ortiz-de-Mandojana, 2013).

Ghassim and Bogers (2019) investigated companies of the mining industry and proved that the Sustainability-oriented innovation (SOI) links stakeholder's engagement with profitability. They found that the company's ability to develop Sustainability-oriented innovation (SOI) is improved by the engagement of stakeholders, as it provides a wide range of knowledge that supports the efforts and results of innovations. With a greater capacity to innovate and a focus on sustainability, the company's profitability tends to be bigger and the stakeholder's engagement helps to overcome the uncertainties of innovation.

Maletič *et al*. (2016) found empirical evidence that innovation, when guided by sustainable practices, can improve economic results. The authors verified the effect of Sustainability-oriented innovation (SOI) on economic, quality, innovation, environmental and social performance. In addition, they found out a positive relationship between Sustainability-oriented innovation (SOI) practices and environmental performance and also between the development of competence to achieve innovations and improve the economic performance of industrial companies and service providers in five countries (Germany, Poland, Serbia, Slovenia and Spain).

Despite everything, many companies still act as if they should choose between products and/or services that involve better design and processes from a socio-environmental point of view and those that only offer financial benefits. However, they do not realize that when Triple Bottom Line (TBL) principles guide innovation processes, costs tend to decrease due to more efficient use of resources and the adoption of processes that promotes less waste and that improve the company's image (Nidumolu *et al*., 2013).

The literature indicates that innovation has the potential to improve social and environmental sustainability (Lin *et al*., 2013; Huang and Li, 2017), besides that, those are understood as components that are not causally related. About that, the organization with low performance in market and technical

innovation tends to have the managers prioritizing and dedicating themselves to the survival of the company, leaving aside socioenvironmental sustainability practices, except by imposition of a coercive force (Nidumolu *et al*., 2013; Islam *et al*., 2019).

Duque-Grisales and Aguilera-Caracuel (2019) have observed a moderating effect of the financial clearance in the relationship between the environmental, social and governance dimensions on financial performance. They highlighted that financial resources could facilitate the investment in other issues than their own operation, such as environmental, social and governance, because these resources can be appropriately designated.

When companies are successful in their process innovation efforts, they develop better quality products with better market performance, besides that, they reduce the production time cycle, what leads to an improved performance in a significant way (Rajapathirana and Hui, 2018). According to Guerrero-Villegas *et al*. (2017), innovation improves the relation between the adoption of corporate social responsibility practices and the performance of companies.

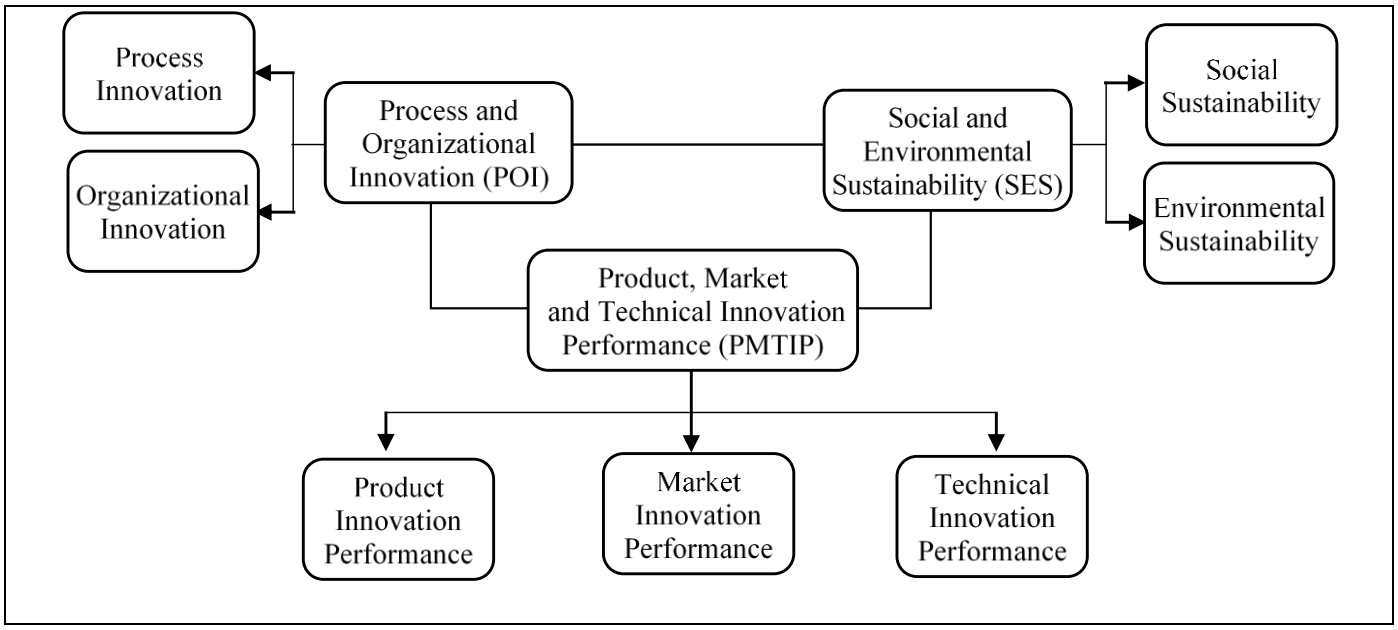
A company's proactive posture in developing new organizational processes and formats that improve sustainability practices, such as reducing CO2 emissions, reducing the use of energy and toxic materials, leads to the development of products and services that meet a demand for eco-friendly products, and also improves the company's sustainability indicators (Tsai and Liao, p.10, 2017).

The process of manufacturing products or providing services can cause of the environment's degradation. Thus, the design of "eco-friendly" products/services reduces the socio-environmental impacts caused by the manufacturing process, improving the company's socio-environmental indicators (Fuller and Ottman, 2004).

H_4: Process and organizational innovation, mediated by product, market and technical innovation performance has a positive and significant relation with social and environmental sustainability.

The established hypotheses define the theoretical research model (Board 1) with "process and organizational innovation", "product, market and technical innovation performance", "market and technical innovation" and "social and environmental sustainability".

Board 1 - Theoretic model



3 Research Methodology

3.1 Population, sample, and data collection

This research is descriptive and has a quantitative approach, since the relation between the Process and Organizational Innovation, Social and Environmental Sustainability and the Product, Market and Technical Innovation Performance of industrial companies was statistically verified.

The research population was formed by 288 industrial companies located in the Chapecó region, in Santa Catarina, Brazil. As for the minimum sample size, one of the criteria is the observation of the maximum number of predictors of the theoretical model. In this study there was a maximum of 4 predictors used, and parameters with a 5% significance level and statistical power of 80%. Thus, to detect a minimum R^2 value of 0.25, at least 41 cases are required (Hair et al., 2017).

The data collection occurred through the application of a questionnaire, using an online platform. There was no missing data identified because the instrument was configured to not allow the respondent to go ahead without answering all the statements. The sample consisted of accessibility and 66 responses were obtained. Three companies that were part of the same economic group were excluded, resulting in 63 valid questionnaires and the survey was applied in October and November of 2019.

Box plots analysis was performed using IBM SPSS Statistics software to identify possible outliers. Six indicators were identified and a maximum of 4 cases had outliers, deleting only the data, and generating missing data. No cases were deleted, since it was not identified as a typical response of a specific group of the population (Sarstedt and Mooi, 2014).

Statistical calculations were performed using SmartPLS software version 3.3.2 (Ringle et al., 2005). A variance-based PLS (Partial Least Squares) approach is preferable to covariance-based methods, since PLS imposes less strict restrictions on sample size and distribution (Chin et al., 2003). PLS is a SEM (Structural Equation Modeling) technique, which simultaneously evaluates a measurement model with the theoretical structural model (Chin, 1998). The application of the PLS model occurs in two stages. The first stage estimates the measurement model using confirmatory factor analysis to assess the reliability and

validity of the theoretical constructs. Then, the structural model's estimate examines the associations between the research constructs.

3.2. Measures

As a technique for data collection, it was used a questionnaire composed of 57 questions and Likert scale, which ranged from 1 (strongly disagree) to 5 (strongly agree). The assertions for each dimension in Board 2 are found in Appendix A.

Board 2 - Research construct

Code	Dimension	Authors
PI	Process Innovation	Shaukat *et al.* (2013); Lee *et al.* (2019); González-García *et al*. (2012)
OI	Organizational Innovation	Shaukat *et al*. (2013); González-García *et al*. (2012)
PIP	Product Innovation Performance	Kneipp *et al.* (2018); Bocken *et al.* (2019); Duque-Grisales and Aguilera-Caracuel (2019)
MIP	Market Innovation Performance	Kneipp *et al*. (2018); Bocken *et al.* (2019); Duque-Grisales and Aguilera-Caracuel (2019)
TIP	Technical Innovation Performance	Kneipp *et al*. (2018); Bocken *et al.* (2019); Duque-Grisales and Aguilera-Caracuel (2019)
SS	Social Sustainability	Nidumolu *et al*. (2013); Albareda and Hajikhani (2019); Ramadani *et al.* (2019)
ES	Environmental Sustainability	Nidumolu *et al*. (2013); Albareda and Hajikhani (2019); Ramadani *et al.* (2019)

Source: prepared by the authors.

4 Results and Discussion

4.1 Measurement model

The evaluation of convergent and discriminant validity determines the measurement model's validation. The convergent validity of the scales depends on the fulfillment of three criteria: loading of indicators must exceed 0.700 (Bagozzi et al., 1991; Hair et al., 2011; Hair et al., 2017), Composite Reliability (CR) must be higher than 0.700 (Bagozzi and Yi, 2012; Hair et al., 2011; Hair et al., 2012) and less than 0.950 (Hair et al., 2017) is recommended, this way the indicators with low and high loading were removed. Finally, the AVE - Average Variance Extracted is admitted if the value is higher than or equal to 0.500 (Hair et al., 2011; Hair et al., 2013).

The data to observe the convergent and discriminant validity conditions are valid and shown in Board 3.

Board 3 - Descriptive statistics and convergent and discriminant validity

Second-order Constructs	First-order constructs	Mean	S. D.	Range of loadings		CR	AVE	HTMT confidence interval does not include 1
				Min	Max			
Process and Organizational Innovation (POI)	Process innovation	3,090	1,439	0,808	0,867	0,881	0,711	YES
	Organizational innovation	3,222	1,350	0,700	0,804	0,798	0,570	YES
Product, Market and Technical Innovation Performance (PMTIP)	Product Innovation performance	3,450	1,370	0,819	0,834	0,866	0,683	YES
	Market Innovation performance	3,889	0,971	0,831	0,878	0,918	0,737	YES
	Technical Innovation performance	3,464	0,902	0,884	0,891	0,918	0,788	YES
Social and Environmental Sustainability (SES)	Social Sustainability	3,587	1,248	0,804	0,870	0,876	0,701	YES
	Environmental Sustainability	3,099	1,451	0,732	0,870	0,869	0,624	YES

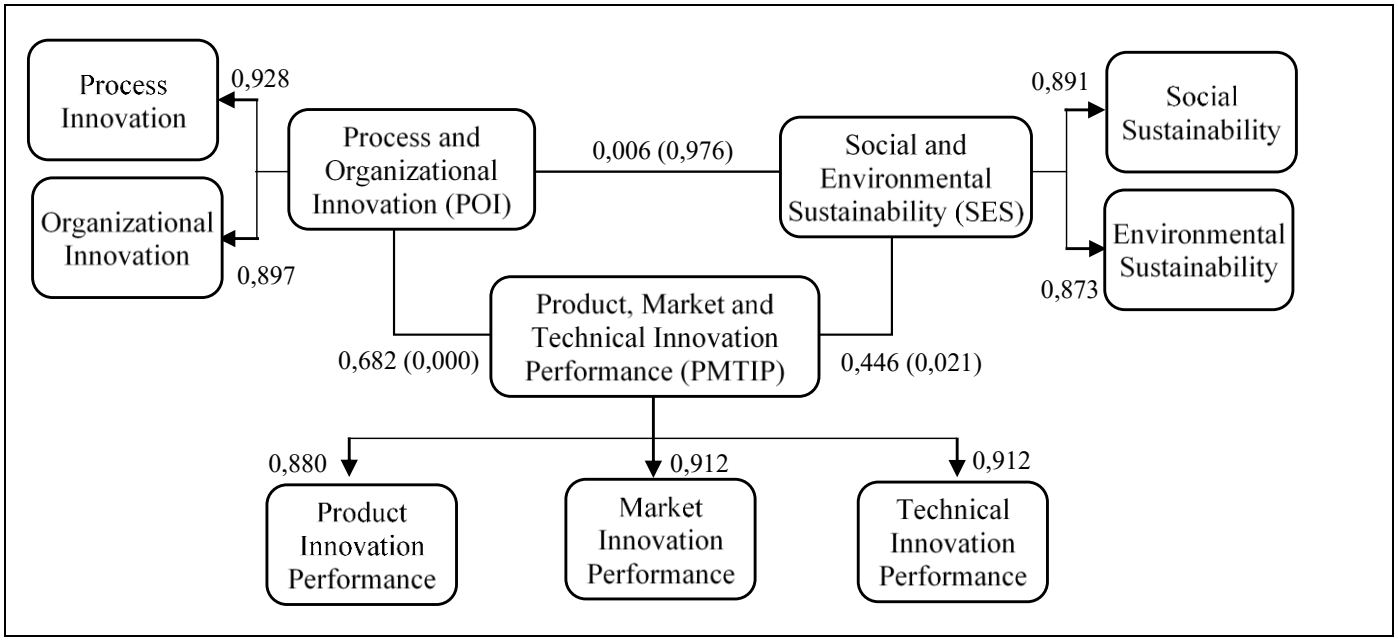
Source: survey data.

To define the discriminant validity, the HTMT (Heterotrait Monotrait Ratio) proposed by Henseler et al. (2015) was verified, which should assume a lower value than 1.00. Thus, HTMT (Heterotrait Monotrait Ratio) does not include 1, verified by a bootstrapping procedure calculated at a 95% confidence interval, considered adequate.

4.2 Structural Model

A PLS-SEM approach was selected to estimate the results' evaluation model. This procedure raised the generation of path coefficients and R^2 squares. R^2 squares were calculated to assess the predictive power of the structural model, innovation performance explained 20.20% of the variation in sustainability. A bootstrapping technique with a 10,000 re-sampling was performed by the SmartPLS software to calculate the path estimates and p-value to test the significance of the hypotheses (Board 4).

Board 4 - Research model



Source: survey data.

The 5th Board summarizes the empirical results to meet the research objective, testing the following hypotheses.

Board 5 - Structural model: decomposition of effects

Hypotheses	Structural Path	Total Effect	p-value	Hypotheses Testing*
H1	POI➔SES	0,310	0,011	Supported
H2	POI➔ PMTIP	0,682	0,000	Supported
H3	PMIP➔ SES	0,446	0,021	Supported
H4	POI ➔ PMTIP ➔ SES	0,310	0,011	Supported

Significance: p-value ≤ 0,05

Source: survey data

Concept related results of mediation analysis regarding hypothesis H4 can be defined as the relation between an independent variable and the dependent one, mediated by a third variable that carries itself the effect of the independent variable on the dependent one (Baron and Kenny, 1986; Hair et al, 2017), understood as complete mediation.

A bootstrapping test of the indirect effect was performed, which is suitable for evaluating the effect of mediating variables in the PLS-SEM method. It was implemented in the SmartPLS 3 software (Hair et al., 2017; Ringle et al., 2015). The mediating approach between innovation and sustainability, with performance as a mediating variable had the indirect effect of the coefficients between innovation and performance. However, there was a positive but not distinguished sign in the direct effect between innovation and sustainability, so it was characterized as a complete mediation.

4.3 Discussion of Research Results

The research realized that innovation has an indirect effect on sustainability through performance. Performance depends on innovation. Therefore, if an organization strives to improve performance, it needs to focus on creating an environment that is opened to innovation. This study demonstrated a positive and significant relationship between innovation and performance and that a manager who focuses on improving innovation also helps to improve performance.

Process innovation can use manufacture, goods production, or services, either if they are new or significantly improved. It also can use a new or significantly improved logistics system or delivery method or it can use new or significantly improved equipment and techniques in production support activities, such as: production planning and production control software, IT infrastructure in performance measurement, quality control, purchase, maintenance or computing.

Innovation can also be organizational, making significant changes in relationship with other companies or public and nonprofit institutions, such as the establishment of alliances, partnerships, outsourcing or subcontracting activities for the first time. Innovation can occur by making significant changes in new media's concepts/strategies, or the use of techniques for promoting product marketing. There could also be implemented new work methods organization to improve the distribution of responsibilities and of the decision-making power, such as the establishment of teamwork, decentralization, or departments integration.

As a conclusion, the managerial effort in process and organizational innovation can be defined as a mechanism for improving performance in product, market, and technical innovation of industrial companies in Chapecó, Santa Catarina, Brazil. It was clear that process and organizational innovation have no direct effect on social and environmental sustainability, but they have an indirect effect mediated by performance.

As for the performance in product innovation, there is the likely effect of introducing a new product (good or service) or significant changes in aesthetics, design or other subjective changes, at least in one of the products, or even introducing a new or significantly improved product (good or service) to the national market. The market performance results in maintenance and expansion of the company's market share, as well as the opening of new markets. Finally, technical performance provides an improvement in the quality of goods or services, expansion in the variety of goods or services offered, powered by operational flexibility, increase in production or service provision capacity, reduction of production costs or of services provided.

As a conclusion, good performance helps socio-environmental sustainability. Social sustainability, defined as documented and formal practices that clarify the parameters encouraged in the company's relationship with interested ones, the search for stakeholder's participation in the review of the formal document, the relevant observation of actions to develop the local community by generating work and income, as well as measures to reduce poverty and increase inclusion in society. Finally, the encouragement of the voluntary work of its employees in the community and recognition of the importance of the voluntary work of its employees, disseminating it through murals, an internal newspaper, or a local newspaper.

Environmental sustainability, defined as the company's understanding and evaluation of the impacts of its activities in the environment (such as emission of pollutants and high consumption of energy, water

and fuel), combined with the maintenance of indicators and reports to measure and accompany them. Also, the search to use materials that reduce damage in the environment in its processes and the discussion of partnerships with suppliers to return discarded materials to the manufacturer. An effective way to reduce environmental impacts ans raise awareness is the promotion of environmental education for employees, their families, and the community.

In recent years, some studies have investigated the relationship between process and organizational innovation and its effect on product, market, and technical performance (Gunday et al., 2011; Shaukat et al., 2013 and Lee et al., 2019). The results confirm that process and organizational innovation benefits the performance of product, market, and technical innovation. However, it does not directly predict socio-environmental sustainability, confirming the results of some previous studies (Muhamad et al., 2014; Moyano-Fuentes et al., 2017).

The conclusions of this article indicated that good performance creates a favorable environment for socio-environmental practices. Therefore, there is evidence that financial resources facilitate the efforts to combine innovation with environmental and social sustainability practices (Duque-Grisales and Aguilera-Caracuel, 2019).

5. Conclusions

The aim of the study was to analyze the relationship between process and organizational innovation, performance in product, market and technical innovation and social environmental sustainability. The study proposed a theoretical that provided insights to understand the mechanisms of this relationship, analyzing the impact between innovation and sustainability, mediated by performance.

The literature review indicates the existence of several studies relating innovation to performance; besides that, few studies relate performance to the socio-environmental dimensions of sustainability. This relation has implications since institutions with good performance find a favorable environment for socio-environmental sustainability. In the other hand, organizations with a lack in performance do not have available resources and time of managerial dedication to their socio-environmental practices.

This result is possibly occasioned by the fact that companies that are more aware of environmental sustainability are also concerned about preserving good environmental conditions for the surrounding community, so they adopt cooperation practices that involve the education and the environmental awareness of stakeholders. In addition, companies that are concerned about social aspects of sustainability seek, in their internal public, ways to contribute and improve the life quality of those close to them, starting by buying from and training closer suppliers, what generates business opportunities, income and tends to improve the social indicators of the surrounding community. Another theoretical contribution is focused to fill the lack of Sustainability-oriented innovation (SOI) studies aimed at micro, small and medium-sized companies, as warned by Klewitz and Hansen (2014).

The practical contributions point to the importance attributed by managers of micro, small and medium companies to the need of considering innovation elements for good performance, and in the sequency adopting sustainable practices to seek the global sustainability of the enterprises.

The limitations of the study were the condition of a non-probabilistic sample, whose results should

be simply considered, avoiding generalization, even though they provide important insights about the investigated companies' behavior. Additionally, the use of a questionnaire as a data collection instrument does not allow to deepen the qualitative aspects of innovation, sustainability practices and the reasons for their adoption.

Future studies may consider the influence of coercive forces in organizational performance and that could indirectly interfere in socio-environmental sustainability. It is also recommended to implement the research in other regions of the country, to verify whether the behavior of micro, small and medium-sized companies is similarly manifested. Another possibility is to apply a qualitative study, using in-depth interviews to assess the motivations that drive companies to adopting innovative and sustainable practices. Additionally, other performance criteria of the companies can be considered.

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Appendix A

CODES	ASSERTIVES
PROCESS INNOVATION	
PI_01	In the last three years, the company started to use a new or significantly improved method of manufacturing or producing goods or services.
PI_02	In the last three years, the company started using a new or significantly improved logistics system or delivery method for its inputs, goods, or services.
PI_03	In the last three years the company started using equipment, and new or significantly improved techniques in production support activities, such as: production planning and control software, performance measurement, quality control, purchase, maintenance or computing / infrastructure from you.
ORGANIZATIONAL INNOVATION	
OI_01	In the past three years, the company has made significant changes in relations with other public or non-profit companies or institutions, such as the establishment of alliances, partnerships, outsourcing or subcontracting activities for the first time.
OI_02	In the last three years, the company has made significant changes in the concepts / strategies of new media or techniques for promoting product marketing, for example; new ways of placing products on the market or sales channels; or new pricing methods for the sale of goods and services.
OI_03	In the last three years, the company has implemented new methods of work organization to improve the distribution of responsibilities and decision-making power, such as the establishment of teamwork, the decentralization or integration of departments, etc.
PRODUCT INNOVATION PERFORMANCE	
PIP_01	In the last three years the company has introduced a new or significantly improved product (good or service) for the company, but already existing in the national market.
PIP_02	In the last three years, the company has made significant changes in aesthetics, design, or other subjective changes in at least one of the products.
PIP_03	In the last three years, the company has introduced a new or significantly improved product (good or service) for the national market.
MARKET INNOVATION PERFORMANCE	
MIP_01	It allowed to maintain the company's participation in the market
MIP_02	Expanded the company's market share
MIP_03	Allowed to open new markets
TECHNICAL INNOVATION PERFORMANCE	
TIP_01	Improved the quality of goods or services
TIP_02	Expanded the range of goods or services offered
TIP_03	Increased production or service capacity
TIP_04	Reduced production or service costs

SOCIAL SUSTAINABILITY	
SS_01	The company has a formal document that clarifies the parameters encouraged in its relations with interested parties.
SS_02	The company seeks to involve its stakeholders (employees, customers, suppliers, community, and management) in the preparation and review of this document.
SS_03	The company considers it important and applies actions for the development of the local community through the generation of work and income, as well as measures to reduce poverty and increase inclusion before society.
SS_04	The company encourages the voluntary work of its employees in the community and recognizes the importance of the voluntary work of its employees, promoting it through murals, an internal newspaper, or a local newspaper.
ENVIRONMENTAL SUSTAINABILITY	
ES_01	The company knows, understands, and evaluates the impacts of its activities on the environment (such as emission of pollutants and high consumption of energy, water, and fuel), maintaining indicators and reports to measure and monitor them.
ES_02	The company seeks to use materials that can reduce damage to the environment in its processes. For example: it seeks to control and reduce noise, visual and air pollution caused by its processes.
ES_03	The company discusses partnerships with suppliers, aiming to return discarded materials (such as expired products, batteries, used tires and used lamps, packaging, etc.) to the manufacturer.
ES_04	The company promotes environmental education for employees, their families, and the community, as an effective way to reduce environmental impacts.

HYBRID MODE OF BIBLIOMETRY AND TECHNIQUE OF PROSPECTIVE SCENARIOS FOR INDUSTRY 4.0 ASSOCIATED WITH INTELLECTUAL CAPITAL

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Abstract

The prospective scenarios technique conducts strategic planning as a futuristic signpost for the management goals of Industry 4.0 in its technological advances, directed towards the development of productive digitalization and creation of value connected to Intellectual Capital as an aggregator of economic value in the organizational process. The objective of this research is to propose a hybrid modality of bibliometrics and the prospective scenario technique for Industry 4.0 associated with Intellectual Capital. In the methodological stages of this study, the insertion of the Bibliometric Laws of Lotka,

Bradford, and Zipf and its informative potential stand out, aiming to assist in the decision-making process of strategic planners.

Keywords: industry 4.0, prospective scenarios, intellectual capital, bibliometrics.

1. INTRODUCTION

The resources of the company's knowledge have a positive influence on products and their values, stimulating competition and growth. Therefore, the drive towards the strategic development, success and growth of a company in the present and in the future, such as Industry 4.0, potentially depends on the use of the set of elements that constitute Intellectual Capital, increasing over the decades and asserting itself as a significant theme in the economic environment, as well as in the different theories that focus their attention on intangibles in order to provide explanations, useful information for measuring and identifying plausible variables for incorporation and increased performance assisting in the business management process (Hernandez, Moreno, & Arroyo, 2012, Angelini, Gennaro, & Labella, 2019).

In turn, in the business knowledge management process, there was a strong influence due to the incorporation of the Industry 4.0 model, conceptualizing itself as the consolidation of a fourth industrial revolution strengthened and triggered by a series of technological advances aimed at achieving the complete digitalization of production and promotion of the use of connected devices in increasing customization through analytical data from customers and consumers (Abreu, 2018).

This real-time data connectivity of the company marks Industry 4.0, providing successive information through a tablet on the factory floor and offering numerous advantages and facilities in the current production models, its growth in the course of discoveries and evolutions had its beginning at the end of the 18th century with steam engines and the use of hydraulic power, beginning the 1st Industrial Revolution, representing a great advance at the time. The 2nd Industrial Revolution appeared at the end of the 19th century and the beginning of the 20th century with the arrival of electric energy and essentially corrective production due to productive prioritization. The 3rd Industrial Revolution is represented by means of electronics and investigative technologies (information systems), allowing productive automation and spreading extremely quickly, directly influencing the need to reduce time, personnel and unproductivity, giving rise to the term predictive maintenance. Given this evolutionary process, the future is a construction resulting from several changes in the course of history that impacted the industry we know today (Borlido, 2017).

The objective of this research is to propose a hybrid modality of bibliometrics and the prospective scenario technique for Industry 4.0 associated with Intellectual Capital. The methodology is anchored in the modalities of prospective scenarios relevant to strategic organizational planning adapted from de Schwartz (2004), Marcial, Chervenski, Okado, Wosgrau, and Carvalho (2015), Stelzer, Meyerbrötz, Schiebel, and Brecht (2015), Sturari and Korilio (2017), and Araújo, Hoffmann, abd Pizzolato (2018).

2. RELEVANCE AND JUSTIFICATION OF THE FUTURISTIC THEME

The importance and justification of the futuristic theme for the prospective scenarios for Industry 4.0 in

association with Intellectual Capital is anchored in the need for organizational survival in face of the challenges imposed by the globalized market. It is worth mentioning that the prospective of scenarios is not a forecast or a projection, scholars of this area do not aim at a proposal to guess the future, "this is the result of the actions, attitudes and decisions" taken since the present and, should it not exist at all, all those who intend to foresee it would be impostors. However, there is the possibility of reducing uncertainties towards the construction of a better future for organizations, through the use of techniques, prospective methods and the adoption of proactive actions jointly by the interested parties, towards the changes with plausibility of occurrence inserted in the temporal perspective. in question. Complying with this vision, the industry that does not commit itself to the perspective of innovation and knowledge through its Intellectual Capital, anticipating the future (Schenatto, Polacinski, & Abreu, 2011, Sturari, 2008, & Angelini *et al*., 2019).

Through the future benefit or all knowledge about the market, functional experience and its importance in the management of the company's intangible resources, Intellectual Capital encompasses all hidden assets that generate value, it can also be understood as the ability to surpass the sum of other assets, creating value through interactivity that benefits companies in operation and adds value in the development of internal activities or when they are in connection with different stakeholders (Rossato, Zancan, Kesseler, & Piccinin, 2015).

The measurement of Intellectual Capital will laterally remain in an adaptable and modeled process for evaluating the added value of other new types, leading the models for measuring Intellectual Capital to a constant evolution, aiming to encompass new theories, new knowledge and new types of capital. The measurement of corporate intangible assets plays a central, continuous and intermittent role in any organization, aiming at competitive advantage and sustainability. (Oliveira, Nascimento, & Dalkir, 2016)

In this sense, the importance of managing intangibles with an intense focus on Intellectual Capital (CI) is highlighted as the main source of value creation and a plausible way to reconfigure the business models of the productive industries, focused on strategic decision making in the future of Industry 4.0 (Cabrita, Cruz-Machado, & Duarte, 2018).

2.1 The Strategic Perspective of the Prospective Scenarios

In 1956 the philosopher Gaton Berger, considered one of the fathers of the "prospective" in France, for being the creator of this word as an intelligence of the present, illuminating the probable future to come, this process originated by virtue of his participation in two world wars, testifying about the human capacity of irreversible acts and their philosophical reflections on the meaning of life in a fast-paced world, where the future needed a meaning (Pinto, 2015).

This panoramic direction towards the uncertainties of the future and the prediction of occurrences aiming at a more adapted response to the rapid changes of the external environment, towards the guarantee of competitiveness and longevity is provided by the process of construction of prospective scenarios, assisting in the high management of the development of the strategic planning. On the other hand, some managers demonstrate a short-sighted and only projective view based on statistics from the past without considering the future variables that potentially will affect the company's results in a positive or negative way (Netto, 2018).

Thus, the scenarios are the beginning of a long process of strategic achievements to be adopted by the company and do not guarantee the exemption of the negative results of the organization; although these representations were elaborated as close to the future reality, the understanding and application of a forecast adjusted to the market and its uncertainties depends on the potential of the actions on the formulated strategies and the flexibility and speed of the necessary changes (Faller & Almeida, 2014).

Complementing this view, the strategic perspective assumes that prospective scenarios are fundamental tools for managing auxiliary risks in the conduct of organizational objectives, expanding the potential towards defenses and threats using the opportunities arising from the external environment, ensuring the success of business in the present, past and future (Netto, 2018).

The futuristic representation by the modality of widely used prospective scenarios, should not be confused as a forecast, since its purpose is to guide strategic decision making (Schenatto *et al*., 2011).

Inserted in the route of definitions and strategic options that prioritize qualitative aspects, centralization of efforts and conjugation of actions aiming to make the desire for a plausible future in the business environment, these "prospecting" studies involve exploratory or normative methods and consider collective reflection for the challenges of future decision-making, based on economic, social, scientific and technological aspects (Stelzer *et al*., 2015).

In this way, Bibliometrics can be understood as a trail of knowledge and complementary research in the development of studies that seek to systematize the academic literature on a specific subject, expanding the notion that this complement will occur as the quantification of bibliographic data in certain content, plausible answers such as: Who researches in partnership?; What are the most common key terms?; What are the most influential works?; Where is it most researched?; Who is in the forefront of research?; What group of authors is systematically cited by others? The analysis of the answers to these questions from the perspective of laws and bibliometric indicators, presents potentiality of criteria for predilection of readings that should constitute the theoretical framework, state of the art, argumentation, production of insights for new areas of study and in accordance with the quantity of bibliographic data, the use of bibliometric software/tools certify their potential aid to the researcher in the analysis of bibliometric studies, their combination with the scenario technique leads to a more accurate projection of future states (Stelzer *et al*, 2015, Leite, Silva, Aragão & Camargo, 2019).

2.2 The Benefits of Combining Bibliometry with the Scenario Technique

The general benefit of combining bibliometric methods with the scenario technique is the integration of scientifically based information that exceeds the knowledge bases of the scenario team and other experts. Most notably, the examination of large amounts of specific information that facilitate the identification of emerging technologies (Stelzer *et al*., 2015).

Table 1 shows articles that combine Bibliometry with the Scenario Technique and other modalities.

Table 1. Articles that combine Bibliometrics and other modalities

AUTHOR	TITLE	MODALITY ASSOCIATION
Piirainen, K. A., Kortelainen, S. and Lindqvist, A. (2010)	Translating scenarios for management: Use of system dynamics modeling to quantify scenarios	Scenarios and Simulation
Saritas, O. and Aylen, J. (2010)	Using scenarios for roadscript: The case of clean production	Scenario Technique with Roadmapping Technology
Hirsch, S., Burggraf, P. and Daheim, P. (2013)	Scenario planning with integration quantification: Managing uncertainty in building corporate strategy	Scenario Technique with System Dynamic Simulation
Li, X., Zhou, Y., Huang, L., Wang, K. and Huang, Z., (2013)	Research on the development path of China's solar photovoltaic industry based on technology and bibliometrics roadmap	Bibliometrics with Roadmapping Technology
Zhang, Y., Guo, Y., Wang, X., Zhu, D. and Porter, A. L, (2013)	A hybrid visualization model for technology roadmap: bibliometrics, qualitative methodology and empirical study	Bibliometrics with Roadmapping Technology
Gerdsri, N., Kongthon, A., Vatananan, R.S. (2013)	Mapping the evolution of knowledge and the professional network in the field of technology roadmapping: a bibliometric analysis	Bibliometrics with Roadmapping Technology
Watatani, K., Xie, Z., Nakatsuji, N. and Sengoku S. (2013)	Global competences of regional stem cell research: bibliometrics to investigate and predict research trends	Scenario Technique with Bibliometrics
Letaba, P. T., Pretorius, M. W. and Pretorius, L. (2014)	The Use of Bibliometrics in the Development of Technological Roadmaps: Planning the Industrial Impact of Emerging Technologies	Bibliometrics with Roadmapping Technology
Huang, L., Zhang, Y., Guo, Y., Zhu, D, and Porter, A. L. (2014)	Science and technology planning in four dimensions: a new approach based on bibliometrics and technology roadmap	Bibliometrics with Roadmapping Technology
Stelzer, B., Meyerbrötz, F.,	Combining scenario technique with bibliometrics for technology prediction: The	Scenario Technique with Bibliometrics

Schiebel, E. and Brecht, L. (2015)	case of personalized medicine	
Cho, Y, Daim, T. U. and Sklar, P. (2015)	Prediction of OLED TV technology using bibliometrics and Fisher-Pry diffusion model	Scenario Technique with Bibliometrics
Sheikh, Nasir J.; Sheikh, Omar (2016)	Prediction of biosensor technologies for emerging point of care applications and medical IoT using bibliometrics and patent analysis	Bibliometrics, Technical Scenarios with Technology and Patent Analysis
Lokuhitige, S. and Brown, S. (2017)	Forecasting the maturity of IoT technologies in the top 5 countries using bibliometrics and patent analysis	Bibliometrics, Technical Scenarios with Technology and Patent Analysis
Wang, B. Liu, Y., Zhou, Y. and Wen, Z. (2018)	Emerging nanogenerator technology in China: a review and forecast using the integration of bibliometrics, patent analysis and technology mapping methods.	Technology Roadmapping, Bibliometrics, Scenario Technique, with Technology and Patent Analysis
Yuchen, H., Yajuan, Y., Kai, H. and Lei, W. (2019)	Development trend and future response on methods of recycling spent lithium-ion batteries based on bibliometric analysis	Scenario Technique with Bibliometrics

Source: Adapted from Stelzer et al. (2015)

Stelzer *et al*. (2015) listed the advantages and benefits of combining bibliometric methods with the scenario technique, which are: a) Corrects deficiencies in mutual combinations, resulting in a holistic tool for conducting predictions; b) Integrates and allows projections of precise analysis of long-term scenarios and considers socioeconomic factors, thus overcoming the short term associated with bibliometrics; c) Avoids fictitious forecasts inserted in the scenario technique and demonstrates usefulness in the short-term evaluation of bibliometric approaches ; d) It leads to a more accurate projection of future states by narrowing the scenario's funnel; e) Facilitates the identification of emerging technologies; f) It aggregates ample and current information from the scientific literature that exceeds the knowledge base of the scenario team and other specialists. Bibliometric studies can contribute to the task of systematizing research in a field of knowledge, seeking solutions so that the researcher is not influenced in their literature reviews and proposing problems for the investigation of future research (Chueke & Amatucci, 2015, & Gianardolli, 2016).

2.3 The Visual Notability of Bibliometric Networks

The establishment and prominence of research in several scientific areas of bibliometric studies is mainly due to the emergence of these different software tools. The most notable advantage of these tools stands

out, the visualization of bibliometric networks, which aim to identify knowledge bases and research fronts in a large number of articles. These authors identified sixteen bibliometric tools, four of which were selected for an in-depth comparison of resources, in order to highlight their advantages and deficiencies; its final results show that Biblioshiny and VOSviewer proved to be the most complete of the tools analyze (Moreira, Guimarães & Tsunoda, 2020).

Biblioshiny proved to be the most complete tool; however, it has deficiencies in relation to the visualization of the maps and its launch in 2017, it certainly shows limitations concomitantly with its evolutionary potentialities. On the other hand, although VOSviewer does not provide specific analyzes for the laws of Lotka and Bradford, its strong point is concentrated on the visualization of the networks, allowing the visualization of the processed data in table format, being able to be exported to other programs, enabling new types of analysis (Moreira *et al*., 2020),

Although there is an absence of specific Vosviewer analyzes for Lotka's bibliometric laws (relationship between authors and their scientific productivity), Bradford (relationship between number of journals and published articles) and Zipf (correlation between the number of words and the frequency of their use) in documents with a specific subject), the identification of these triple laws, can be inserted through the analysis of co-authoring networks (Lotka's Law), word co-occurrence networks (Zipf's Law) and periodical citations networks (Bradford's Law) (Leite *et al*., 2019).

Regarding bibliometric laws, it is understood that Lotka's Law examines the authors' scientific productivity; in short, it analyzes the contribution of each one to scientific dissemination in their respective area of knowledge, aiming at the identification of the most productive authors. Bradford's Law admits the calculation of the degree of relevance of journals in a defined area of knowledge, their historical evolutionary process in number of publications, as well as the journals that most published on the subject. The frequency of occurrence of words and the main thematic approaches are estimated by the Zipf Law in a given scientific / technological text (Rodrigues & Vieira, 2016).

2.4 Vosviewer and its Application in the Viewing, Construction and Analysis of Bibliometric Networks

The VOSviewer software focuses on visualization of bibliometric networks, meets the main requirements of the area and presents a clean and simple graphical interface with reliable results, using an equally reliable data source, its processing has several data reduction options through presentation of your resources to the user. Its techniques are based on similar principles that avoid results that are inconsistent with the unified principle for the production of maps and clusters. Its approach holds a differential when it takes into account the theoretical foundations through which clusters (clusters that represent elements that have interconnection) are formed and maps constructed (Gianordoli, 2016, Moreira *et al*., 2020);

Schaller and Thesenvitz (2019) point out that in the process of building the network maps of links, the Vosviewer software is used in its essence in: Analysis of citations, which allows the researcher to detect popular sources and publications, as well as authors; cocitation analysis, which allows to understand the extended effects of the citations in a given body of knowledge; bibliographic coupling, which allows the researcher to see documents, authors and even journals connected based on the number of common references; coauthor analysis, which allows the researcher to find articles that are co-authors. On the other

hand, they highlight the multiplicity of VOSviewer options in different variants, such as, for example, in the process of cocitation analysis, which can be carried out in journals, authors and documents.

3. Methodology Procedures

The methodology procedures of this research were adapted from Araújo *et al*, (2018); two central phases were inserted by these authors: a) analysis of the chosen prospective scenarios and b) proposal for the construction of the stages, as can be seen in the following topics.

3.1 Analysis of the Chosen Prospective Scenarios

In this phase, the analysis of the modalities of prospective scenarios chosen for this proposal occurs, containing the "Strategic Prospective" as an intersection point and the "Strategic Planning", as a connective point in its general structure, synthesized in stages of Schwartz's modalities (2004), Marcial (2015), Araújo *et al*. (2018), Sturari & Korilio (2017), and Stelzer (2015) summarized in Table 2.

Table 2. Modalities used for the construction of prospective scenarios

	Schwarz (2004)	Marcial *et al* (2015)	Sturari e Korilio (2017)	Araújo *et al* (2018)	Stelzer (2015)
1	Identify the central issue or decision	Document identification	Context Analysis (classify uncertainties)	Identification of Problem	Define the analysis object
2	Key Forces in the Local Environment	Identification of the seeds of the future	Selection of Critical Uncertainties	Analyze the Environment	Identify the main driving forces
3	Identification of the driving forces of the macroenvironment	Evaluation and Integration	Identification of Predetermined Elements	Analyze the historical and current moment of the company	Derive projections and decide on the number of scenarios to be built
4	Hierarchization of key factors by importance and uncertainty	Identification of Global Megatrends	Morphological Analysis	Identify the main variables	Cluster projections in consistent packages of alternatives
5	Selection of scenario logic	Justification of Global Megatrends	Augur Consultations	Create Alternative Scenarios	Describe scenarios

		and their seeds of futuro			
6	Scenario writing		Augur Consultation Processing	Describe the scenario in detail	Identify disturbing events and their effects on scenarios
7	Analysis of implications		Identification of Reference and Optimistic Scenarios	Develop strategies	Identify emerging technologies for each scenario
8	Selection of initial indicators and warning signs for Monitoring the future		Identification of Focal Scenario	Monitor scenarios and strategies	Explore the implications for technology strategy and develop action plans
9			Determining Structuring Policies		
10			Description of Focal Scenario		

Source: Elaborated by the authors, 2021

The Strategic Prospective allows for a “visit to the future”, essential for the success of management; it is not a forecasting exercise. It consists in adopting a preemptive approach in the face of uncertainty in the planning and management process, ceasing to be an eventual one and becoming a continuous learning process at all levels of administration. Thus, the adjective "strategic" indicates that the Prospective falls within a contextual range of Strategic Management, differentiating itself from merely prospective studies limited to futurology exercises and although they present a certain importance, they do not constitute value aggregator (Sturari & Korilio, 2017).

Thus, Foresight and Planning, pointing out that, although they seem to overlap at times, when in reality they are opposed, while Foresight outlines a path to a desired future, planning guides the way along this path in an efficient and effective manner. This vision of strategic planning can be established through the construction of an ambitious scenario with fundamental assumptions chosen such as: vision, mission, objectives, actions, goals, indicators, etc. In turn, the prospective scenario emerges as a compass that enables a strategic drive of success that will make it possible in the future to achieve the ambitioned goals (Pinto, 2015).

3.2 proposal to Build the Steps

In the constructive proposal of the ten stages of this research, the insertion of the Bibliometric Laws of Lotka, Bradford and Zipf is highlighted in the proposal of the hybrid modality of the Prospective Scenarios of Industry 4.0 in association with Intellectual Capital, with informational potential to assist in the decision-making process of planners strategists and researchers interested in a futuristic industrial vision, consisting of 10 stages adapted from the modalities of Schwartz (2004), Marcial *et al*. (2015), Araújo *et al*. (2018), Sturari and Korilio (2017), and Stelzer *et al*. (2015), as described in Figure 1.

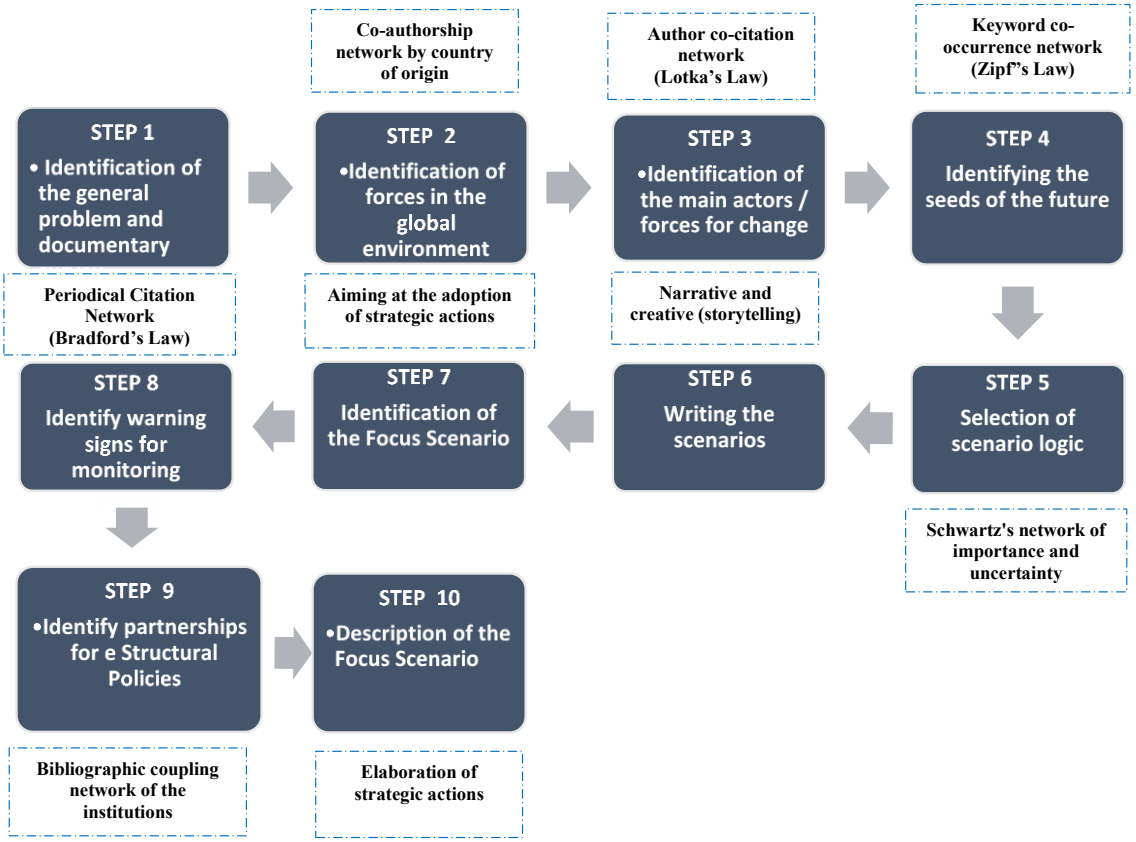

Figure 3. Hybrid modality of bibliometrics and prospective scenario techniques for Industry 4.0 associated with Intellectual Capital.

Source: Elaborated by the authors

The desire for knowledge of the future has impacted human generations with intriguing nods of impossibility; however, through the methods and techniques of Strategic Prospective and Strategic Planning, Prospective Scenarios, the flexibility of these models aims to assist in decisions, to anticipate certain trends and ruptures offering significant competitive advantages in the most challenging business environments (Sturari & Korilio, 2017). In this challenging environment, the modality created in this research, preliminarily intends a better comprehensibility and decision-making aid of strategic planners

and researchers interested in a futuristic industrial vision. In the following topics, there is a description of the construction process of the ten (10) stages with their objectives and aspects.

Step 1 - Identification of the general problem and documentary survey

In the context of prospecting for Industry 4.0 associated with Intellectual Capital, according to the assessment environment, in the analysis process, the provision of alternative paths to new challenges should be a keynote for the scenario team. Ex: What are the prospective scenarios for Industry 4.0, associated with Intellectual Capital?

Using the main academic databases available for analysis of bibliometric networks, make a documentary survey on studies with long-term world scenarios in the dimensions adapted from PESTELE analysis (political, economic, social, scientific and technological, environment, legal, etc.).

Step 2 - Identification of forces in the global environment

In this stage, we seek to identify forces in the global environment surrounding the main question, using the analysis of the co-authorship network by country of origin of the authors.

Step 3 - Identification of the main actors / forces for change, in their historical and current moment

It seeks to identify and understand the behaviors, evolutionary mechanisms of the actors of the past and the present moment of the research object of study through the analysis of the co-citation network of authors.

Step 4 - Identifying the seeds of the future

The identification and projection of the seeds of the future is a key factor in the construction process of prospective scenarios as existing landmarks or signs that point to plausible alternatives for the future through the co-occurrence network of keywords and how they are related to the object of study.

Step 5 - Selection of scenario logic

In this step, the logic of the scenarios is selected, the seeds are classified according to the ranking of importance and uncertainty through which, the logical description of the scenarios will be given in the form of a narrative.

Step 6 - Writing the scenarios

In this stage, the writing of scenarios in the form of narrative and creative, (eg Storytelling) showing the scenarios as photographs of the future, explaining the global evolutionary insertion in the pre-established time horizon, turning to the main question;

Step 7 - Identification of the Focus Scenario

Right after the narrative description of the scenarios, the “Focus Scenario” must be identified at a level of significance for the organization to adopt attitudes and measures.

Step 8 - Identify warning signs for monitoring

Identify warning signs, aiming at monitoring through the main networks of journals and how they are related to the dissemination of their strategic information according to the object of the study by checking the citation network.

Step 9 - Identify partnerships for establishing Structural Policies

Identify external institutions / organizations considering the Focus Scenario for the development of actions and activities by the organization for promising consolidation of the future through the network of bibliographic coupling of the authors' home institutions.

Step 10 - Description of the Focus Scenario

In this stage, the Focus Scenario is described with the evolutionary narrative of the actions taken by the main actors and how strategies were developed to face threats and opportunities.

In the process of creating the scenarios, the basic steps are the same, whether for an individual, small business or large company; essentially, this creative path is improved in the decisions, in the search for other key elements, in the attempt of new plots and in the insistence of the essays. The ordering of the stages can be mixed, its beginning can be based on a new discovery, justifying that the development of the scenarios is an art and not a science (Schwartz, 2004).

4. CONSIDERATIONS

The proposition of the ten (steps) of the bibliometric hybrid modality and the prospective scenarios technique for Industry 4.0 associated with Intellectual Capital was preliminarily anchored, due to the relevance of the prospective scenarios technique to allow the strategic planning direction as a guiding arrow of the management goals of Industry 4.0, its connective and technological advances in association with Intellectual Capital in the view of Rossato *et al*. (2015) emerges as a role that aggregates economic and future benefits and creates value in the internal activities of industrial operations in its connectivity with the different stakeholders.

The proposed modality was analyzed, compared and adapted from five existing prospective modalities Schwartz (2004), Marcial *et al.* (2015), Araújo *et al*. (2018), Sturari and Korilio (2017), and Stelzer *et al*. (2015).

Among the advantages of the combined methods, the correction of mutual deficiencies stands out, avoiding the insertion of fictitious forecasts of the scenario technique and aggregation of an amplified long-term perspective for bibliometrics, highlighting also the potential of the knowledge inserted in the texts academics compared to the stage crew and other futuristic experts.

Thus, mentioning preliminarily that the creation of the modality evidenced in the course of the text, inserts the Focus Scenario as a differential hybrid inducer for the organizational elaboration of strategies to face threats and opportunities. In turn, its other objectives signal for informational potential, aiming to assist in the decision process of strategic planners and researchers interested in a futuristic industrial vision.

For future work, we suggest the practical application of the hybrid modality of bibliometrics and the technique of prospective scenarios for Industry 4.0 associated with Intellectual Capital, as well as its adaptation to other themes connected in several interdisciplinary areas of organizational management.

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Optimal Pairs Trading Strategy under Geometric Brownian Motion and its Application to the US stocks

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Abstract

This study is a study on pair trading, a representative market-neutral investment strategy. A general pair trading strategy uses econometric techniques to select a pair of stocks and calculates the trading price level depending on a single variable called the variance of stock returns without any theoretical background. This study applies the optimal pair trading strategy proposed by Liu et al. (2020) to the top US market cap stocks and examines its performance. This strategy proposes a mathematical background for optimally calculating the trading price level. Since the statistical method for pair selection can be omitted, a pair can be formed only with good stocks with guaranteed liquidity. In addition, strategic risk management is possible because the stop loss set according to the market situation is performed. As the top 10 market cap stocks traded on the US exchange, daily closing price data for 10 years from 2011 to 2020 were applied to optimal pair trading. It was confirmed that the rate of return may differ depending on the adjustment of various parameters including the level of stop loss. In this study, an applicated strategy that properly managed pairs trading and stocks together earned the minimum annual average return 17.88% and the Sharpe ratio reached 1.81. These numbers can be better with the adjustment of the parameters.

Keywords: Pair Trading Strategy; US Stocks; Optimal Trading; Market Neutral Strategy;

1. Introduction

This study is about pairs trading strategy, one of the representative market neutral trading strategies. Pairs trading is a strategy for two stocks with interlocking stock price flows, and make a profit with buying relatively undervalued stock and selling overvalued stock at the same time. This is a statistical arbitrage strategy that realizes returns based on the assumption that the prices of these two stocks will return to similar values at some point in the future.

Pairs trading strategy is a long-short strategy developed by Nunzio Tartaglia, a Wall Street quant in the 1980s. (Gatev, Goetzmann and Rouwenhorst (2006)) In addition to this, extensive research has already been conducted on general pair trading strategies, and well-organized subjects can be found in Vidyamurthy (2004). Kim and Kim (2019) suggested an optimized price level by applying deep learning technology to a pair trading strategy. However, in a typical pairs trading strategy, the trade timing is determined when the

spread between two linked stocks is ±2 standard deviation, and there is no mathematical background for this. In particular, the time series of stocks selected as pairs must intersect within a certain period due to the assumption of the strategy, and the number of pairs that satisfy this must be relatively small. Therefore, even if enough data is collected, there is inevitably little data available. Because of these weaknesses, the pair is mainly selected for stocks in the same sector. The statistical method of selecting pairs usually uses a cointegration test.

Portfolio selection and trading rules based on mathematical theory have been studied for about 20 years. Zhang (2001) proposed a mathematical solution for optimizing transaction returns based on regime switching model. Song and Zhang (2013) calculated the optimal price level for the trading point of the two stocks, assuming that the difference between the two stock pairs statistically related to each other follows a regime switching model. Tie, Zhang and Zhang (2018) calculated an optimized price level by expanding the conditions of the pair with a very common assumption that the two stock pairs each follow the geometric Brown model. However, in the study of Tie et al. (2018), there is a lack of a stop loss condition, which is an essential risk management method when operating a pair trading strategy. Liu, Wu and Zhang (2020) introduces the optimal pairs trading strategy of the two stocks following the geometric brown model by supplementing the weakness of cut loss.

In this study, I intend to apply the model of Liu et al. (2020) to the actual US stock market. This model has the advantage that there is no need to consider statistical methods for selecting pairs, as it makes the general assumption that stocks follow the geometric Brownian model. The limitation of Liu et al. (2020) seems to have been concluded with an emphasis on mathematical results. There are only two practical examples of applying the results of their paper to the market, Walmart and Target, and GM and Ford.

The contributions of this study are summarized in three ways. First, there is a clear mathematical background that was not found in the existing general pairs trading strategy, and by omitting the statistical procedure for pair selection, a simple and reliable pairs trading strategy is presented. Second, the method proposed by Liu et al. (2020) is applied to the actual US market to find its results. Third, we examine the sensitivity to portfolio performance of parameters not covered in detail in Liu et al. (2020) to find ways to improve performance.

The structure of this paper is as follows. Section 2 summarizes the methodology of Liu et al. (2020) Section 3 briefly introduces the collected U.S. market capitalization data and stocks, and presents methods for measuring performance. Section 4 summarizes the research results, and Section 5 summarizes the results of the study with conclusions.

2. Determination of the trading price levels of the optimal pairs trading strategy

Let $\{X_t^i, t \geq 0\}$ denote the price level of stock S^i at the time t for i $\in\{1, 2\}$. Then

$$\mathrm{d}\begin{pmatrix} X_t^1 \\ X_t^2 \end{pmatrix} = \begin{pmatrix} X_t^1 & 0 \\ 0 & X_t^2 \end{pmatrix}\left[\begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} dt + \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{pmatrix} d\begin{pmatrix} W_t^1 \\ W_t^2 \end{pmatrix}\right] \quad (1)$$

where μ_i, i $\in\{1, 2\}$, are the return rates, σ_{ij}, i, j $\in\{1, 2\}$, are the volatility constants, and (W_t^1, W_t^2) is a 2-dimensional standard Brownian motion. Let Z_t be the position of long S^1 and short S^2 at time t. Let

$\tau_0 < \tau_1 < \tau_2 < \cdots$ denote sequence of stopping time. $\tau_0 < \tau_2 < \tau_4 < \cdots$ is the time sequence of selling Z_t, and $\tau_1 < \tau_3 < \tau_5 < \cdots$ is the time sequence of buying Z_t. Let K denote the fixed percentage of transaction costs associated with buying and selling of stocks S^i, i $\in\{1, 2\}$. Let $\beta_b = 1 + K, \beta_s = 1 - K$. Let $\rho > 0$ is a given discount factor, or a penalty for late earnings realization, and $\mathrm{I_A}$ is a dummy variable for event A. (i.e., 1 if event A occurs, 0 otherwise).

In this study, I consider the state constraint variable for cutting loss. The stop loss level is set to M, and the transaction will continue only in the state of $X_t^2/X_t^1 \leq \mathrm{M}$. Let us call the point of stop loss as $\tau_{\mathrm{M}} := \inf\{t: X_t^2/X_t^1 > \mathrm{M}\}$. Given the initial state $(X_0^2/X_0^1) := (x_1, x_2)$, the corresponding reward functions:

$$\mathrm{V}(\mathrm{x}_1, \mathrm{x}_2) := sup_{\{\tau_0,\tau_1,\ldots\}} E\{[(\beta_s X_{\tau_2}^1 - \beta_b X_{\tau_2}^2) I_{\{\tau_2<\tau_{\mathrm{M}}\}} - (\beta_b X_{\tau_1}^1 - \beta_s X_{\tau_1}^2) I_{\{\tau_1<\tau_{\mathrm{M}}\}}]$$

$$+[(\beta_s X_{\tau_4}^1 - \beta_b X_{\tau_4}^2) I_{\{\tau_4<\tau_{\mathrm{M}}\}} - (\beta_b X_{\tau_3}^1 - \beta_s X_{\tau_3}^2) I_{\{\tau_3<\tau_{\mathrm{M}}\}}] + \cdots\} \quad (2)$$

Suppose that $\rho > \max(\mu_1, \mu_2)$. Based on the above notation and assumptions, the procedure for obtaining the price levels of trading during the back-testing period by applying the data during the observation period is as follows.

1. Applying the stock price data of S^1 and S^2 during the observation period, calculate the annualized stock returns μ_1, μ_2, covariance $\sigma_{12} = \sigma_{21}$, and standard deviations σ_{11}, σ_{22}.

2. Calculate $a_{11} = \sigma_{11}^2 + \sigma_{12}^2, a_{12} = \sigma_{11}\sigma_{21} + \sigma_{12}\sigma_{22}, a_{22} = \sigma_{21}^2 + \sigma_{22}^2$ and $\lambda = \frac{a_{11} - 2a_{12} + a_{22}}{2}, \lambda \neq 0$.

3. Calculate $\delta_1 = \frac{1}{2}\left(1 + \frac{\mu_1 - \mu_2}{\lambda} + \sqrt{(1 + \frac{\mu_1 - \mu_2}{\lambda})^2 + \frac{4\rho + 4\mu_1}{\lambda}}\right) > 1,$

$$\delta_2 = \frac{1}{2}\left(1 + \frac{\mu_1 - \mu_2}{\lambda} - \sqrt{(1 + \frac{\mu_1 - \mu_2}{\lambda})^2 + \frac{4\rho - 4\mu_1}{\lambda}}\right) < 0.$$

4. Define a function $f(r) = \delta_1(1 - \delta_2)(\beta_b r^{-\delta_2} - \beta_s)(\beta_b - \beta_s r^{1-\delta_1})$

$-\delta_2(1 - \delta_1)(\beta_b r^{-\delta_1} - \beta_s)(\beta_b - \beta_s r^{1-\delta_2})$, and find r_0 which satisfies $r_0 > (\frac{\beta_b}{\beta_s})^2$ and $f(r_0) = 0$. In this study, I used the Newton-Raphson method to obtain a numerical solution of r_0.

5. Find $k_1 = \frac{\delta_2(\beta_b r_0^{-\delta_1} - \beta_s)}{(1-\delta_2)(\beta_b - \beta_s r_0^{1-\delta_1})} = \frac{\delta_1(\beta_b r_0^{-\delta_2} - \beta_s)}{(1-\delta_1)(\beta_b - \beta_s r_0^{1-\delta_2})}$,

$$k_2 = \frac{\delta_2(\beta_b r_0^{1-\delta_1} - \beta_s r_0)}{(1 - \delta_2)(\beta_b - \beta_s r_0^{1-\delta_1})} = \frac{\delta_1(\beta_b r_0^{1-\delta_2} - \beta_s r_0)}{(1 - \delta_1)(\beta_b - \beta_s r_0^{1-\delta_2})}.$$

6. Let $f_2(\mathrm{x}) := \frac{\mathrm{M}^{\delta_1}(\mathrm{x}(1-\delta_2)\beta_\mathrm{s} + \delta_2\beta_\mathrm{b})}{\mathrm{x}^{\delta_1}} + \frac{\mathrm{M}^{\delta_2}(\mathrm{x}(\delta_1 - 1)\beta_\mathrm{s} - \delta_1\beta_\mathrm{b})}{\mathrm{x}^{\delta_2}} + (\beta_\mathrm{s} + \mathrm{M}\beta_\mathrm{b})(\delta_1 - \delta_2)$, and find $f_2(k_3) = 0$ such that $k_3 \in (k_2, \mathrm{M})$. In this study, I used the binomial method to find a numerical solution of k_3.

7. Sell Z_t if the time series data X_t^2/X_t^1 is less than k_1 and buy Z_t if the time series data is greater than k_2 during the back-testing period. If X_t^2/X_t^1 is greater than k_3, then sell Z_t and close the transaction.

8. Calculate the outcome of the transaction by calculating the value function $\mathrm{V}(\mathrm{x}_1, \mathrm{x}_2)$ which is the sum of the profits from the transaction of portfolio Z_t during the back-testing period.

3. Data, strategy, and performance measurement

The data in this study uses daily adjusted closing price data of the top 10 US market caps for 11 years from January 4, 2010 to December 30, 2020. Data was obtained from https://finance.yahoo.com/, and these data are allowed for general use. To secure the trading liquidity of stocks, the stocks were selected by renewal at the beginning of each year, focusing on the top stocks based on the US market cap. Once 10 stocks are selected, data on the observation period to generate the parameters and the back-testing period to measure the performance are obtained. The parameters for selling, buying, and stopping loss of the portfolio (k_1, k_2, k_3) introduced above are recalculated every 6 months using data from the past 1 year before the start of trading (called observation period), and the back-testing period is maintained for 6 months after the parameter's calculation. For example, suppose that the investment principal is P, and pairs trading is conducted with 10 stocks for 6 months. For the selection of stocks, 10 stocks that are ranked among the top 10 in the US market cap are obtained for the business day prior to the back-testing period. Among these stocks, the number of pairs of randomly selected S^{i} and S^{j}, $1 \leqslant \mathrm{i}, \mathrm{j} \leqslant 10$, is $10 \times 9 = 90$ kinds of portfolios. When the price level of S^{i}, S^{j} is divided by each initial value, the initial value of Z_t is 0, and the value at point t of Z_t is $X_t^i/X_0^i - X_t^j/X_0^j$.

Let us consider the transaction of Z_t for the use of investment principal. Since the initial value of the initial Z_t is 0, there is no initial required amount. For purchase Z_t at $t=\tau_1$, S^{j} are required as much as $X_{\tau_1}^j/X_0^j$. This means that you can buy 1 stock of S^{j} at the beginning of the back-testing period, and it makes self-financing to buy S^{i} and sell S^{j}, so purchasing Z_t. This is because the stock S^{i} is relatively undervalued and the stock S^{j} is relatively overvalued at time $t=\tau_1$, and it makes $X_{\tau_1}^i/X_0^i - X_{\tau_1}^j/X_0^j < 0$. If short selling is possible, the above preparation of S^{j} is not required anymore, but even if short selling is prohibited, holding S^{j} stock at the start of investment will resolve the investment principal of the transaction. By adding the all returns until the end of the back-testing period, the value function $\mathrm{V}_{ij}(1,1)$ for the investment principal \$1 can be calculated. If you invest \$1 in the initial stock S^{j}, and buy S^{j} stocks with amount of $1/\beta_b$, and start trading, you can get the value function $\mathrm{V}_{ij}(1,1)/\beta_b$ for the pairs trading. By selling the initially purchased stock S^{j} at the end of the back-testing period, the final return is calculated as $(\mathrm{V}_{ij}(1,1) + \beta_{\mathrm{s}} X_{\mathrm{T}}^j/X_0^j - 1)/\beta_b$. In summary, if short selling is allowed, the final return is calculated as $\mathrm{V}_{ij}(1,1)$ through pure pairs trading. On the other hand, if short selling is not allowed, the initial \$1 is invested to S^{j} and the final return is calculated as $(\mathrm{V}_{ij}(1,1) + \beta_{\mathrm{s}} X_{\mathrm{T}}^j/X_0^j - 1)/\beta_b$. To simplify the calculation of the return on investment of principal, this study assumes that \$1 is initially invested in stocks S^{j} and considers two valuation methods.

An additional consideration is about the end of the back-testing period with buying Z_t. In this case, there may be gains or losses when selling, but I assumed that the average is converged to zero. This is extended for a total of n=90 positions, and if you invest P/n in each position, you can calculate the sum of all value functions multiplied by the investment amount $\mathrm{P}(\sum_{\mathrm{i,j}}^{\mathrm{n}} V_{\mathrm{ij}}(1,1))/(\mathrm{n}\beta_b)$ as the net return over 6 months. If

you carry this over for one year (two periods), you will get an annual return on investment, and for universal results, we will look at the average rate of return over 10 years.

In this study, I will compare three strategies. If short selling is allowed, the profit from pure pairs trading strategy is denoted as PT, if short selling is not allowed, the profit is denoted PTwS $= (V_{ij}(1,1) + \beta_s X_T^j / X_0^j - 1) / \beta_b$ that reflects the fluctuation of stocks along with pure pairs trading, and the third strategy is similar with a stock index denoted as 10 US stocks that the top 10 stocks based on the US market cap are weighted evenly. I will compare the returns and standard deviations for three types of investment strategies. And by calculating the Sharpe ratio (Sharpe (1994)), I will find out the adequacy of the return to risk of the three investment strategies. The definition of Sharpe's ratio is as follows. If R_a is the return on the investment strategy, σ_a is the standard deviation of the return on the investment strategy, and R_f is the risk-free interest rate, then the Sharpe index is given by:

$$S_a = \frac{E[R_a - R_f]}{\sigma_a}$$

4. Empirical result

In the 10-year period from 2011 to 2020, the number of business days for each year varies, but for convenience of calculation, the number of business days per year is supposed to be 252 days. Among the parameters, I assumed that the transaction cost ratio K=0.1%, a kind of discount rate ρ =100, and the level of cutting loss M=2. The list of the top 10 US stocks (10 US stocks) updated every year was collected as Table 1.

Table 1. Top 10 US stocks based on market cap from 2011 to 2020

When to measure	The ticker of 10 US stocks
2010 Dec	XOM, AAPL, MSFT, BRK-A, GE, WMT, GOOG, CVX, IBM, PG
2011 Dec	XOM, AAPL, MSFT, IBM, CVX, GOOG, WMT, BRK-A, GE, PG
2012 Dec	AAPL, XOM, GOOG, WMT, MSFT, BRK-A, GE, IBM, CVX, JNJ
2013 Dec	AAPL, XOM, GOOG, MSFT, BRK-A, GE, JNJ, WMT, CVX, WFC
2014 Dec	AAPL, XOM, GOOG, BRK-A, MSFT, JNJ, WMT, WFC, GE, PG
2015 Dec	AAPL, GOOG, MSFT, BRK-A, XOM, AMZN, FB, GE, JNJ, WFC
2016 Dec	AAPL, GOOG, MSFT, BRK-A, XOM, AMZN, FB, JNJ, JPM, GE
2017 Dec	AAPL, GOOG, MSFT, AMZN, FB, BRK-A, JNJ, JPM, XOM, BAC
2018 Dec	MSFT, AAPL, AMZN, GOOG, BRK-A, FB, JNJ, JPM, V, XOM
2019 Dec	AAPL, MSFT, GOOG, AMZN, FB, BRK-A, JPM, V, JNJ, WMT

Match of ticker and company			
Ticker	Company	Ticker	Company
AAPL	Apple Inc.	JNJ	Johnson & Johnson
AMZN	Amazon.com, Inc.	JPM	JPMorgan Chase & Co.
BAC	Bank of America Corporation	MSFT	Microsoft Corporation
BRK-A	Berkshire Hathaway Inc.	PG	The Procter & Gamble Company

CVX	Chevron Corporation	V	Visa Inc.
FB	Facebook, Inc.	WFC	Wells Fargo & Company
GE	General Electric Company	WMT	Walmart Inc.
GOOG	Alphabet Inc.	XOM	Exxon Mobil Corporation
IBM	International Business Machines Corporation		

As for the selection criteria, the top 10 stocks in the US stock market capitalization were selected in the month prior to the start of investment.

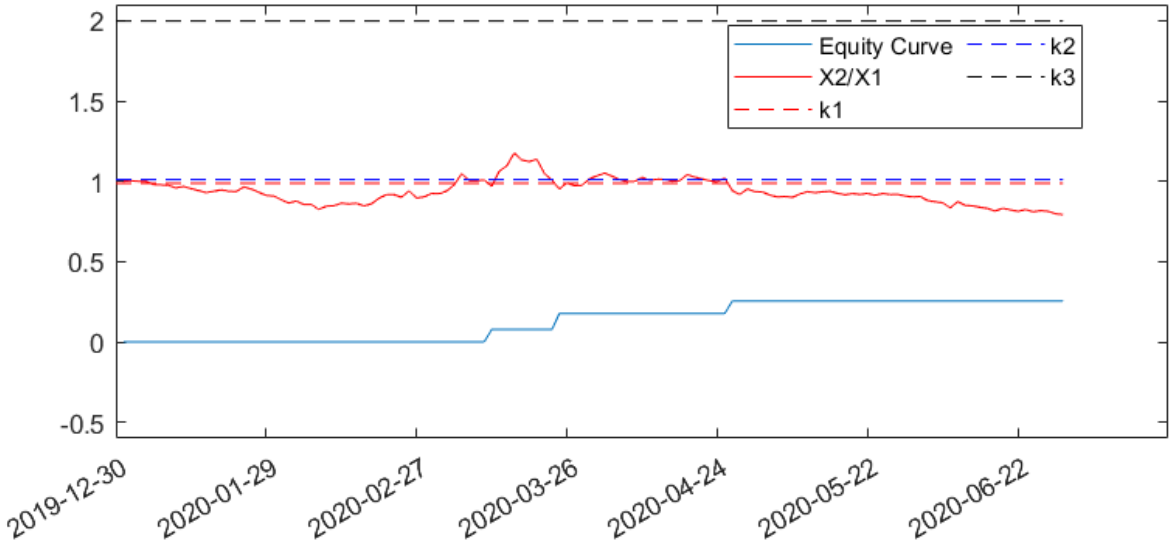

Figure 1. The performance of the pairs trading strategy in the first half of 2020 when substituting S^1 for MSFT and S^2 for WMT.

Figure 1 is a graph showing the price ratio (X_t^2/X_t^1) graph, the trading price levels, the stop loss level, and the curve of profit/loss after selecting an arbitrary pair to help understand the pair trading strategy described in this study. The blue line shows the Equity Curve, assuming that the pairs trading strategy is implemented in the first half of 2020 (126 business days) after substituting S^1 for MSFT and S^2 for WMT. I obtained k_1=0.9870, k_2=1.0097, and the level of stop loss k_3=1.9970, calculated by applying the daily adjusted closing price data for the one-year observation period in 2019, and the rate of return obtained through the three transactions reached 25.41%. Of course, all the 90 trades cannot be so successful. Let us look at the transaction when a stop loss occurs.

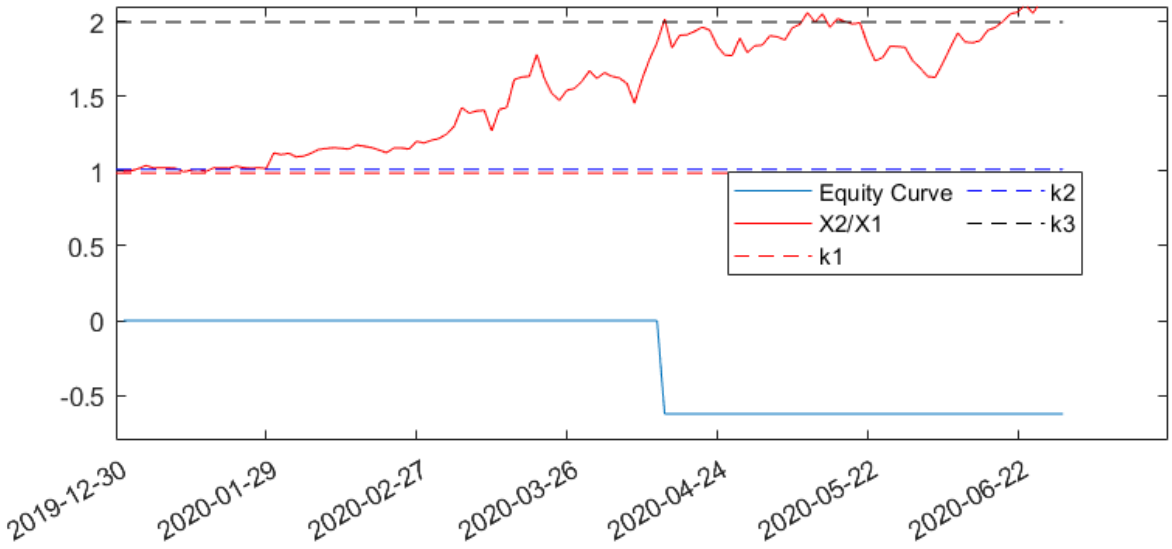

Figure 2. The performance of the pairs trading strategy in the first half of 2020 when substituting S^1 for JPM and S^2 for AMZN.

Figure 2 is a graph showing the execution of the pair trading strategy by substituting S^1 for JPM and S^2 for AMZN. This graph shows the Equity Curve when the price ratio reaches the stop loss level of k_3=1.9965 at the early of April. As a result of calculating the trading level in the same way, k_1=0.9862 and k_2=1.0110 were obtained, and the final loss due to stop loss was -62.27%. Both figures show only two cases of 90 portfolios traded in the first half of 2020, and the returns of all portfolios during this period are as follows.

Table 2. Return performances of all pairs that can consist of 10 stocks for the first half of 2020.

$S^1\backslash S^2$	AAPL	MSFT	GOOG	AMZN	FB	BRK.A	JPM	V	JNJ	WMT
AAPL	0	0	0.153	0.04	0.116	0	0	0.14	0.083	0.085
MSFT	0.051	0	0.092	0.084	0.1	0.024	0	0.028	0.077	0.254
GOOG	0.113	0	0	0	0	0	0	0.155	0.044	0.057
AMZN	0.057	0.117	0.039	0	0.125	0.096	0	0.039	0.057	0.074
FB	0.049	0	0.053	0	0	0.072	0	0.123	0.109	0.053
BRK.A	0	0	0	0.034	0.077	0	0	0	0	0.029
JPM	0	0	0	-0.62	0	0	0	0	0	0.049
V	0.133	0	0.171	0.034	0.107	0	0	0	0.153	0.08
JNJ	0.092	0.05	0.047	0.034	0.057	0	0	0.143	0	0
WMT	0.092	0.211	0.067	0.05	0.046	0.054	0.049	0.124	0.028	0

Table 2 shows the returns of all pairs earned by the pair trading strategy in the first half of 2020. Excluding the diagonal elements, their average is 41.49%, so it means that investing M/90 in 90 strategies with the initial principal of M earns 1.41M after 6 months (126 business days. When S^2 is AMZN and S^1 is JPM, the portfolio had negative return, but this is the case when the ratio of stocks X_t^2/X_t^1 reached the level of stop-loss, resulting in a loss.

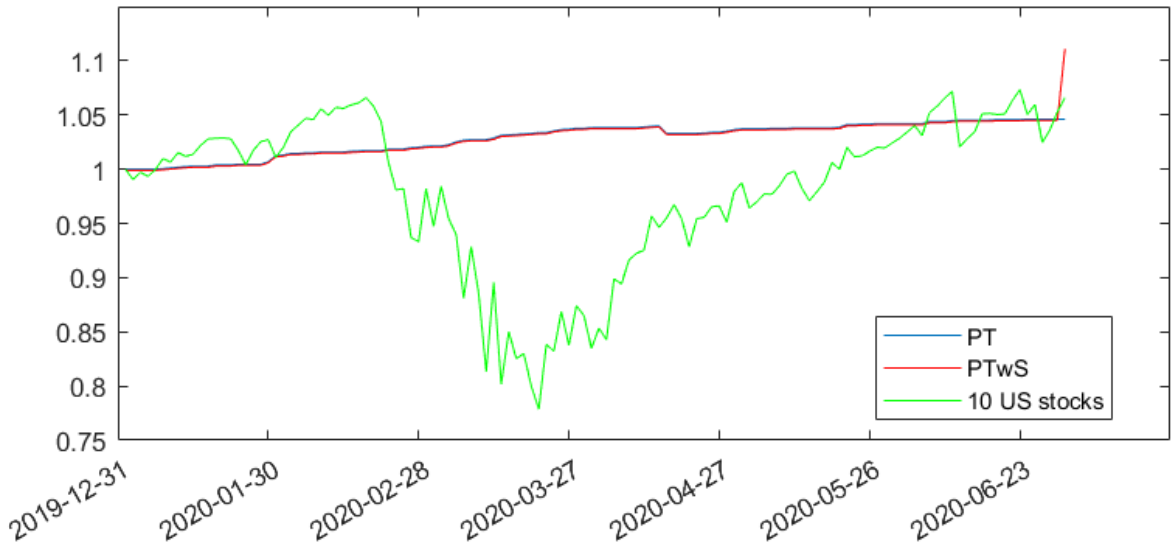

Figure 3. Comparison of the equity curves of PT, PTwS, and 10 US stocks for the first half of 2020.

Figure 3 shows the equity curves obtained from pure pairs trading (PT), pairs trading strategy with initial stock for S^2(PTwS), and an index (10 US stocks) generated by equal weights of the top 10 U.S. market capitalization stocks during the first half of 2020. Except for the maturity date of the transaction, the equity curves of PT and PTwS are very similar because the value of $1/\beta_b$ is close to 1. Since the PTwS strategy also considers the return of stock S^2, the profit/loss of stock S^2 purchased at the beginning of the transaction are realized on the maturity date, showing a dramatic difference only on the maturity date compared to the PT strategy.

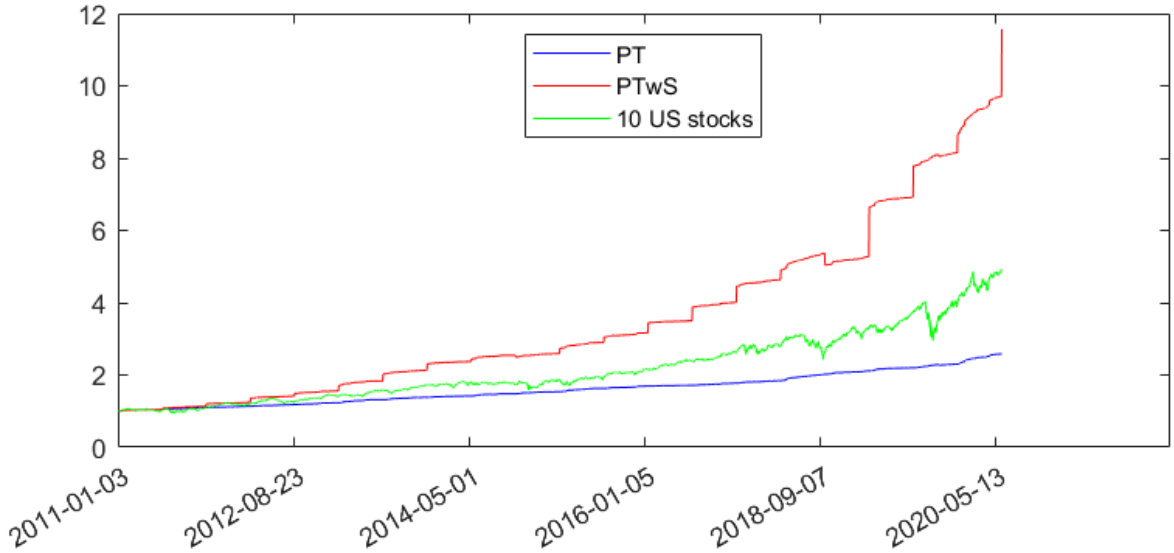

Figure 4. Comparing the equity curves of the three strategies when maintaining the PT, PTwS, and 10 US stocks strategies from 2011 to 2020

Figure 4 compares the equity curves of the three strategies continued for 10 years from 2011 to 2020. PTwS takes the form of realizing the fluctuations in the stock price purchased at the beginning of the back-testing period every six months along with the steady return of PT. Assuming the investment began in 2011, PT recorded a return of 158.01% and a return of 390.49% for 10 US stocks after 10 years. On the other hand,

PTwS showed the highest return of 1057.08%, reflecting the change in stock price of 10 US stocks every 6 months.

Table 3. Average and standard deviation of the 20 back-testing period returns

		PT	PTwS	10 US stocks
six month return	mean	4.88%	13.38%	8.51%
	standard dev.	2.36%	7.89%	7.31%
annual return	mean	9.99%	28.67%	17.88%
	standard dev.	3.53%	14.15%	13.11%
Sharpe ratio		1.98	1.81	1.13

Table 3 shows the average and standard deviation of the returns, assuming that the three strategies are executed for 20 back-testing periods every 6 months from 2011 to 2020. The return from the PT strategy achieved a stable rate of return of 4.88% on average and 2.36% standard deviation over the 6-month back-testing period. In terms of annual returns, it recorded stable returns with an average of 9.99% and standard deviation of 3.53%. The average return of the PTwS strategy was 13.38% for 6 months and 28.67% per year. The standard deviation of the PTwS strategy was 7.89% and 14.15% for 6 months and 1 year, respectively. The average return and standard deviation of the 10 US stocks strategy averaged 8.51% and 7.31% over 6 months and recorded 17.88% and 13.11% per year. Assuming risk-free interest rate of 3%, and calculating the Sharpe ratio, PT was 1.98, PTwS was 1.81, and 10 US stocks was 1.13. In general, if the Sharp ratio is less than 1, it is evaluated as a non-optimal strategy, if it is more than 1, it is a good strategy, and if it exceeds 2, it is evaluated as a very good strategy.

Table 4. Dependency of PT to K and ρ.

K \ ρ	5	10	50	100	500
0.0005	204.68%	228.73%	260.72%	267.96%	278.52%
0.001	193.42%	220.50%	253.62%	258.01%	277.12%
0.002	181.93%	206.45%	238.68%	249.85%	266.57%
0.003	177.70%	198.68%	227.92%	237.54%	259.68%

Table 4 is a measure of the sensitivity of the performance of the pairs trading strategy to the value of K and ρ. Since PTwS fluctuates often depending on the stock price, we will measure and compare relatively stable PT performance as a representative.

As an expected result, the performance of PT decreases as the K related to the transaction cost increases. As ρ increases, the rate of return increases more as described in Section 2. As mentioned above in Section 2, a big ρ with the observed data during the observation period calculates k_1 and k_2 so that they derive to realize returns in an early time. Therefore, it is more advantageous to increase the transaction performance by realizing profits during the back-testing period that maintains the nature of the observation period for an initial period. Therefore, the larger the rho is, the more advantageous it is. However, when it

is too large, the difference between k_1 and k_2 decreases, and it makes the opportunities of profit decreases as mentioned in Tie et al. (2018).

Finally, let us look at the data related to the sensitivity of PT performance to the change in the stop loss level and the number of cases reaching the stop loss level.

Table 5. Data related to the level of stop loss

Levels of cutting loss	PT returns after 10 years	CLn	ratio of approaching cutting loss level
1.5	202.48%	60	0.33%
1.6	228.08%	29	0.16%
1.7	237.83%	18	0.10%
1.8	245.57%	10	0.06%
1.9	251.54%	5	0.03%
2	258.01%	1	0.01%

Table 5 shows the data that can be observed when the price ratio of S^2 stocks compared to S^1, which is the level of stop loss, is changed from 1.5 to 2 times. The second column shows the sensitivity of PT earnings according to the level of stop loss. The higher the level of stop loss, the higher the PT income, but the higher the level of stop loss, the more the profit result is reflected without removing the uncertainty at maturity. The third column CLn (number of cut loss) shows how many 90 portfolios each year reach a stop loss every 20 investment periods over 10 years. In other words, it represents the number of cases where the change in the price level of 900×20 different portfolios reach the stop-loss level. The lower the level of stop loss, the higher the number of cases that reach the level of stop loss in the entire portfolio. The last column, ratio of approaching cutting loss level, represents the ratio of CLn (CLn/18000) in the entire scenario (900 portfolios × 20 investment periods). The higher the level of stop loss, the lower this rate.

5. Conclusion

Pairs trading is a risk neutral strategy that allows profits regardless of market conditions, and there are several operating methods to generate optimal profits. Through this study, we investigated how the pairs trading strategy can make a profit in the US market under the assumption that stocks follow the geometric Brown model. Unlike the traditional pair trading strategy, this study is a very simple pair trading strategy in that it achieves some profit while omitting the pair selection process. For the method of obtaining the optimal solution for determining the trading level, the research results of Liu et al (2020) were referred to, and the secondary application conditions were interpreted according to the actual market. Since the statistical analysis process for stock selection could be omitted, the liquidity of stocks was considered first in order to apply good stocks - the top 10 stocks based on the market capitalization of the U.S. stock market were selected from 2011 to 2020. The hypothetical portfolio that applied the same weight to the top 10 stocks in the U.S. posted an annual average return of 17.88% and volatility of 13.11%. Pairs trading strategy with cutting loss level as 2 has the return of 9.99% and volatility of 3.53%. On the other hand, the PTwS

strategy, which combines the two strategies, recorded a one-year yield of 28.67% and volatility of 14.15%, which was similar in volatility and a 10% higher return than the 10 US stocks strategy invested in ordinary stocks.

Research results related to the sensitivity of performance to ρ show that the above performance can be further improved. Depending on the appropriate application value of the variable ρ, it is possible to construct a trading strategy with better performance. In addition, when the price ratio of S^2 stocks to S^1, which is the level of stop loss, is 1.5 times or more, the probability of a stop loss is less than 0.5% of the total portfolio.

If high-frequency data is applied based on this study, it is expected to create a better strategy as more trading opportunities can be captured. In addition, a more efficient strategy may be operated if a suitable pair selection method is found for this strategy, or an optimal combination of the ratio and length of the observation period and the back-testing period is added.

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PHYSIOLOGY AND MORPHOLOGY OF RICE PLANTS WITH SILICON SUPPLEMENTATION AND DIETHOLATE SEED TREATMENT UNDER WATER DEFICIT

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Abstract

Silicon is an enzyme stimulator that promotes signaling for the production of antioxidant, osmoprotective compounds and attenuates interference in photosynthesis in rice plants subjected to water deficit. The aim of this study was to evaluate the possible effects of silicon as a stress reliever in rice plants grown from seeds treated with dietholate under of water deficit conditions. The experimental design was fully randomized with three replicates, 144 experimental units consisting of pots containing 4.4 pounds soil, and a 3x2x2x4 factorial arrangement: three soil water conditions (50% and 100% of soil water retention capacity and water blade of 5.0 cm); two cultivars (IRGA 424 RI and Guri INTA CL); two sources of Si (sodium and potassium metasilicate); and four Si rates (0; 4.0; 8.0 and 16 g L^{-1}). Silicon boosted stomatal density; induced an increase in the maximum photochemical efficiency of photosystem II (PSII) under both water deficit and optimal conditions, boosting photosynthesis; and increased effective quantum yield of PSII and levels of total dry mass. Thus, silicon attenuated the effects of water deficit in plants grown from seeds treated with dietholate.

Keywords: abiotic stress; *Oryza sativa* L.; Safener.

1. Introduction

Irrigated rice (*Oryza sativa* L.) is grown on over 167 million hectares of land (FAO, 2018) in ecosystems with varying temperatures and water regimes. Annual worldwide yield is estimated at over 487 million tonnes, with 11 million tonnes produced in Brazil (EMBRAPA, 2018). Rio Grande do Sul is the largest rice producer in Brazil, responsible for approximately 71% of production (CONAB, 2017).

Almost all areas cultivated with rice are irrigated by controlled flooding, representing more than 90% of Brazil's total national production (EMBRAPA, 2018). The high costs of electric energy, the seasonality of rains and the increase in temperatures, makes it the option to rationalize the use of water, however, it can cause several morphological, biochemical and physiological changes in the plants, directly interfering in the final productivity (Carneiro et al., 2011).

Around 40% of the total crop losses are because of the single abiotic stress i.e., drought (Fàbregas et al.,

2018), diminishing yield and inducing biochemical and physiological changes in plants, including higher stomatal density (Luković et al., 2009), impaired stomatal opening and a drop in the photosynthetic rate (Bota et al. 2004). Plants also regulate stomatal closure and their development to control water loss as one of the stress adaptation strategies (Yadav et al., 2019). Furthermore, these adverse responses to water deficiency are aggravated in plants grown from seeds treated with the dietholate safener (0.0-diethyl 0 phenyl phosphorothioate) (Mauad *et al*., 2011).

Dietholate is a seed protector, which gives culture, tolerance to the herbicide clomazone, even in low doses (Sanchotene et al., 2010). However, the enzymatic compounds inhibited by dietholate are also responsible for reducing the harmful effects of reactive oxygen species (ROS) formed during cellular metabolism (Gill et al., 2013) under biotic and abiotic stress conditions. Thus, the use of biostimulants (Inoue et al., 2012), such as silicon (Si) (Mauad et al., 2011) has been recommended to minimize the phytotoxic effects of dietholate in the presence of water deficit.

Silicon (Si) is an enzymatic stimulant (Taiz et al., 2017) and can affect plant growth and development by initiating signaling for the production of antioxidant compounds (Etesami et al., 2017) and osmoprotectants, such as proline and glycine betaine (Etesami et al., 2017). The accumulation of silicon in plants can mitigate the stresses that result in interference in rice plant photosynthesis under water deficit conditions (Artigiani et al., 2012) or due to anaerobic conditions and the formation of ROS (Zia et al., 2017). By increasing stomatal conductance and maintaining elevated electron transfer, high rates of photosynthesis are possible, together with high levels of total chlorophyll that affect photosynthetic rates.

Si is also associated with the prevention of leaf senescence by maintaining continued photosynthesis and protecting chlorophyll distribution, especially under high air temperature and water deficit conditions (Agarie et al., 1998). According to the authors, silicon promotes the thermal stability of lipids in cell membranes and, under stress conditions, prevents rice cell membranes from structural and functional deterioration. Thus, the aim of this study was to evaluate the possible effects of Si as a water drought reliever in rice plants grown from seeds treated with dietholate.

2. Material and methods

The experiment was conducted in the greenhouse (6 x 20 m, headroom 5 m) from February to April 2018. The experimental design was fully randomized with 48 treatments and three replicates, organized in a 3x2x4x2 factorial arrangement: three soil water regimes (50% and 100% of soil water retention capacity (WRC) and water blade of 5.0 cm); two cultivars (IRGA 424 RI and Guri INTA CL); four Si rates applied to the furrow (0; 4.0; 8.0 and 16 g L^{-1}) and two sources of Si (sodium metasilicate (composition: Na_2O≅ 28%; SiO_2 ≅ 27%; Fe ≅ 0.02%) and potassium metasilicate (composition: N≅ 3%; P_2O_5≅ 2%; K_2O≅ 15%; SiO_2≅ 25%)).

The 144 experimental units each consisted of a pot containing 4.4 pounds de soil. The fertilization of the experimental units was based according to the soil physical analyses report of the Soil Physics Laboratory – UFSM. The soil belonging to sandy loam textural class (SBCS), with base saturation < 50, 60.6 of sand, 22.8% of silt and 16.6% of clay. Ten seeds treated with dietholate seed protector (Permit Star®) at

a rate of 6 mL per kg seed were sown in each pot at a depth of two centimeters, and after emergence the six most uniform seedlings in each pot were retained.

Irrigation was carried out daily through the weighing method, using an electronic scale (ACS System) with precision of 5 g, by adding water until reaching the total predetermined mass (pot + dry soil + water volume to reach 100 or 50% soil WHC). To determine soil water conditions (50 and 100% soil WHC), the following adapted formulas were used (Schwab, 2011):

$$MP50\% = (MPWHC - MPdry)0.5 + MPdry \quad (1)$$

$$MP100\% = (MPWHC - MPdry)1.0 + MPdry \quad (2)$$

Where: MPn% - mass of pot for each treatment; MPWHC - mass of pot at water holding capacity; and, MPdry - mass of pot filled with dry soil.

Treatments related to soil water conditions were begun 15 days after sowing, simulating water ingress conditions in an irrigated rice crop. Physiological and morphological variables were evaluated when the rice plants had reached vegetative stage, scale 39 of the BBCH (MEIER, 2001).

The physiological variables of chlorophyll "a" fluorescence, including the ratio of variable fluorescence to maximum fluorescence (maximum photochemical efficiency of PSII) (Fv/Fm), effective quantum yield of PSII (YII_{125}) and the electron transport rate (ETR_{1500}), were measured with a JUNIOR-PAM modulated pulse fluorometer (Walz, Germany) between 3:00 am and 8:00 am. Measurements were taken using the fourth leaf fully expanded of three different plants from three experimental units for each treatment. Before measuring, the leaves to be analyzed were pre-adapted in the dark for a period of 30 minutes to determine the initial fluorescence (Fo) and subsequently subjected to a pulse of saturating light (10,000 µmol m^{-2} s) for 0.6 s to determine the maximum fluorescence (Fm). The maximum photochemical efficiency of PSII (Fv/Fm) was calculated using the fluorescence ratio variable (Fm-Fo). The electron transport rate (ETR_{1500}) was determined using a light curve (electron transport rate x light intensity - PAR), which was constructed by subjecting each sample to radiation levels of 285µmol electrons m^{-2} s^{-1} every 10 s. The measurements were adjusted using the equation ETR = ETRmax [1– e^_kQ], where k is a fitting constant and Q represents the light intensity (PAR), according to the method described by Rascher et al. (2000).

Stomatal density (n^o/mm^2) was determined based on the epidermal impression of the abaxial and adaxial surfaces of the leaf on glass slides using instant adhesive (Super Bonder®). This was done by collecting one fully expanded leaf, in three experimental units different, for each treatment. The slides were then photographed under a microscope and the images processed using Image Pro Plus software to obtain the area and stomata count. To evaluate plant dry weight, three plants were removed from each pot, placed in porous paper bags and dried in a forced air oven at 65° C until a constant dry weight (g) was reached.

Response variables were subjected to analysis of variance, and factors analyzed by the Tukey test at 0.05 error probability, except for the silicon rates which were fit to polynomial models using Sisvar® 5.3 statistical software (Ferreira, 2014).

3. Results and discussion

Total dry weight, ratio of variable fluorescence to maximum fluorescence and adaxial surface stomatal density showed significant interaction for all factors (soil water conditions × cultivar × Si rate x Si source). Abaxial surface stomatal density showed a significant interaction for soil water x Si rate x cultivar, and no effect was produced for the Si source in the F-test ($p < 0.05$). Thus, for this variable, regression models and tables were obtained using the means of the two Si sources. For effective quantum yield of PSII (YII_{125}) and electron transport rate (ETR_{1500}), there was a significant effect only for the Si rate, with no effect for the cultivar, Si source and soil water in the F-test ($p < 0.05$). Thus, regression models were obtained for the means of the cultivar, Si source and soil water.

It can be seen from an examination of soil water conditions, that, for adaxial surface stomatal density (Table 1), that of the sixteen comparisons between the water conditions of the soil, within the levels of the other factors, 81% of the cases the plants under water deficit (50% WRC) did not differentiate the number of stomata of the adaxial face per mm^2, in relation to the plants under 100% WRC and immersed plants. These results may indicate that transpiration control can be done more by stoma closure than by the presence of fewer stomata.

Comparing the results for Si sources, in terms of adaxial surface stomatal density (Table 1), of the twenty-four comparisons between the Si sources, given the levels of the other factors, 79% of cases did not show any statistical difference between sources. In terms of the cultivar variable (Table 1), in general, of the twenty-four comparisons between cultivars, given the levels of the other factors, 79% of cases did not show any statistical difference between cultivars, possibly due to their genetic similarity.

Table 1 – Comparison of means for adaxial surface stomatal density in rice leaves for water conditions and Si sources at different Si rates and for different cultivars. Santa Maria, RS, 2019.

		WATER SOIL CONDITIONS AND CULTIVARS					
RATES OF Si	SOURCES OF Si	50 % WRC		100 % WRC		Water blade	
		Guri INTA CL	IRGA 424 RI	Guri INTA CL	IRGA 424 RI	Guri INTA CL	IRGA 424 RI
0 $g.L^{-1}$	Potassium metasilicate	11.00 aα*	09.00 a α	11.33 a α	06.66 aβ	07.66 aα	08.00 aα
	Sodium metasilicate	09.00 aα	08.66 aα	09.33 a α	10.66 aα	09.33 aα	10.33 aα
4.0 $g.L^{-1}$	Potassium metasilicate	09.00 Ba α	11.00 Aa α	09.00 Aa α	10.00 Aaα	12.66 Aaα	12.00 Aaα
	Sodium metasilicate	13.00 Aa α	09.66 Aaβ	12.33 Aa α	12.00 Aaα	06.33 Bbα	08.66 Aaα
8.0 $g.L^{-1}$	Potassium metasilicate	12.00 Aa α	10.66 Aa α	07.33 Abα	10.33 Aaα	10.00 Aabα	13.00 Aaα
	Sodium metasilicate	09.33 Aaβ	13.33 Aa α	09.00 Aaα	12.33 Aaα	09.00 Aaα	09.33 Baα

16 g.L^{-1}	Potassium metasilicate	13.33 Aa α	08.33 Abβ	12.33 Aaα	12.33 Aabα	06.33 Bbβ	13.00 Aaα
	Sodium metasilicate	09.00 Baα	10.33 Aa α	09.66 Aaα	11.66 Aa α	12.33 Aaα	10.33 Aaα

* Means not followed by the same uppercase letter in the column were statistically different for different sources of Si and the same lowercase letter and the greek one, in the line differed for water regimes in the soil and between the different cultivars respectively, in the Tukey test ($p \leq 0.05$). WRC: water holding capacity in the soil.

The regression analysis of Si rates for adaxial surface stomatal density (Figure 1) show that at the highest rate of sodium metasilicate (16 g L^{-1}), there was a linear increase of 32% in the number of stomata for the immersed Guri INTA CL cultivar compared to non-supplemented plants (0.0 g L^{-1}), whereas none of the other soil water conditions fit the polynomial models (Figure 1a). For the IRGA 424 RI cultivar, there was a quadratic increase at 50% WRC (water deficit), reaching a maximum at a rate of 9.9 g L^{-1} sodium metasilicate; none of the other soil water conditions fit the polynomial models (Figure 1b). The presence of a greater number of stomata can be a useful strategy to increase atmospheric CO_2, absorption or carbon exchange rate.For the potassium metasilicate source and both cultivars (Guri INTA CL and IRGA 424RI, Figures 1c and 1d), at 100% WRC there was a quadratic adjustment in adaxial surface stomatal density for the Guri INTA CL cultivar and linear increase of 85% in the number of stomata for the IRGA 424 RI cultivar at the highest rate of Si (16 g L^{-1}) compared to non-supplemented plants (0.0 g L^{-1}). In immersed plants, increasing the rate of potassium metasilicate resulted in a linear increase of 65% in adaxial surface stomatal density in the IRGA 424 RI cultivar at the highest rate of Si (16 g L^{-1}) and Guri INTA CL cultivar there was a quadratic increase in adaxial surface stomatal density, reaching a maximum at a rate 8 g L^{-1} compared to non-supplemented plants (0.0 g L^{-1}) (Figure 1c and 1d). At 50% of the WRC, there was not adjustment of polynomial models in both cultivars (Figure 1c and 1d). In rice (*Oryza sativa* L.) seedlings, 2 mM Si treatment increased the stomatal density and decreased the stomatal size of the adaxial epidermis (Ju et al., 2017). These same authors suggest that higher stomatal densities and smaller stomatal sizes improved the sensitivity of the stomatal regulation of the plants and improved the stomatal function at similar leaf areas. Agarie et al. (1998) showed that Si applications significantly decreased stomatal transpiration by influencing stomatal movement in rice plants.

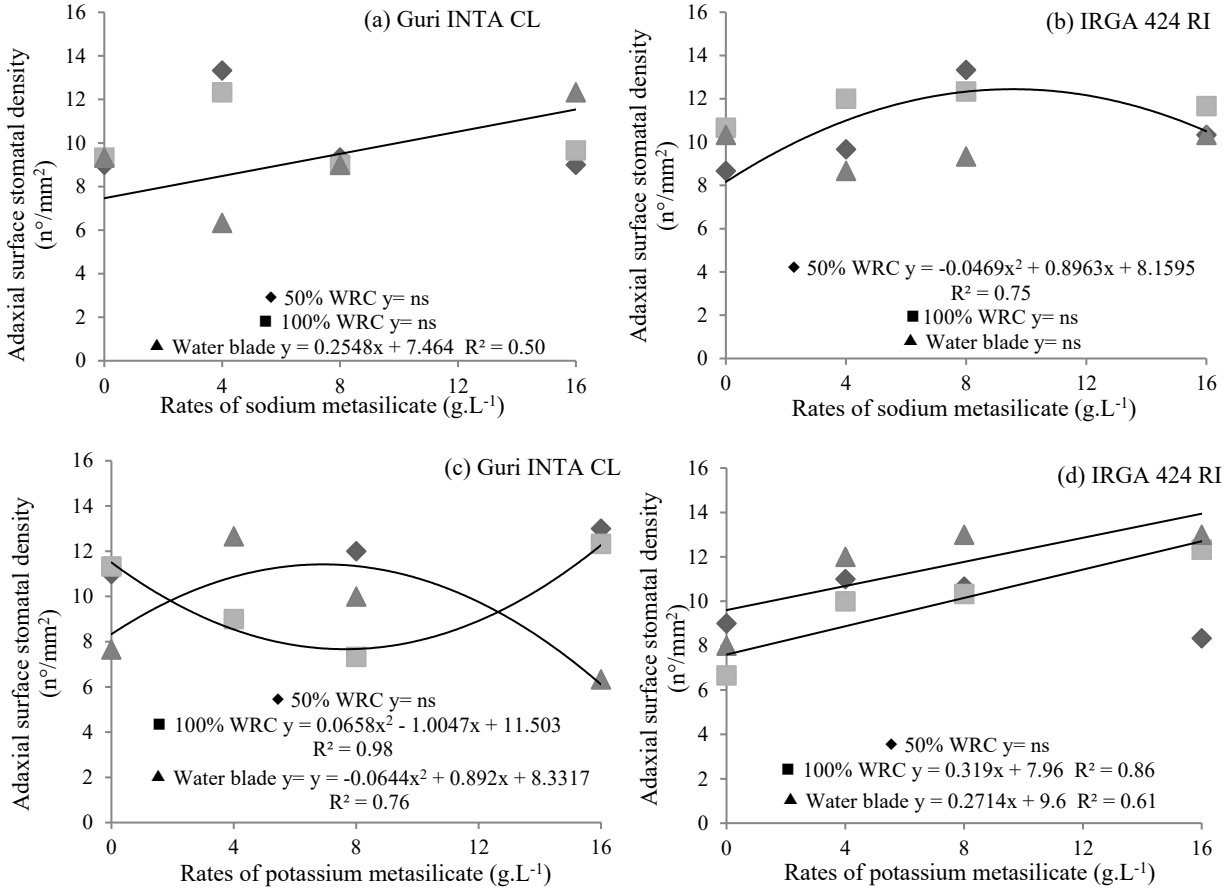

Figure 1 – Relationship between adaxial surface stomatal density and silicon rates in IRGA 424 RI (b and d) and Guri INTA CL (a and c) cultivars under different water conditions (50 and 100% WRC and water blade) and for different Si sources (sodium and potassium metasilicate). Santa Maria. RS. 2019.

In general, 25% of the six soil water comparisons exhibited a statistical difference for the effect of soil water conditions on abaxial surface stomatal density, given the levels of the other factors (Table 2). The Guri INTA CL cultivar supplemented with 4.0 mg L^{-1} Si and at 50% WRC showed a higher stomatal density per mm^2 than at 100% WRC and did not differ statistically from immersed plants.The IRGA 424 RI cultivar supplemented with 8.0 g L^{-1} at 100% WRC showed higher stomatal density, but there was no statistical difference compared to plants at 50% WRC.

Comparing the cultivars, the only statistical difference was for abaxial surface stomatal density at 100% WRC and 4.0 g L^{-1} Si, and the IRGA 424 RI cultivar exhibited a higher mean abaxial surface stomatal density than the Guri INTA CL cultivar (Table 2). This may indicate a greater capacity to absorb and fix CO_2 in this cultivar and under these conditions.

Table 2 – Comparison of means for abaxial surface stomatal density in rice leaves for cultivars under different water conditions and Si rates. Santa Maria, RS, 2019.

RATES OF Si	CULTIVAR	WATER SOIL CONDITIONS		
		50 % WRC	100 % WRC	Water blade
0 g.L^{-1}	Guri INTA CL	09.16 Aa*	10.16 Aa	07.33 Aa
	IRGA 424 RI	11.33 Aa	09.00 Aa	09.66 Aa

4.0 g.L^{-1}	Guri INTA CL	11.00 Aa	07.83 Bb	10.00 Aab
	IRGA 424 RI	11.16 Aa	12.66 Aa	10.33 Aa
8.0 g.L^{-1}	Guri INTA CL	12.33 Aa	11.50 Aa	10.83 Aa
	IRGA 424 RI	10.50 Aab	12.66 Aa	08.83 Ab
16 g.L^{-1}	Guri INTA CL	11.00 Aa	9.00 Aa	09.50 Aa
	IRGA 424 RI	11.00 Aa	10.33 Aa	11.83 Aa
			Coefficient of variation = 21.46%	

*Means not followed by the same uppercase letter in the column were statistically different between cultivars and the same lowercase letter on the rows for soil water regimes in the Tukey test ($p \leq 0.05$). WRC: soil water retention capacity.

In terms of regression analysis for the rates of Si, abaxial surface stomatal density (Figure 2a) for the IRGA 424 RI cultivar showed a quadratic increase at 100% WRC, rising to a maximum at an Si rate of 9.0 g L^{-1}. None of the other water conditions fit the polynomial models. Under water deficit (50% WRC) and water blade conditions (Figure 2b), the Guri INTA CL cultivar also showed a quadratic increase in abaxial surface stomatic density, reaching a maximum at a rate of 11 g L^{-1} Si for both water conditions. At 100% WRC, there were no fits to any polynomial model. Research has shown that environmental factors (e.g. light) regulate the development of stomata in young leaves through a mechanism for detecting the levels of these factors in mature leaves on the same plant (Nadeau, 2002). The presence of a layer of silica on leaf surfaces is capable of altering the emissivity spectrum (Da Luz, 2006). Thus, higher rates of Si can induce a thicker layer on leaf surfaces, which can affect light transmittance and consequently the formation and density of stomata.

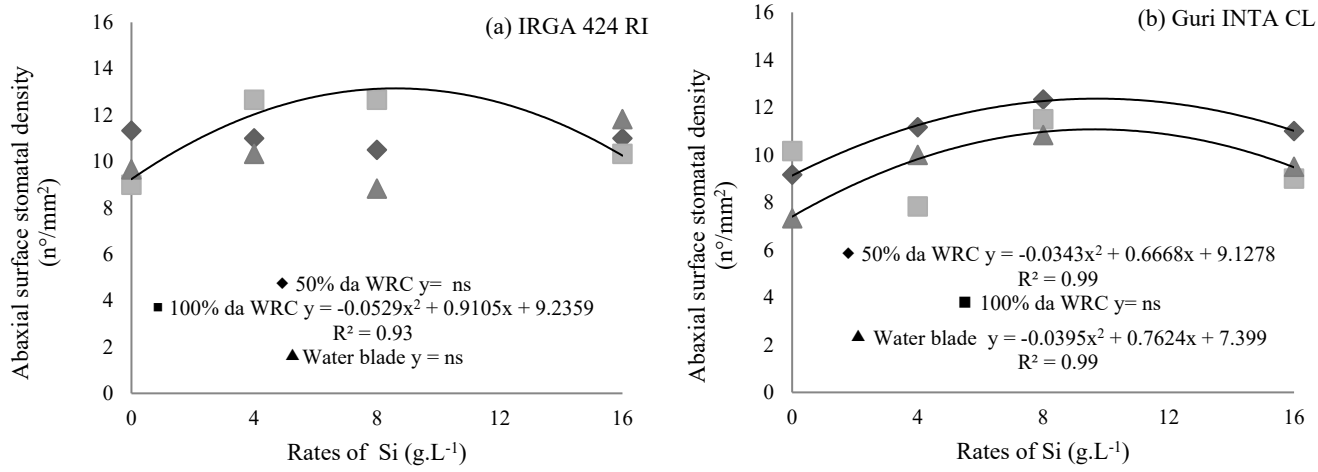

Figure 2 – Relationship between abaxial surface stomatal density in IRGA 424 RI and Guri INTA CL rice cultivars. under different water conditions (50 and 100% WRC and water blade) and Si rates. Santa Maria. RS. 2019.

In regard to the way in which soil water conditions affect maximum photochemical efficiency of PSII (Fv/Fm) (Table 3), in general, of the sixteen comparisons of soil water conditions, given the levels of the other factors, Fv/Fm was higher at 100% WRC and water blade in 31% of cases, indicating that the efficiency of the PSII light absorption system was higher compared to water deficit conditions (50%

WRC), increasing capacity to transfer excitation energy from the antenna pigments to the reaction centers. The fact that Fv/Fm values were maintained in 43% of comparisons for water deficit condition, given the other factors, may be related to supply of Si. Tatagiba et al., (2017) in a study with *Oryza sativa* L leaves, supplied or not with Si, they found increases in the values of Fv/Fm, in the plants that were supplied with Si. The Fv/Fm value differed between plants under water deficit (50% WRC) and water blade, in the other 19% of comparisons, with lower Fv/Fm values in plants under water deficit, evidence of an impairment of the photosynthetic apparatus. Decreases in the efficiency of PSII can be caused by a drop in the accumulation of acceptors, and by increased thermal dissipation of excess excited energy prior to reaching PSII reaction centers (Demmig-adams *et al*., 1995).

Table 3 – Comparison of means for photochemical efficiency of PSII (Fv/Fm) in rice plants under different water conditions and for two cultivars and two Si sources in different Si rates. Santa Maria, RS, 2019.

RATES OF Si	CULTIVAR	WATER SOIL CONDITIONS AND SOURCES OF Si					
		50 % WRC		100 % WRC		Water blade	
		Potassium metasilicate	Sodium metasilicate	Potassium metasilicate	Sodium metasilicate	Potassium metasilicate	Sodium metasilicate
0 g.L^{-1}	Guri INTA CL	0.66 Abβ*	0.75 Aaα	0.78 Aaα	0.78 Aaα	0.80 Aaα	0.77 Aaα
	IRGA 424RI	0.69 Aaα	0.61 Bbβ	0.76 Aaα	0.74 Aaα	0.75 Aaα	0.81 Aaα
4.0 g.L^{-1}	Guri INTA CL	0.75 Aaα	0.77 Aaα	0.82 Aaα	0.79 Aaα	0.79 Aaα	0.81 Aaα
	IRGA 424RI	0.76 Aaα	0.74 Aaα	0.76 Aaα	0.80 Aaα	0.80 Aaα	0.77 Aaα
8.0 g.L^{-1}	Guri INTA CL	0.81 Abα	0.79 Abα	0.88 Aabα	0.86 Aabα	0.89 Aaα	0.88 Aaα
	IRGA 424RI	0.73 Bbα	0.76 Abα	0.85 Aaα	0.89 Aaα	0.86 Aaα	0.87 Aaα
16 g.L^{-1}	Guri INTA CL	0.79 Abα	0.79 Abα	0.86 Aabα	0.92 Aaα	0.89 Aaα	0.84 Aabα
	IRGA 424RI	0.80 Abα	0.82 Aaα	0.90 Aaα	0.88 Aaα	0.94 Aaα	0.87 Aaα
Coefficient of variation = 5.43%							

*Means not followed by the same uppercase letter in the column were statistically different between cultivars and the same lowercase letter and greek on the rows for soil water regimes and different for Si respectively sourcesin the Tukey test ($p \leq 0.05$). WRC: soil water retention capacity.

With regard to the effects of cultivar and Si source on maximum PSII photochemical efficiency (Fv/Fm), of the twenty-four comparisons for each factor, 92% showed no statistical differences for different Si sources and cultivars (Table 3).

In the regression analysis for Si rates and maximum PSII photochemical efficiency (Fv/Fm) (Figures 3a and 3b), both cultivars IRGA 424 RI and Guri INTA CL, supplemented with potassium metasilicate, showed a linear increase in the values of Fv/Fm under all three soil water conditions, with respective increases of 14, 18 and 25% at 50% and 100% WRC and for immersed plants at the highest rate of potassium metasilicate (16 g L^{-1}) compared to plants not supplemented with Si (0g L^{-1}). For the Guri INTA CL cultivar at 50% WRC, all rates of potassium metasilicate produced a positive quadratic increase, reaching a maximum at a rate of 11 g L^{-1}, whereas at 100% WRC and when immersed, there

was a respective linear increase of 10% and 11% in Fv/Fm values at the highest rate of potassium metasilicate compared to plants not supplemented with Si.

For the sodium metasilicate source, the IRGA 424 RI cultivar under soil water conditions of 50% and 100% WRC (Figure 3c) showed quadratic increases in the values of Fv/Fm, reaching respective maximums at rates of 14 and 12 g L^{-1}, and a linear increase in water blade conditions, with a 7% increase in the Fv/Fm values at the highest rate of sodium metasilicate (16 g L^{-1}) compared to plants not supplemented with Si (0 g L^{-1}) (Figure 3c). For the Guri INTA CL cultivar, the rates of sodium metasilicate resulted in respective linear and quadratic increases at 100% WRC and water blade, with an 18% increase in the Fv/Fm values at 100% WRC at the highest rate of sodium metasilicate (16 g L^{-1}) compared to plants not supplemented with Si (0 g L^{-1}), and reaching a maximum at a rate of 10 g L^{-1} in immersed plants. There were no fits to polynomial models at 50% WRC.

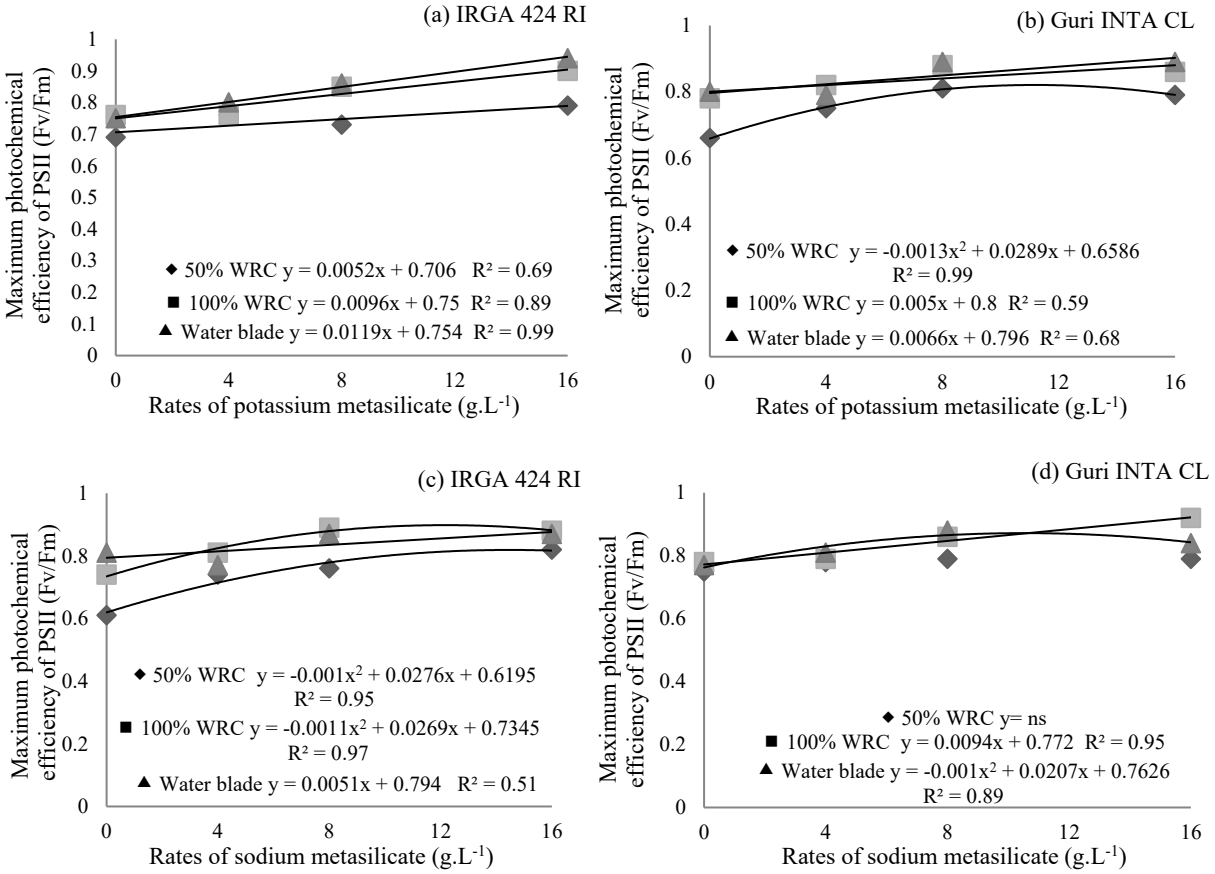

Figure 3 – Relationship between maximum photochemical efficiency of PSII (Fv/Fm) and Si rates in IRGA 424 RI and Guri INTA CL rice cultivars under different water conditions (50 and 100% WRC and water blade) and for different Si sources (sodium and potassium metasilicate). Santa Maria. RS. 2019.

The relationship between Si rate and electron transport rate (ETR_{1500}) (Figure 4a) was quadratic, reaching a maximum at a rate of 16 g L^{-1}, resulting in an increase in photosynthesis, possibly due to the Si boosting the photosynthetically active leaf area index (Kozlowski, 2002). The beneficial effect of Si on Fv/Fm and ETR_{1500} values can be attributed, at least in part, to anatomical variations produced by the

deposition of silica on the walls of epidermal cells, which keep the leaves upright and improve light interception, stimulating photosynthesis (MA & TAKAHASHI, 2002; SAVIO et al., 2011).

Figure 4 b shows that the regression analysis of Si rates for effective quantum yield of PSII (YII_{125}), which, as for an ETR_{1500} resulted in a quadratic increase, reaching a maximum at 16 g L^{-1}, evidence of increased photosynthetic performance in plants supplemented with Si. Normally, the stress on the plant caused by any environmental factor can lead to an initial reduction in YII_{125} and in Fv/Fm, linked to impaired functionality of the photosynthetic apparatus (Kramer *et al*., 2004). The maximum efficiency photochemical efficiency of the FSII or the FV / FM ratio is a sensitive indicator of the photosynthetic performance of plants, with values ranging from 0.75 to 0.85 (Wagner & Merotto Junior, 2014). In plants not supplemented with Si and kept at 50% WRC, Fv/Fm values were below optimal, evidencing impairment of the photosynthetic apparatus during water drought. In the presence of Si, there was an increase in Fv/Fm in plants under water deficit and under optimal conditions, indicating the importance of this element for boosting photosynthesis. One possible explanation for the highest YII_{125} values observed in plants supplemented with Si is that, in the presence of Si, the plants began using a higher fraction of YII_{125} excitation energy instead of dissipating it in the form of heat, thus increasing photosynthetic yield (Klughamer and Schreiber, 2008). Therefore, according to the findings of this study, Si supplementation enhances photosynthetic yield in rice plants.

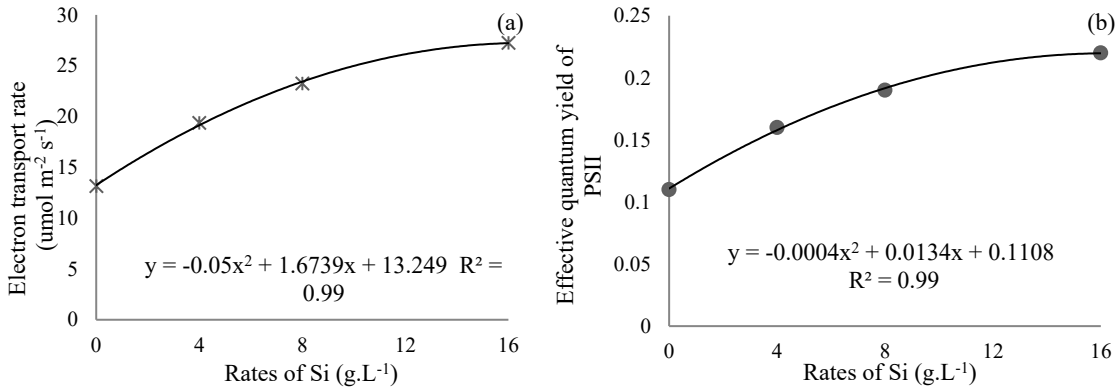

Figure 4 – Relationship between electron transport rate (ETR_{1500}) (a) and effective quantum yield of PSII (YII) (b) and silicon rates in rice shoots (means for Si sources (sodium and potassium metasilicate). cultivars (IRGA 424 RI and Guri INTA CL) and water conditions (50 and 100% WRC and water blade). Santa Maria. RS. 2019.

Comparing the effect of soil water conditions on total dry mass (Table 4), in the sixteen comparisons, given the other factors, 56% showed higher total dry mass for immersed plants. The drop in total dry mass under the other soil water conditions was probably due to lower cell expansion and lower turgor pressure (Kramer, 1994), impairing plant growth and development and impacting dry mass accumulation. Similar results in rice cultivars were reported by Mauad (2003; 2006), Crusciol et al. (2003 a) and Crusciol et al. (2003b).

Table 4 – Comparison of means for rice plant total dry mass for different water conditions and cultivars at different Si rates and for different Si sources. Santa Maria. RS. 2019.

RATES OF Si	CULTIVAR	WATER SOIL CONDITIONS AND SOURCES OF Si					
		50 % WRC		100 % WRC		Water blade	
		Potassium metasilicate	Sodium metasilicate	Potassium metasilicate	Sodium metasilicate	Potassium metasilicate	Sodium metasilicate
0 g.L^{-1}	Guri INTA CL	0.29 Abβ*	0.67 Aabα	0.65 Abα	0.36 Abα	1.44 Aaα	0.82 Aaβ
	IRGA 424RI	0.28 Abα	0.26 Bbα	0.52 Aabα	0.71 Aaα	0.76 Baα	0.92 Aaα
4.0 g.L^{-1}	Guri INTA CL	0.25 Abα	0.57 Abα	0.49 Aabα	0.54 Abα	0.92 Aaβ	1.32 Baα
	IRGA 424RI	0.32 Abα	0.51 Abα	0.75 Aaα	0.61 Abα	0.68 Aabβ	1.80 Aaα
8.0 g.L^{-1}	Guri INTA CL	0.24 Abα	0.49 Abα	0.53 Abα	0.80 Abα	2.93 Aaα	2.35 Aaβ
	IRGA 424RI	0.31 Abα	0.50 Abα	0.65 Aabα	0.73 Abα	0.99 Baβ	2.17 Aaα
16.0 g.L^{-1}	Guri INTA CL	0.53 Abα	0.53 Abα	0.53 Bbα	0.64 Abα	2.79 Aaα	2.55 Aaα
	IRGA 424RI	0.45 Aaα	0.38 Abα	0.94 Abα	0.51 Abβ	1.47 Bcβ	2.31 Aaα
Coefficient of variation = 24.75%							

*Means not followed by the same uppercase letter in the column were statistically different between cultivars and the same lowercase letter and greek on the rows for soil water regimes and different for Si respectively sourcesin the Tukey test ($p \leq 0.05$). WRC: soil water retention capacity.

In terms of the effects of cultivar and Si source on total dry mass, in the twenty-four comparisons, 75% showed no statistical difference between cultivars, indicating very similar Si action for both factors, possibly due to the genetic similarity of the cultivars (Table 4). For Si source (Table 4), in 16% of comparisons the sodium metasilicate source resulted in higher mean total dry mass compared to potassium metasilicate; in most cases, this statistical difference between Si sources was found in immersed plants.

In the Guri INTA CL cultivar supplemented with potassium metasilicate (Figure 5a), there was a quadratic adjustment for immersed plants, where for the soil water conditions of 50 and 100% of the WRC there were not adjustments of polynomial models. For the IRGA 424 RI cultivar, potassium metasilicate rates at 100% WRC and in immersed plants (Figure 5b) there was a linear fit, increase of 77 and 93%, respectively, at the highest rate of potassium metasilicate (16 g L^{-1}) compared to plants not supplemented with Si (0 g L^{-1}).

For the sodium metasilicate source, both cultivars when immersed (Figures 5c and 5d) showed a quadratic increase, reaching respective maxima at rates of 15 and 13 g L^{-1}. At 50% and 100% WRC, there was no significant polynomial fit.

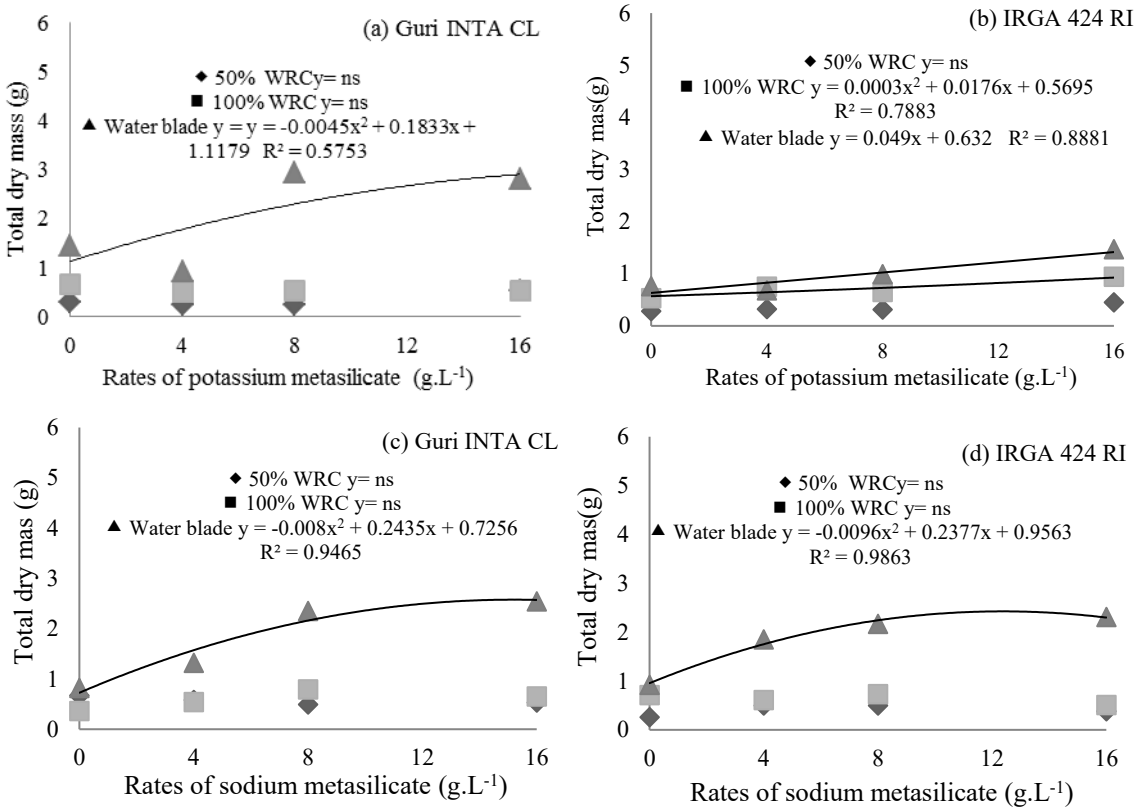

Figure 5 – Relationship between total dry mass and Si rates in IRGA 424 RI and Guri INTA CL rice cultivars under different water conditions (50 and 100% WRC and water blade) and Si sources (sodium and potassium metasilicate). Santa Maria. RS. 2019.

Thus, we found that there was a relationship between the availability of Si and total dry mass of the plant, possibly due to improved use of the water available in the soil. Lee et al. (2010) reported that Si boosts growth by enhancing the absorption of mineral nutrients, possibly through a kinetic relationship with the absorption processes for some nutrients. Faria Junior et al. (2009), evaluating the effects of increased Si rates on rice cultivars (Conai and Curinga), found an increase in plant root dry matter. Sávio et al. (2011) reported that *Brachiaria brizantha* and *Panicum maximum* responded positively to Si in terms of dry weight yield. These results are not consistent with those reported by Melo et al. (2003), who studied the effect of Si on dry matter yield in two species of the genus *Brachiaria* under different soil water conditions. Melo et al. (2003) reported that, despite the accumulation of high quantities of Si in the shoot, there was no effect on the tolerance of both species to water deficiency in the presence of Si.

4. Conclusion

The physiological responses of rice plants to silicon supplementation were a) higher stomatal density, adapting them to water deficit; b) increased maximum photochemical efficiency of PSII (Fv/Fm) in plants under both water deficit and optimum conditions, boosting photosynthesis; and c) increased effective quantum yield of PSII (YII). In morphological terms, there was an increase in the total dry weight in plants supplemented with silicon under both water deficit and optimum conditions.
Therefore, silicon attenuated water deficit stress in plants grown from seeds treated with dietholate.

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GUIDELINES FOR THE CLEANING OF EQUIPMENT AND ACCESSORIES USED IN THE BEAUTY INDUSTRY

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Abstract

In the current scenario caused by Coronavirus Disease 2019 (COVID-19) pandemic, biosafety practices in the cleaning of surfaces, equipment and accessories used in aesthetic care are essential to ensure the health of professionals and clients who attend the health, beauty, and wellness segments. In view of the importance of preserving and preparing the work environment for safe attendance, issues related to procedures, materials and processes for cleaning, disinfecting and sterilizing equipment and accessories used in aesthetic environments according to the degree of criticality have been elucidated.

Keywords: biosafety practices; disinfection; sterilization; beauty industry

Introduction

The cleaning of surfaces, equipment and accessories used in beauty treatments is essential to ensure the health of the professionals and customers of these establishments. The cleaning, disinfection, and sterilization of materials is meant to decontaminate and interrupt the transmission of microorganisms that cause infections. In the current scenario caused by the Coronavirus Disease 2019 (COVID-19) pandemic, biosafety practices have become even more essential to maintain the operation of establishments in the health, beauty, and wellness segments.

This chapter will seek to shed light on important issues related to the cleaning, disinfection, and sterilization of equipment and accessories used in environments of the beauty industry, taking into account their preservation and the preparation of the work environment for safe care. As such, the utensils, equipment and sanitizers needed for these processes will be listed, as will the objects to be decontaminated according to their degree of criticality.

1. Cleaning, Disinfection and Sterilization

The equipment and utensils used in the beauty industry may be sources for the spread of microorganisms if they are not subjected to a cleaning and disinfection/sterilization process after use. The places where these objects are processed, just as the professionals who perform the cleaning, disinfection and sterilization procedures, could also become vehicles of contamination if they do not have the proper training (BRASIL, 1994). According to the Brazilian regulatory standard 32 (*Norma Regulamentadora 32*, NR32), which addresses the health and safety of workers in healthcare services, the professionals responsible for cleaning in healthcare services should therefore be trained in advance and keep up to date

regarding personal hygiene, the risks involved in the process, signage, product labeling, the proper use of personal and collective protection equipment, and conduct in emergency situations (BRASIL 2005).

The cleaning of materials is the first step to be taken before disinfection and/or sterilization in order to ensure that the following procedures are effective in eliminating the agents that cause infection. It consists of removing organic matter (blood, body secretions, fat, etc.) from the materials through mechanical friction with soap and water using cloths, sponges, or brushes, and then rinsing them in clean, running water. The drying of the materials and surfaces also requires care to avoid further contamination, and can be done with clean, dry cloths (BRASIL, 1994).

The most commonly used products for cleaning are soaps made from alkaline salts of fatty acids associated or not with other surfactants, which produce a saponification reaction to remove the dirt (BRASIL, 2010). If this cleaning is not properly performed, the organic matter present on the objects may act as a barrier, preventing the elimination of pathogens through disinfection and/or sterilization (BRASIL, 1994).

When the surfaces have no organic matter, the Brazilian health surveillance agency (*Agência Nacional de Saúde*, ANVISA) recommends removing excess dust from the material with water and a disposable paper towel or washable cloth, followed by cleaning with soap or detergent, and then rinsing the surface with water and drying it. If the surface contains organic matter, the recommendation is to remove it with disposable paper before performing the steps described above (BRASIL, 2010). In the case of electrotherapy equipment, they should be turned off and disconnected from the power source, the procedures should follow the instructions of the manufacturer's manual, and the sanitizer should be chosen according to the type of material (plastic, glass, acrylic, etc.) in order to avoid risks to the professional and damage to the equipment.

The disinfection of surfaces and objects is the process of destroying microorganisms (except those with spores (more resistant)) through the application of chemical agents, after the cleaning of the materials. The following are some important pieces of information that must be taken into account by the professionals performing the disinfection of utensils: only products that are regulated by ANVISA should be used; products after their expiration date should not be used and products should not be mixed, using only one product at a time; the manufacturer's recommendations and labels of the product should always be followed to check the concentration, method of application, and time that the product needs to be in contact with the surface to be disinfected, among others (GOVERNMENT OF THE STATE OF MATO GROSSO DO SUL, 2020).

The total removal of microorganisms from utensils used in the beauty, health, and wellness services is carried out through the sterilization process, which can be either physical or chemical. Sterilization is a necessary procedure for equipment that is considered critical, and it is recommended for semi-critical ones. For heat-resistant critical materials, the indicated method for sterilization is steam, and for steam-sensitive materials there are chemical sterilization options. The choice of sterilization medium is essential to avoid damaging the items and/or compromising sterility, as is the sterilization time, which should follow the instructions specified by the manufacturer. In order for the material to be considered compatible with the sterilization method, it must be sterile and functional at the end of the process. The entire cleaning, decontamination, packaging, sterilization, transport, and storage process of sterile items is crucial to ensure the supply of sterile material for care (WHO, 2016).

2. Classification of the Materials Used in the Beauty Industry

The accessories used in healthcare services can be classified into critical, semi-critical, and non-critical items, and, depending on this classification, they will require different cleaning, disinfection, and

sterilization procedures. **Critical items** are all those invasive items that penetrate/perforate the skin and/or mucous membranes, reaching subepithelial tissues and the vascular system. They require sterilization to eliminate microorganisms, including their resistant forms. This sterilization is done by moist heat (autoclave) or other methods recognized by ANVISA or the Ministry of Health. **Semi-critical items** are those that come in contact with non-intact skin, with restricted reach of the skin layers or intact mucous membranes. These require high-level disinfection or sterilization. If these materials are resistant to high temperatures, the most recommended method is sterilization by autoclave, which ensures better quality in the fight against infectious agents. The **non-critical items**, on the other hand, are all those that come in contact with the patient's healthy skin, which acts as a barrier against most microorganisms. These instruments require low or medium-level cleaning and disinfection after use (BRASIL, 1994).

Table 1 lists some examples of critical, semi-critical and non-critical materials used in the beauty industry.

Table 1 - Classification of materials used in the beauty industry

	Critical Items		**Semi-critical Items**	**Non-critical Items**	
Description	When they come in contact with body fluids (penetrate skin and mucosa).		When they come in contact with non-intact skin and intact mucous membranes	When they come in contact with intact skin.	
Processing required	**Cleaning, disinfection and sterilization**	**Individual use and disposable**	**Cleaning, high-level disinfection or sterilization**	**Cleaning, and low or medium level disinfection**	**Individual use and disposable**
	- Nail pliers - Nail clippers - Metal manicure/pedicure sticks - Scissors - Comedone extractors - Electrodes/heads in contact with bodily secretions - Instruments used in podiatry - Tweezers	- Needles - Razors - Blades - PPEs - Sheets - Pigment holder - Wooden manicure/pedicure sticks - Nail and toenail files	- Make-up brushes and sponges - Electrodes in contact with mucous membranes	- Towels - Bandages - Sheets - Hair bands - Reusable caps - Coveralls - Hair-cutting cap - Cuvettes - Spatulas - Combs - Brushes - Hair rollers - Silicone ear protector	- Surgical cap - Surgical Glove - Surgical Mask - Surgical apron - Paper or disposable sheets - Wooden manicure/pedicure sticks

			- Caliper - Equipment console and electrode holder - Hose for connecting electrodes and equipment power cables - Plastic hair chemistry cap - Basin - Tray - Brushes for facial and body aesthetics and make-up - Make-up sponges - Electrodes/heads with no contact with bodily secretions - Bamboo - Massage roller - Pantala massage tool - Stretcher - Quick massage chair - Hairdressing chair	

Source: Developed by the author (2020)

All materials classified as non-critical or semi-critical that come in contact with bodily secretions, non-intact skin or mucous membranes during aesthetic care need special attention. If the material of these instruments is not thermosensitive, they should be sterilized. If they are thermosensitive, they should undergo a high-level disinfection process, following the recommended steps for the previous cleaning.

Personal protective goggles and face shields also require special care, as there may be contamination by microorganisms during care. Since these PPEs cannot undergo autoclave sterilization, high-level cleaning and disinfection is recommended after each service.

3. Products Used to Disinfect the Surfaces of Beauty Appliances and Utensils

Beauty, health and wellness establishments must make the necessary amount of equipment and materials available to meet demand and respect their required cleaning, disinfection and sterilization times, keeping them in the necessary operating and ergonomic conditions. The instruments used must be sanitized, disinfected or sterilized in accordance with their purpose and the applicable legislation, or following the specifications of the establishment's Operating Procedures Manual. All utensils that come into contact with blood or secretions must be discarded or sterilized (BRASIL, 2009). Table 2 contains suggestions of sanitizing products used for the disinfection of surfaces and equipment.

Table 2 - Commonly used sanitizers

Product	Characteristic	Mechanism of action	Concentrations of use	Directions for use	Advantages	Disadvantages
Ortho-phthalaldehyde (OPA).	Chemical agent used for high-level disinfection.	Antimicrobial.	Recommended at 0.55%.	The time required for high-level disinfection varies according to national manufacturing standards.	Excellent stability over a wide pH range (3-9). Fast action with excellent material compatibility. Almost imperceptible odor. Not carcinogenic, but its use is recommended for ventilated areas.	More expensive than glutaraldehyde. May cause eye irritation and skin stains. Must be disposed of according to local regulations. May require neutralization before disposal in the sewer.
Glutaraldehyde	Compound aldehyde and available as acid or alkaline solutions.	Antimicrobial.	For high-level disinfection, it is recommended at 2% at alkaline pH.	Immersion times vary between countries, but 10 minutes is the minimum for bactericidal activity, 20 minutes for tuberculocidal activity, and more than 3 hours for sporicidal activity.	Widely used to disinfect heat-sensitive items. Non-corrosive to metals and other materials. Can destroy all types of microorganisms (including sporulated bacteria and fungi, the tuberculosis bacillus and viruses).	Irritation and potential toxicity. Vapors can cause occupational asthma and contact dermatitis. Should be stored away from heat sources. Should be applied in a well-ventilated area.

Peracetic Acid.	Oxidizing agent that acts similarly to hydrogen peroxide.	It denatures proteins and alters the permeability of the cell wall.	Used in concentrations of 0.1% to 0.2% with a contact time of 5 to 15 minutes.	Solutions are available for manual immersion of items after cleaning. Automated machines using peracetic acid are available for chemical sterilization.	Wide range of antimicrobial activity (including spores). Fast acting. Does not produce toxic residues. Effective in the presence of organic matter. More effective than glutaraldehyde in penetrating organic matter, such as biofilms.	Corrosive to copper, brass, bronze, plain steel and galvanized iron, but these effects can be minimized by additives and pH correctors. May cause eye irritation, mucous membrane irritation, and skin damage.
Hydrogen Peroxide.	Oxidizing agent used for high-level disinfection.	Antimicrobial.	For high-level disinfection, concentrations of 6% to 7.5% are recommended for 30 minutes.	It is stable and has disinfectant action for inanimate surfaces.	Antimicrobial activity against a wide range of microorganisms, including Cryptosporidi. Has low toxicity and irritation. Odorless. Does not damage glass or plastic items.	Oxidizes metal items. May cause eye irritation.
Chlorine-based compounds (sodium	Aqueous solutions of sodium	Inhibits enzyme reactions, denatures	Concentrations from 0.1% to 0.5%.	Objects should not be submerged for more than 30	Fast acting. Low cost.	Corrosive to metal, damages plastic, rubber and similar components

hypochlorite, calcium hypochlorite, or sodium dichloroisocyanurate).	hypochlorite widely used as household bleach.	proteins, and inactivates nucleic acids.		minutes due to its corrosive activity.	Wide antimicrobial activity (including bacterial spores). Does not leave toxic residues. Effective against a wide variety of viruses and disinfectant of choice for environmental decontamination.	(on exposure > 30 minutes). Hypochlorites can cause eye, lung and mucous membrane irritation, especially if used in poorly ventilated areas.
Chlorine dioxide.	Oxidant and disinfectant.	Causes the interruption of nutrient transport through the cell wall. Reacts easily with the amino acids cysteine, tryptophan and tyrosine, but not with viral ribonucleic acid (RNA), but it inactivates viruses by altering the protein capsule.	From 0.5 to 50 mg/l.	High-level disinfection can be achieved in 5 minutes; however, 10 minutes are needed for sporicidal activity.	Can be applied to heat sensitive instruments. Wide range of antimicrobial activity.	May be harmful to some metals and plastics.

Alcohol.	Alcohol (ethanol or propanol).	Bactericidal /virucidal, acts by dissolving the cell membrane. Intermediate level of disinfection, this includes isopropyl alcohol and 70% ethyl alcohol.	Commonly used in concentrations of 60% to 70%.	Isopropyl alcohol is commonly used as an antiseptic on surfaces. Ethyl alcohol has better bactericidal than bacteriostatic activity and also acts on the tuberculosis bacillus, fungi, and viruses.	Antiseptic. Miscible with water. Wide range of antimicrobial activity including viruses and mycobacteria. Does not require rinsing after application.	Used to disinfect only physically clean surfaces or equipment. It is explosive. May cause eye, skin and mucous membrane irritation if used in large quantities. Must be used in a ventilated environment. If inhaled in large amounts, it can cause headache and drowsiness.

Adapted from the WHO (2016).

4. Final Recommendations Regarding the Cleaning, Disinfection and Management of Beauty Accessories and Equipment in Coping with the COVID-19 Pandemic.

The cleaning and disinfection process of beauty equipment and accessories should be carried out with care, keeping in mind that any equipment that comes into contact or is close to the patient may be considered a risk of contamination. As such, it is essential to establish standard operating procedures for the decontamination of these materials, thus avoiding cross-infection (WHO, 2016).

The World Health Organization recommends the use of 70% ethyl alcohol to disinfect small areas, such as reusable equipment, and 0.5% sodium hypochlorite for the disinfection of exposed surfaces, always taking into account the manufacturer's characteristics and recommendations to avoid damage to the equipment (WHO, 2020b).

During the procedures, it is recommended that only the materials in use are left exposed, thus minimizing the risk of contamination, and to always perform proper hand hygiene between procedures. Attention should also be given to any surface that becomes soiled with secretions from respiratory problems or other body fluids; these surfaces will require cleaning with a solution containing 0.1% sodium hypochlorite by keeping this solution in contact for 10 minutes and then rising with water. The use of bleach should be avoided in equipment with buttons, for which alcohol 70% is indicated (WHO, 2020a).

Preferably, the material used for cleaning the equipment should be disposable, avoiding absorbent fabrics. When necessary, non-porous cleaning materials should be properly disinfected with a 0.5% sodium hypochlorite solution or according to the manufacturer's instructions (WHO, 2020a).

During care, a cloth towel should be used for each procedure performed to avoid contamination, regardless of whether it is the same client. All soiled towels should be isolated in a lidded container identified with a label. For the cleaning of the cloth material, it is recommended that they are washed with soap and water and immersed for 30 minutes in sodium hypochlorite. After drying, the fabrics should be ironed and stored in a clean, ventilated and dry environment, preferably packed in plastic bags individually (SEBRAE, 2016). The stretchers (massage, facial/body aesthetics and hair removal), pillows and chairs should have a waterproof and intact lining, preferably using disposable sheets (SANTA CATARINA, 2012).

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Computational meta-heuristics based on Machine Learning to optimize fuel consumption of vessels using diesel engines

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Abstract

With the expansion of means of river transportation, especially in the case of small and medium-sized vessels that make routes of greater distances, the cost of fuel, if not taken as an analysis criterion for a larger profit margin, is considered to be a primary factor , considering that the value of fuel specifically diesel to power internal combustion machines is high. Therefore, the use of tools that assist in decision-

making becomes necessary, as is the case of the present research, which aims to contribute with a computational model of prediction and optimization of the best speed to decrease the fuel cost considering the characteristics of the SCANIA 315 machine. propulsion model, of a vessel from the river port of Manaus that carries out river transportation to several municipalities in Amazonas. According to the results of the simulations, the best training algorithm of the Artificial Neural Network (ANN) was the BFGS Quasi-Newton considering the characteristics of the engine for optimization with Genetic Algorithm (AG).

Keywords: Internal Combustion Engine (MCI), Optimization and Forecasting, Artificial Neural Networks (RNA), Genetic Algorithm, Meta-heuristics of computing.

1. Introduction

One of the river activities widely practiced is the transportation of cargo and passengers by vessels (DELGADO-HIDALGO, RAINWATER and NACHTMANN, 2020), where the travel flow develops actively according to the vessel's travel needs. However, one of the problems of this mode of transport is the cost of supply, considering that the lack of resources that allow a strategic view of the business is a reality (TAN, DURU and THEPSITHAR, 2020).

Considering the characteristics related to the vessel in terms of estimated travel time, specific fuel oil consumption, average speed and distance, it is possible to analyze intelligent measures to achieve the minimum effort for the engine and, consequently, the reduction of fuel costs, such as occurs in the SCANIA model of power 315hp where the production of emission gases harm the environment according to the relative fuel consumption (HATAMI, HASANPOUR and JING, 2020).

Thus, one of the great difficulties in measuring or analyzing methods that assist in decision making is the lack of intelligent models that optimize or make projections of the best scenario studied (MENZEL *et. al.*, 2020), thus, the idea of the present research arises to contribute with a combination of algorithms for optimization and prediction of fuel consumption that inform the best speed solution for the vessel.

Heuristic computation methods are commonly used in optimization problems where an efficient algorithm is not known, despite the computational effort to find the best solution, it is still a viable procedure when combined with other methods (HOSSEINIOUN *et. al.*, 2020), in the classification of meta-heuristics we have: Genetic Algorithms, Simulated Annealing, Greedy Randomized Adaptive Search Procedure (GRASP), Taboo Search, Ant Colony, Bee Colony and Lichtenberg Algorithm (CHEN *et. al.*, 2020; ABD ELAZIZ, EWEES, OLIVA, 2020). The objective function aims to provide mathematical means of solving the problem to be optimized, however, hybrid models have been used assiduously, showing satisfactory results with regard to approximation of results (GAO *et. al.*, 2020).

Among the existing combination methods is the computational model based on machine learning, Artificial Neural Networks that are inspired by the human nervous system, with this bio-inspired method it is possible to perform pattern recognition, prediction and classification procedures (HUANG *et. al.*, 2020; FAGUNDEZ *et. al.*, 2020). The application of the aforementioned methods allows the combination of algorithms for optimization and prediction where finding the best solution to the fuel consumption problem of vessels using internal combustion machines is the problem (FAGUNDEZ *et. al.*, 2020). Thus, the research aims to develop a computational model for optimizing and predicting the best speed for the characteristics of the SCANIA 315hp engine considering the reduction in fuel consumption.

2. Theoretical Reference

2.1 Internal Combustion Engines (MCI)

The engine that is one of the inventions that caused great impacts on society, the economy and the environment, are machines that transform energy from chemical reactions into mechanical energy (FAGUNDEZ *et. al.*, 2020; HATAMI, HASANPOUR and JING, 2020). These engines that are commonly used to propel mobile systems are also used in industrial applications such as oil, gas, compression, quarrying, recycling and power generation (SHEYKHI *et. al.,* 2020; BASKOV, IGNATOV and POLOTNYANSCHIKOV, 2020).

These diesel engines are characterized by compression ignition, machines that propel heavy vehicles such as trucks, trains and ships are based on diesel-electric propulsion (FAGUNDEZ *et. al.,* 2020; SILVA et. al., 2019). The reciprocating movement of the piston inside the cylinder is transformed into a rotary movement through the connecting rod and crankshaft (SILVA *et. al.,* 2019). In 4-stroke engines where gases are used, a thermodynamic cycle is completed every two turns on the shaft, at which time admission and compression occurs in one turn and heat transfer in the second (BERTONI JUNIOR, 2020; SINGH, KUMAR and AGARWAL, 2020). The largest marine propulsion engines, Diesel operate in 2 times with the use of only one window and a valve on the cylinder head. Figure 1 illustrates a schematic of a piston internal combustion engine.

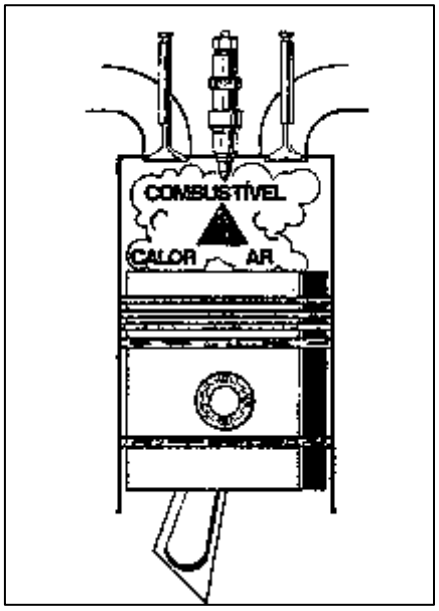

Figure 1: Piston MCI scheme.
Source: Adapted from (DALPRÁ, 2020).

The engine is divided into fixed and moving parts, the fixed ones are: block, crankcase and head, the furniture are: crankshaft, piston, connecting rod and valve control (SINGH, KUMAR and AGARWAL, 2020). The following are some of the component parts of an internal combustion machine as a way of exemplifying the process of composition and operation of the same.

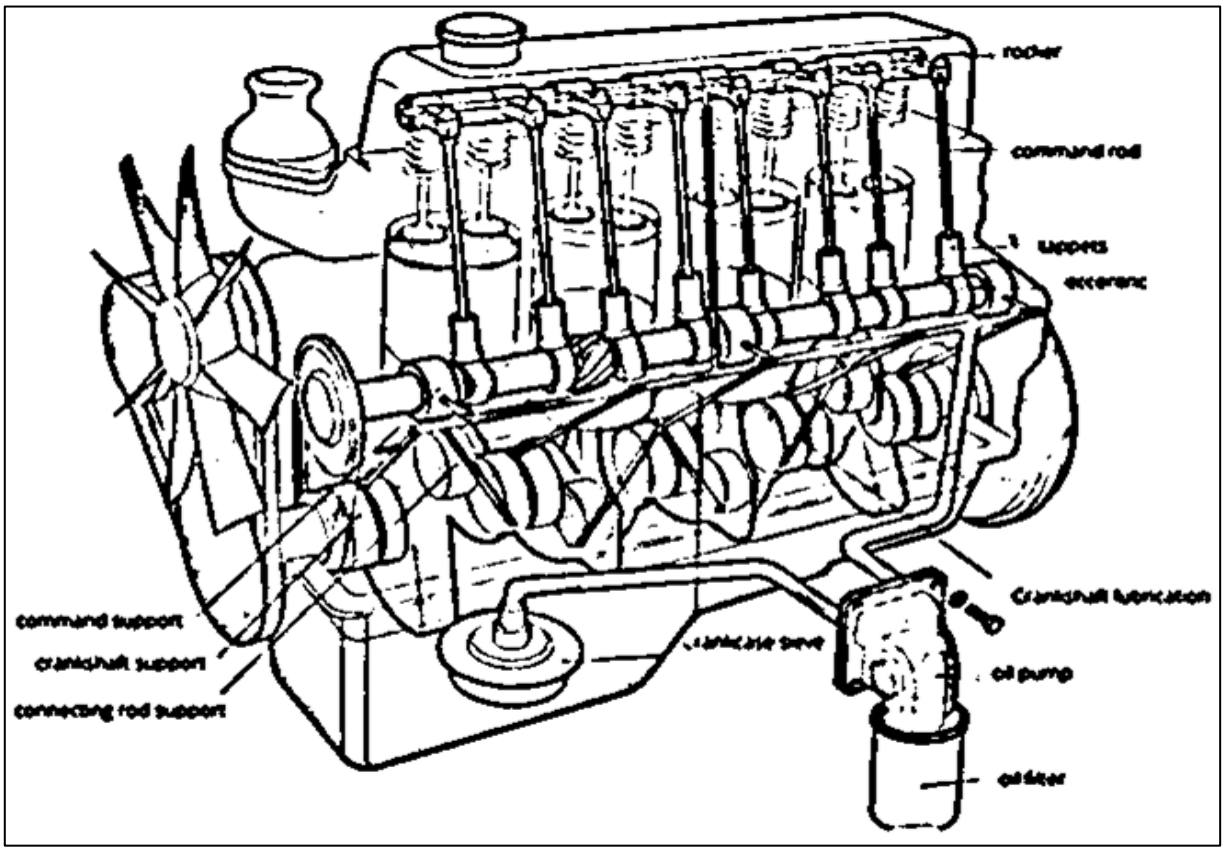

Figure 2: Schematic of a SCANIA MCI model.
Source: Adapted from (JUNIOR and CALLADO, 2020).

The cylinder is the part that receives the movement of gas expansion, normally made of aluminum or aluminum alloy with a cylindrical shape, the middle part is called a cup where there are two circular holes to accommodate the piston shaft that connects it to the connecting rod (SINGH, KUMAR and AGARWAL, 2020; SILVA *et. al.*, 2019). Figure 4 shows a piston or piston inside a cylinder.

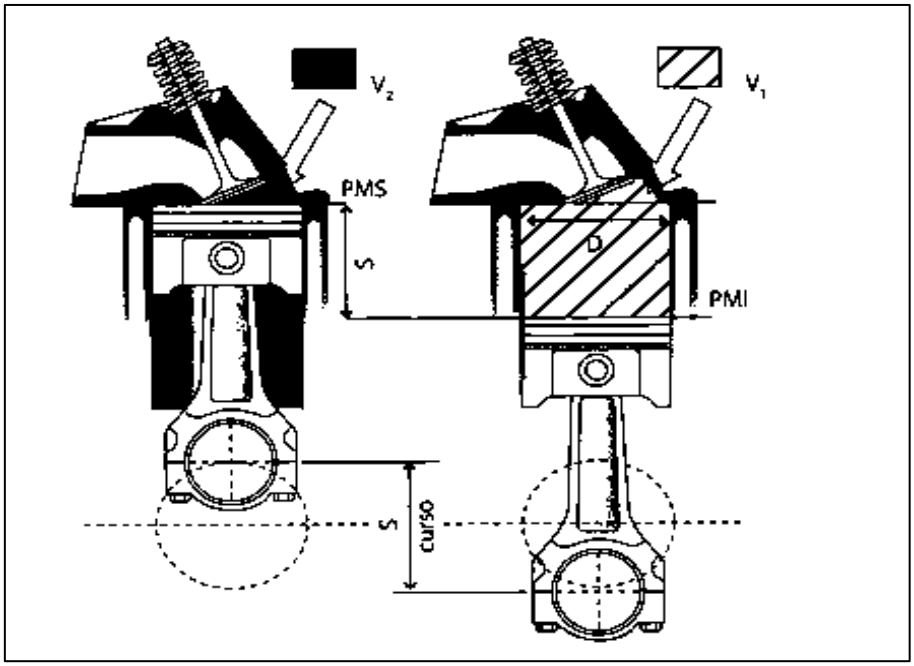

Figure 3: Piston inside a cylinder.
Source: (BRUNETTI, 2018).

To understand the engine displacement, it is necessary to understand the unit displacement also known as useful displaced volume (RUFINO *et.al.*, 2020; BRUNETTI, 2018), the displacement of the volume is obtained by equation 1:

$$V_u = \frac{\pi . D^2}{4} S = V_1 - V_2 \quad (1)$$

Where:
S = piston stroke;
V_1 = Volume of the entire cylinder;
V_2 = Volume of the combustion chamber;
D = Diameter of the cylinder
The total engine capacity is obtained by equation 2:

$$V = V_u . Z \quad (2)$$

Where:
V_u = Unit volume;
Z = cylinders that the engine has

The compression ratio of the engine is the volumetric relationship between the volume of the entire cylinder and the volume of the combustion chamber (RUFINO *et.al.,* 2020; BRUNETTI, 2018), obtained by equation 3:

$$T_c = \frac{V_1}{V_2} \quad (3)$$

Where:
V_1 = Volume of the entire cylinder;
V_2 = Volume of the combustion chamber;

The power of an engine is defined as the work performed in a unit of time (RUFINO *et.al.,* 2020; BRUNETTI, 2018), obtained through equation 4:

$$\bar{W} = \frac{F . d}{t} \quad (4)$$

Where:
$\bar{W}$ = power expressed in cv, ps, hp or watts;
F = intensity of the force;
d = distance between the axis and the force;
t = time

2.2 Computation meta-heuristics

A meta-heuristic can be understood as an unspecified search strategy for a given problem, which tries to efficiently explore the search space, that is, it takes into account the neighborhood. Some authors classify the meta-heuristics in: Search for surroundings, Relaxation, Constructive, Evolutionary (WANG *et. al.*,

2020). Some of the optimization algorithms known to be classified as metaheuristics are: Genetic Algorithms, Simulated Annealing, Greedy Randomized Adaptive Search Procedure (GRASP), Taboo Search, Ant Colony, Bee Colony and Lichtenberg Algorithm (CHEN *et. al.*, 2020; ABD ELAZIZ, EWEES, OLIVA, 2020).

2.3 Systems Optimization

The search strategy for a meta-heuristic depends on the methodology of escaping local and global minimums in order to efficiently explore the search space for better solutions (WANG *et. al.*, 2020; NASCIMENTO *et. al*., 2017).

Whether f is a function with domain S, characterized as a cost function or objective function, there is a minimization problem when given f one wants to find $s \epsilon S$ such that $f(s) \leq f(S), \forall\, s \epsilon S$, if the goal is to find an $s \epsilon S$ such that $f(s) \geq f(S), \forall\, s \epsilon S$, then you have a maximization problem (OSABA *et. al.*, 2020).

Thus, a global optimum point represents the maximum or minimum point corresponding to the best solution of the search space while a local optimum point represents the maximum or minimum point among a set of limited points. (WANG *et. al.*, 2020; OSABA *et. al.*, 2020). Figure 6 illustrates an example of a search space with local and global minimums.

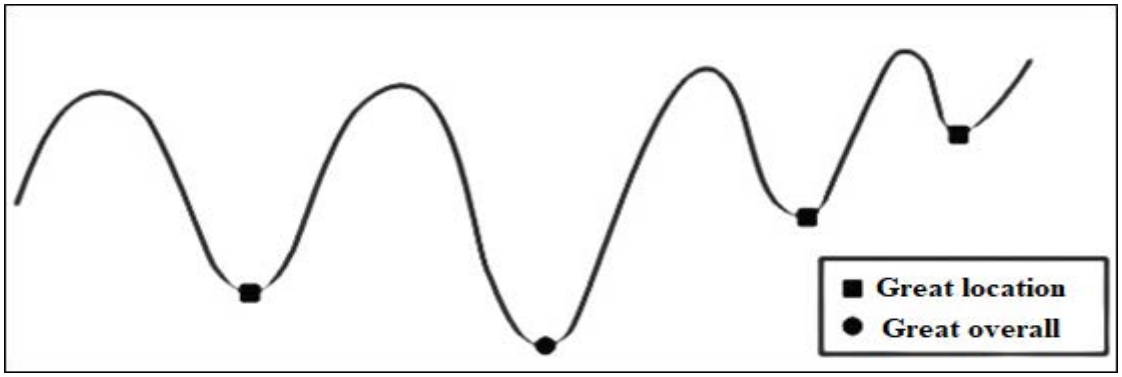

Figure 4: Local and global minima.
Source: Adapted from (SCHELLENBERG, LOHAN and DIMACHE, 2020).

Optimization problems with constraints consider limits for AG variables defined by a number n_{restr} functions $g_{nrestr} : \Re^n \longrightarrow \Re$, which originate a subset $F = \{\vec{x} \in M | g_j(\vec{x}) \geq 0 \forall j\} \subseteq M$, known as a set of viable solutions for f (SCHELLENBERG, LOHAN and DIMACHE, 2020).

2.4 Genetic Algorithm

It is a class of algorithm that performs search procedures based on the concept of natural selection and survival of the fittest individual, composed of a sequence of computational routines in order to simulate evolutionary behavior (WANG *et. al.*, 2020; NASCIMENTO *et. al.*, 2017).

```
function Genetic Algorithm(pop, objective) out: bestIndividual
  inputs: definition pop;
          definition objective
do
    parentSelection(pop)
    recombination(pop)
    mutation(pop)
    evaluation(pop)
    apt(pop)
while don`t hit stop
return bestIndividual
```

Figure 5: AG Model.

Initial population: The AG initializes a population at random, that is, through computational draw, this procedure becomes essential for the coding of strings according to the formation blocks (HUI, ZENG and YU, 2020). Table 1 shows an example of populations in GA.

Table 1: Types of individuals.

		Population 1	Population 2	
Individual	1	0101100001101	17.1	7.9
	2	0101111001101	21.3	8.1
		...	...	
	3	0101100001010	15.7	6.8

Source: Adapted from (HUI, ZENG and YU, 2020).

Selection: For the selection of individuals some algorithms can be used, which are (HUI, ZENG and YU, 2020):

- ***Proportional Selection:*** *known as the Roulette Rule, it draws individuals for crossing, where the probability of drawing an individual* i *is given by* $p_i = \Phi(a_i)/\sum_{j=1}^{u}\Phi(a_j)$*, where u represents the population size and* $\Phi: B^l \longrightarrow \mathcal{R}^+$*, the evaluation function.*
- ***Scheduling:*** *each individual is evaluated to recalculate in* $f' = a.f + b$*, where f is the original evaluation function and the coefficients a and b can be chosen in other ways.*
- ***Selective Pressure:*** *method used to assess the assessment value of individuals that varies according to pressure, which increases or improves the exploration of the search space, tending to converge faster.*
- ***Tournament:*** *draws two individuals for crossing and selects the one with the best rating to participate in a crossing.*
- ***Linear Ranking:*** *In this method the population is ordered according to the evaluation values of each individual, where the probability of the individual's drawing is given by the equation:*$p_i(a_i^g) = 1/\lambda(n_{max} - (n_{max} - n_{min}).\frac{i-1}{\lambda-1})$*, where* n_{min} *= 2 -* n_{max} *e 1* $\leq n_{max} \leq 2, a_i^g$ *corresponds to individual i and* λ *is the number of individuals in the population g.*

2.5 Elitism

Elitism consists of reintroducing a fit individual from one generation to the next avoiding the loss of important information, there are techniques that determine or control the amount of reintroductions from

an individual to the next generation in order to escape local maximums (HUI, ZENG and YU, 2020; SCHELLENBERG, LOHAN and DIMACHE, 2020).

2.6 Crossing

The crossing is summarized in an exchange of substrings between two individuals, this operator recombines solutions and favors a better exploration of the search space. There are some methods for recombination: they are single, multiple and uniform (HUI, ZENG and YU, 2020).

2.7 Mutation

An evolutionary algorithm is able to encode a mutation probability in the individual, as long as there is a different value for crossing between individuals, throughout the execution it is expected that the mutation value will tend to smaller values contributing to the convergence of the same when finding the optimum point in a search space (HUI, ZENG and YU, 2020).

2.8 Artificial Neural Networks

They are computational techniques that present a mathematical model inspired by the human neural structure, through mathematical procedures it is possible to store information and generate knowledge (DADA *et. al*., 2021). The behavior of an ANN comes from the interactions between the processing units of the network.

However, in order to obtain the best performance in the classification, pattern recognition and prediction processes, it is necessary to have the necessary configurations of the ANN architecture, such as the definition of the activation function, number of layers, number of neurons, learning rate, number of iterations and choice of training algorithm (DADA *et. al.*, 2021). Table 2 presents some activation functions used in the configuration of neuron layers.

Table 2: Activation functions.

Acronyms	Function	Expression
Sigmoid	Sigmoid	$\sigma = \frac{1}{1+e^{x}}$
TanH	Hyperbolic Tangent	$tanh(x) = 2\sigma(2x) - 1$ $tanh'(x) = 1 - tanh^{2}(x)$
ReLU	Rectified Linear Unit	$ReLU(x) = \max\{0, x\}, sendo \begin{cases} 1, se\ x \geq 0 \\ 0, c.c \end{cases}$
ELU	Exponential Linear Unit	$ELU(x,\alpha) = \begin{cases} x, se\ x \geq 0 \\ \alpha(e^{x}-1), se\ c.c \end{cases}$ $ELU'(x,\alpha) = \begin{cases} 1, se\ x \geq 0 \\ ELU(x,\alpha) + \alpha, se\ c.c \end{cases}$
Leaky ReLU	Leaked Rectified Linear Unit	$LeakyReLU(x,\alpha) = \max\{\alpha x, x\}$ $LeakyReLU'(x,\alpha) = \begin{cases} 1, se\ x \geq 0 \\ \alpha, se\ c.c \end{cases}$

Source: Adapted from (Koçak and Üstündağ Şiray, 2021).

In addition, it is necessary to define the network architecture by configuring the number of hidden layers to be used and the number of neurons, thus the need for variation goes according to the convergence state of the simulation that can be analyzed by the Mean Square Error (KOÇAK and ÜSTÜNDAĞ ŞIRAY, 2021).

Finally, the definition of the training algorithm that depends on the formality of the problem to be solved, definition of the data set for training the network, as well as the target data of the simulation (BOOB, DEY and LAN, 2020). In short, the choice of the algorithm allows to obtain a precision in the approximation of

functions in the training state and a shorter convergence time, guaranteeing an optimized accuracy in learning.

For Mohammadi *et. al*. (2020) Among the existing training algorithms are: Levenberg-Marquardt, Bayesian Regularization, Broyden – Fletcher – Goldfarb – Shanno Quasi-Newton, Resilient Backpropagation, Scaled Conjugate Gradient, Conjugate Gradient with Powell/Beale Restarts, Fletcher-Powell Conjugate Gradient, Polak-Ribiére Conjugate Gradient, One Step Secant and Gradient Descent.

3. Materials and Methods

For this study, an on-site visit and interviews with specialists were carried out to ascertain the feasibility of the study through the granting of travel records related to the Manaus River Port, where the flow of vessels that carry out the river transportation is frequent, according to the interviews the vessels transport cargo and passengers to several locations in the northern region of the state of Amazonas - Brazil. The data collected from documentary records and experiences of owners and seafarers are from 2018 to 2019.

3.1 Collection and analysis of vessel data and the engine under study

Among the 14 vessels registered to carry out river transport legally, 1 was chosen for the study and which has the following characteristics, figure 6 illustrates an example of the machine under study, on the left side the SCANIA model and on the right a ZF reverser 3x1:

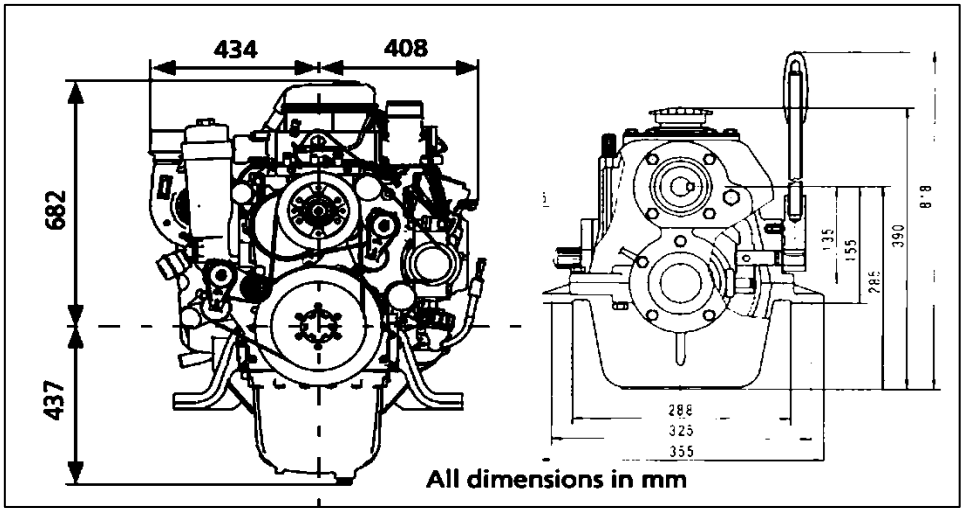

Figure 6: SCANIA machine models and ZF 3X1 reverser.
Source: Adapted from (SCANIA, 2020; ZF, 2020).

- **Vessel name:** Fábio Júnior VI;
- **Length:** 16m;
- **Capacity:** 50 passengers;
- **Type of vessel:** Iron;
- **Allocation:** GRAFA Navigation.

The aforementioned vessel has an internal combustion engine in which it has the following characteristics:

Brand: SCANIA;
Model: Propulsion;
Power: 315 hp;
Number of cylinders: 5;
Weight: 950kg;
Piston speed at 1500 rpm: 7,0 m/s;
Piston speed at 1800 rpm: 8,4 m/s;
Piston type: aluminum;
Oil capacity: from 31 to 36 dm^3
Reverser: zf 3x1 W220;
Reed: aluminum with 3 blades;
Reduction ratio: between 1800 rpm to 2800 rpm;
Approximate oil capacity: 8L;
Approximate dry weight: 105 kg;

3.2 Choice of variables for the optimization model

Thinking about the necessary requirements to implement a computational model that allows the optimization of fuel consumption, the following variables were analyzed and chosen:

- Nautical miles;
- Distance in KM;
- Consumption in Liters.

For this, a temporal analysis from 2018 to 2019 was carried out with travel records and experts' experiences, which allowed a standardized database for the study to be popular, which will be used to train the best ANN model.

3.3 Computational Model for Forecasting and Optimization

In this stage, a bibliographic study of the existing forecasting techniques and models was carried out, in addition, the other Neural Network architectures, training approach and computation meta-heuristics were considered to carry out the forecasting and optimization procedures.

To choose the best RNA architecture, the algorithm classifies among 12 models, namely: Levenberg-Marquardt, Bayesian Regularization, Broyden – Fletcher – Goldfarb – Shanno Quasi- Newton, Resilient Backpropagation, Scaled Conjugate Gradient, Conjugate Gradient with Powell/Beale Restarts , Fletcher-Powell Conjugate Gradient, Polak-Ribiére Conjugate Gradient, One Step Secant and Gradient Descent the best for predicting the parameters that are used in the Simple Genetic Algorithm. Figure 7 illustrates the steps that were taken to consolidate the algorithm.

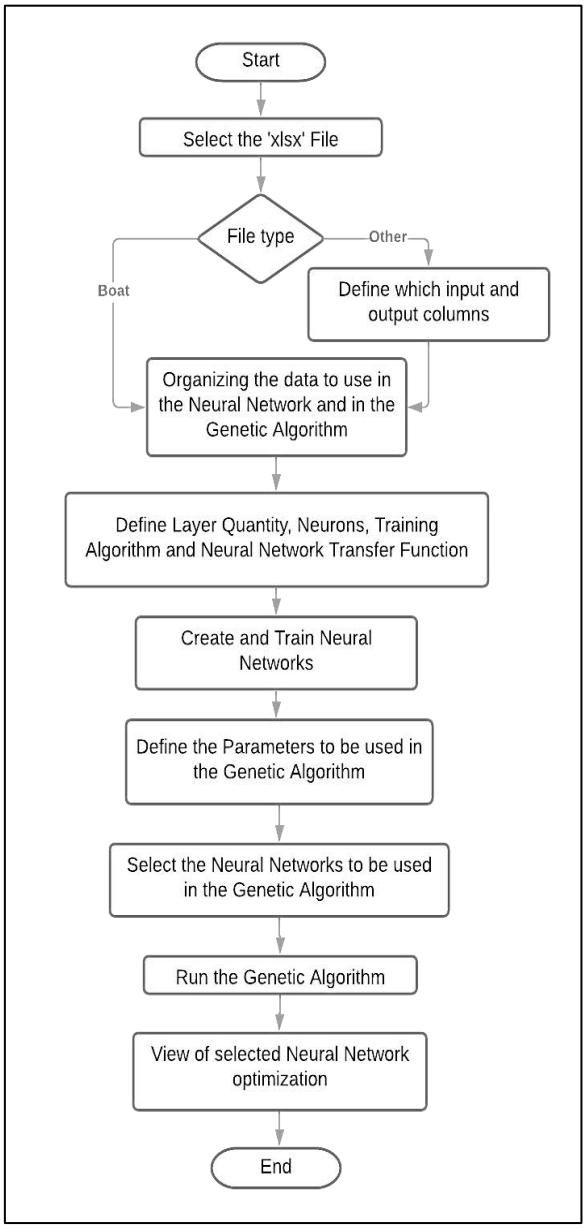

Figure 7: Flowchart of the Algorithm.

The algorithm was dynamically designed to meet the needs of other vessels with other specifications, the algorithm reads the important variables and performs the proper procedures for standardization and data organization, this is done through the MatLab 2016a software.

In this way, the algorithm defines the RNA configurations, later it creates and trains the network and with the defined parameters it is passed to the genetic algorithm where it identifies the optimum speed point considering the model input variables, in the end the algorithm displays the information of the winning RNA models, the optimization model prepared for the simulation and the results.

3.4 Analysis and comparison of the results obtained

To carry out the analysis and comparison of the results, the forecasting model compares the 12 training algorithms of the ANN and through the mean square error it chooses the best forecasting architecture for the optimization model.

- For the stage of training and validation of RNA models, the following configurations were used:
- 70% of the data for training;
- 15% of the data for validation;
- 15% of the test data.

The configurations of the machine that was used to perform the training and simulation of the data were: 16GB of RAM, 10th generation core i5 processor with 2.50 GHZ frequency, 8 processing cores and 500 GB of SSD.

The data used for the network simulation were the same as the input data to validate the accuracy of the model and design forecast scenarios. In addition, to achieve the results presented in the next section, the following RNA architecture configuration was used, which is illustrated in figure 8.

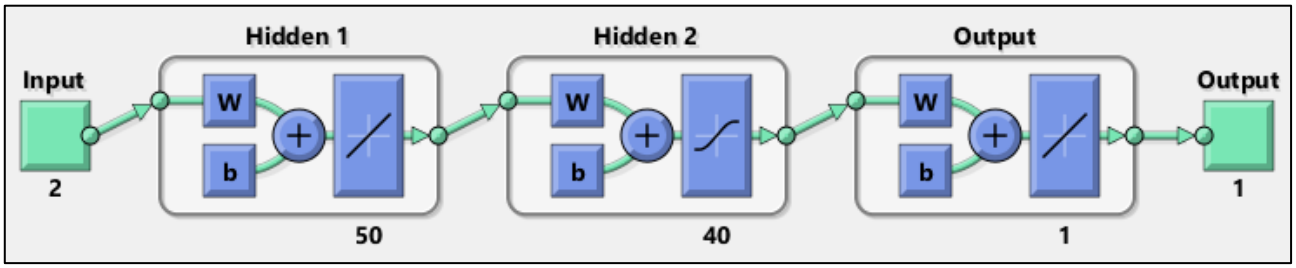

Figure 8: RNA architecture.

Finally, with the data adjusted by the network, the simulation parameters are defined using the genetic algorithm to optimize fuel consumption based on the characteristics already surveyed of the vessel and the engine. In the end the user has a survey of the best neural networks and the results of the optimization.

3.5 Simulation scenarios

Having in hand the results of the best architectures and configurations of neural networks, the necessary configurations and parameterizations for the genetic algorithm were carried out in order to collect the results of optimization of fuel consumption and the prediction of the best speed based on 3 scenarios with a path designed for vessels where distance data was collected from the Rom2Rio platform, which aims to plan trips in advance to any location in the world in a safe and easy way, with transport options: flight, train, bus, boat or car.

Figure 9 illustrates the path that should be taken by a vessel leaving Manaus to Itacoatiara, where the distance is 195.30 km.

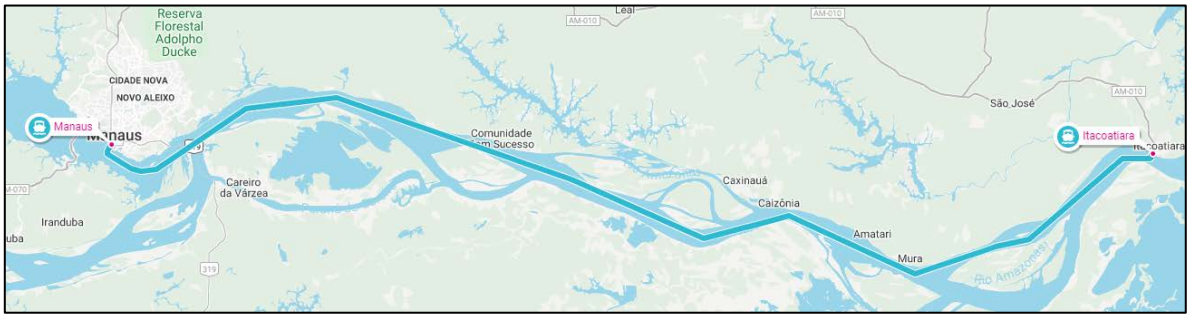

Figure 9: Route Manaus to Itacoatiara.

Source: (ROM2RIO, 2021).

Figure 10 illustrates the route that should be taken in the second scenario by a vessel from Manaus to Parintins, where the distance is given by 433.75 km.

Figure 10: Route Manaus to Parintins.

Source: (ROM2RIO, 2021).

Finally, the last scenario is intended for the route from Manaus to Barcelos, totaling a distance of 440.98 km, both scenarios are designed for vessels.

Figure 11: Route Manaus to Barcelos.

Source: (ROM2RIO, 2021).

4. Results

Results of the best rna arquitectures

Table 3 presents the results achieved with the training of the parameters that serve as the basis for the Genetic Algorithm, according to Table 3 the network model that presented the highest success rate and the minimum error was the number 1 the Bayesian Regularization algorithm using the Sigmoide transfer

function in the input and intermediate layers, this model showed 99% accuracy and a mean square error rate of 2.105840896.

Table 1: Results of best RNA.

#	Algorithm	Transfer Function	MSE	RMSE	NRMSE	MAPE	R
1	Regularização Bayesiana	Sigmoide	4,737465996	2,105840896	0,006289984	0,916017157	0,99997

As shown in figure 12, the best error performance is achieved at the 1000th time of the Bayesian Regularization training algorithm, where the training stood out with a rate of 4.80 average square error, the figure allows us to understand that the state of convergence is stabilized characterizing the optimal point of the function, in this way the trend curve decreases over time, reducing the error rate to a point. where it is stable.

Figure 12: Error performance.

According to figure 13, it is possible to identify the regression results related to training, validation, test and the average of both, where the values coincide with the model's accuracy rate, characterizing 99% accuracy, with this, the line of trend of each result is close to the target line and the points found in accordance with the simulated values are close to the trend line showing the correlation between the resulting target and simulated vectors.

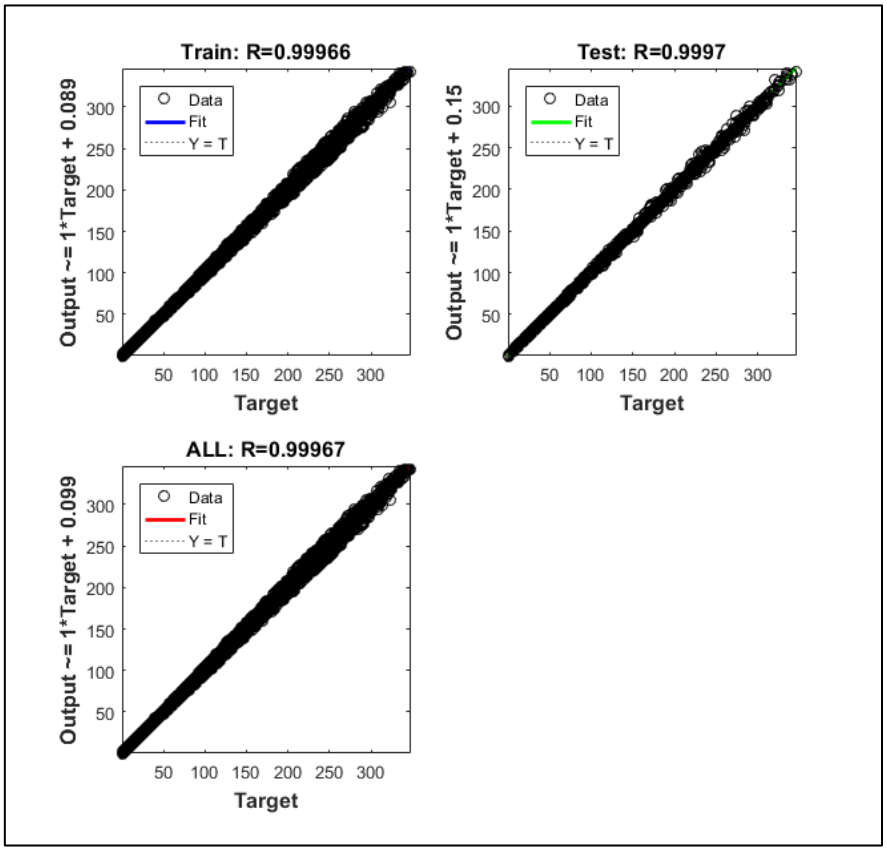

Figure 13: Result of regression of correct answers

Resultados of optimization

For the simulation of a trip from Manaus to Itacoatiara, the AG configuration parameters were:

- Population: 50;
- Máximum generations: 100;
- Fitness: 20;

Simulation at Manaus à Itacoatiara

Table 4 presents the results achieved from the optimization with genetic algorithm, taking as a scenario the trip from Manaus to Itacoatiara, the winning model is the BFGS Quasi- Newton, where the values related to the optimization are presented in Table 4, with the lowest consumption in liters 77.346281 at a speed of 81.030869 km.

Table 2: Optimization at Manaus à Itacoatiara.

#	Training algorithm	Distance in Nautical miles	Distance in KM	Speed in KM	Consumption in liters
1	Bayesian Regularization	105.453564	195.300000	81.030869	77.346281

Figure 14 illustrates two graphs indicating the best individual among 1000 generations and the average achieved for each generation, according to the graph, the best optimization result is given by 78.0781 for fuel consumption.

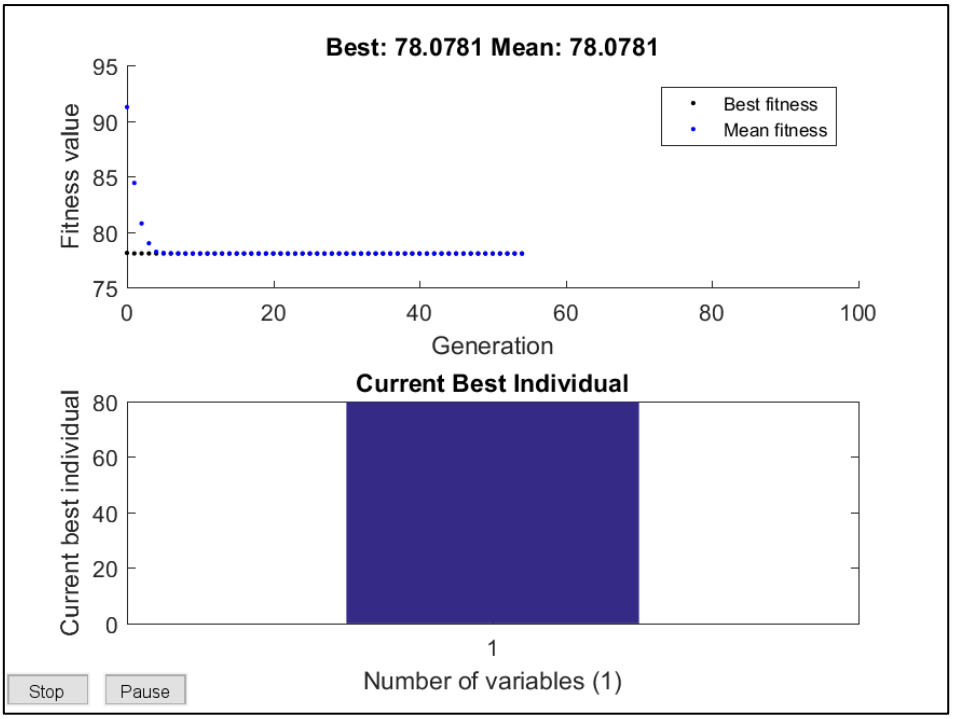

Figure 14: Generation of the best individuals from Manaus to Itacoatiara

Simulation at Manaus à Parintins

Table 5 presents the results obtained from the optimization with genetic algorithm, taking as a scenario the trip from Manaus to Parintins, the winning model is the Bayesian Regularization where the values related to the optimization are presented in the table, with the lowest consumption in liters 171.926091 at a speed 79.101562 km.

Table 3: Optimization at Manaus à Parintins.

#	Training algorithm	Distance in Nautical miles	Distance in KM	Speed in KM	Consumption in liters
1	**Bayesian Regularization**	**234.206263**	**433.750000**	**79.101562**	**171.926091**

Figure 15 illustrates two graphs indicating the best individual among 1000 generations and the average achieved for each generation, according to the graph, the best optimization result is given by 173.519 for fuel consumption.

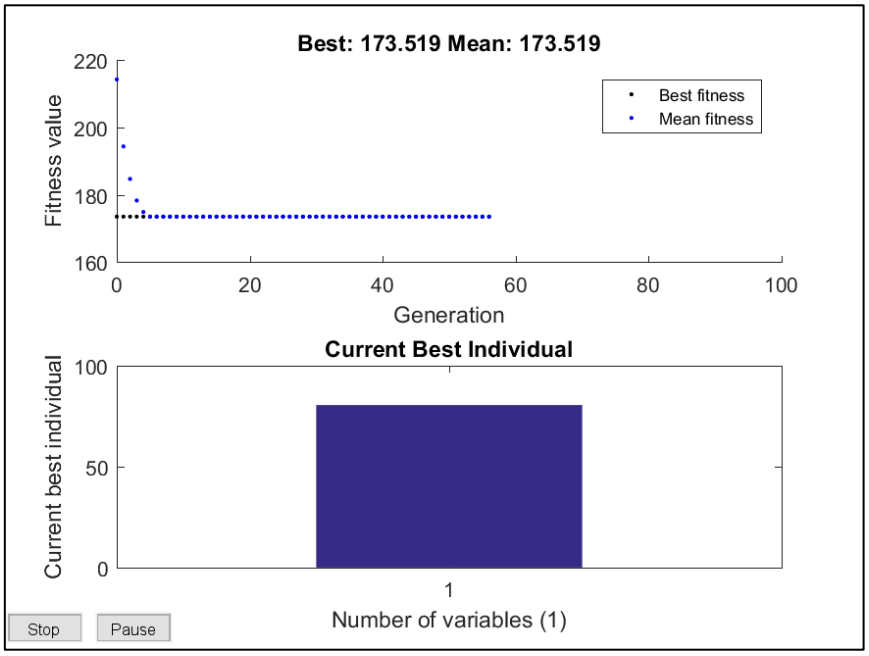

Figure 15: Generation of the best individuals at Manaus to Parintins.

Simulation at Manaus à Barcelos

Table 6 shows the results achieved from the optimization with genetic algorithm, taking as a scenario the trip from Manaus to Barcelos, the winning model is the Bayesian Regularization where the values related to the optimization are presented in the table, with the lowest consumption in liters 174.791856 at a speed 79.101562 km.

Table 6: Optimization at Manaus à Barcelos.

#	Training algorithm	Distance in Nautical miles	Distance in KM	Speed in KM	Consumption in liters
1	**Bayesian Regularization**	**238.110151**	**440.980000**	**79.101562**	**174.791856**

Figure 16 illustrates two graphs indicating the best individual among 1000 generations and the average achieved for each generation, according to the graph the best optimization result is given by 176.405 for fuel consumption.

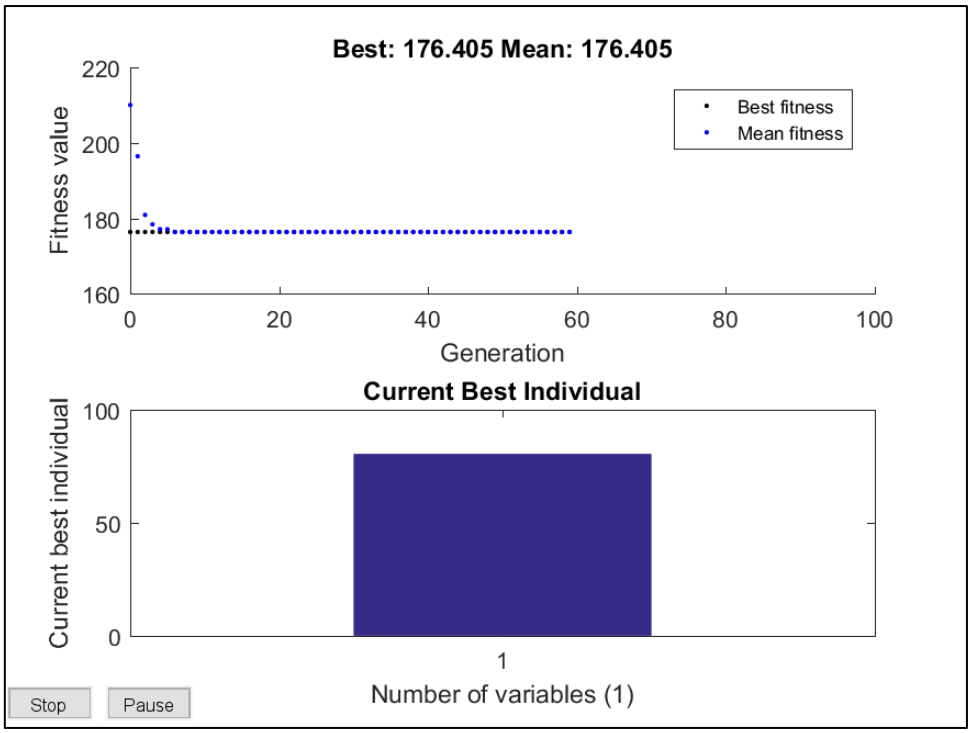

Figure 16: Generation of the best individuals from Manaus to Barcelos.

5. Conclusion

During the development of this work it was possible to identify opportunities for new research, considering that other resources can be explored with regard to the optimization of internal combustion engines, in addition to the continuous improvement of transport logistics with tools that learn routes and consult other databases to design scenarios of possible failures and act in decision making with better routes.

Among the training algorithms used in machine learning, it was possible to highlight and highlight the Bayesian Regularization to minimize fuel consumption considering the 3 simulated scenarios from Manaus to Itacoatiara, Manaus to Parintins and Manaus to Barcelos, with which it is possible to identify the values minimums for time spent and consumption in liters.

6. Acknowledgment

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Educational Counselor as one of the inclusive action facilitators in the school

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Abstract

The Educational Counselor is one of the professionals in the school management team. His role is to be the relationship mediator in every situation in school (student-student, student-teachers, teachers-families, and school-families). This research aimed at discussing the Educational Counselor as one of the facilitating agents for the articulation of inclusive actions in a school environment through an interdisciplinary perspective. To achieve this target a qualitative study was chosen. Nine Educational Counselor have been interviewed, and the generated data were evaluated through content analysis. The results have shown that although the research participants have difficulty conceptualizing school inclusion, they understand the idea of school inclusion as necessary to develop the subjects' potential. They also have shown that there is no effective inclusion of students with disabilities, and they have pointed out that, although the institution can offer the necessary resources for inclusive practice, and even continuing education, there is still a long way to go before school inclusion happens. Regarding health issues, the Educational Counselor' statements have shown a belief in the importance of training in a school environment, but they often seem to forget that the school is a space for education and not for health. We have been taught that professionals who are willing to work with inclusion need continued training to improve their practices, which, despite being recent, are significant and produce paradigm shifts about what they have believed to be inclusive practice.

Keywords: Educational Counselor; Inclusive education; Educational school psychology.

1. Introduction

The Educational Counselor - one of the professionals on the management team of a school - is responsible for mediating relationships in school (student/student, student/teachers, teachers/families, and families/school). He enables the creation of dialogue and listening among those involved in a school community. Studying the training and performance of this professional is, therefore, extremely complex, but necessary, as his work is based on an interdisciplinary approach (SOUZA-SILVA, *et. al*, 2019).

Inclusive Education can be defined as a practice of the inclusion of all people - regardless of their talent, disability, socioeconomic or cultural origin - in provided schools and classrooms in which the needs of those students are met (STAINBACK & STAINBACK, 1999).

Inclusive Education can also be seen as a movement that seeks to rethink school, so that it ceases to be the school of homogeneity and becomes the school of heterogeneity, with the purpose to have schools open to everybody (MARTINS, 2006). However, without "wild inclusion", that is, reducing or extinguishing special aid and services for people who need it to be included regardless of their needs, it is not considered the respectful coexistence that inclusion should provide so that the person can have recognition about their existence (MAZZOTTA, 2008).

The purpose of this article is to discuss the Educational Counselor as one of the facilitating agents for the articulation of inclusive actions in the school environment through an interdisciplinary perspective.

2. Methodology and methodological procedures

To carry out the study, we have chosen qualitative research, which, according to MINAYO (2007), is a method that considers the uniqueness of the participating subjects.

Nine educational counselor who work in private schools in the city of São Paulo were interviewed.

Table 1. Characterization of the participants

Participant	Age	Gender	Graduation	Postgraduation	Time of work
P1	56	Female	Pedagogy	Psychopedagogy	8
P2	51	Female	Pedagogy	Psychopedagogy, Vocational Guidance	14
P3	36	Male	Psychology	Master in Developmental Disorders	3
P4	30	Female	Psychology	Neuropsychology	3
P5	66	Female	Pedagogy	Psychodrama	20
P6	33	Female	Pedagogy	Education Bilingual	2
P7	56	Female	Psychology	Learning Disorders	9

P8	44	Female	Pedagogy	Psychopedagogy	14
P9	52	Female	Psychology and Pedagogy	Mental health of children and adolescents and Family Orientation	20

The participants' average age is 47.1 years, with the youngest being 30 years old and the oldest 66 years old. The average length of time in the role of Educational Counselor is 10.3 years, with the least length of time of 2 years and the most experienced has 20 years of work in this role. Five of the professionals are graduated in pedagogy, four in psychology and one has double graduation in psychology and pedagogy courses. All of them have *lato sensu* postgraduate program, and it is noteworthy that only one subject in this research has *stricto sensu* graduate program that is an academic master's degree.

The recorded interviews were organized and transcribed. The technique used was content analysis, which according to BARDIN (2009) is a set of investigation techniques that, through an objective and systematic description of the manifest content of communications, has the purpose of interpreting what has been said.

3. Results and discussion

The interviews were conducted individually due to the Covid-19 pandemic by mobile device, through a video conference platform at a previously scheduled time made by telephone contact with the participant. The audio of the interview was recorded and later it was transcribed and organized for data analysis.

3.1 Conception of school inclusion

All of those who work with school inclusion, even if they have never reflected on such concept, bring with them, intuitively, a concept of school inclusion, and this possibly underpins their way of reading and interpreting the facts within this school universe.

P1 School inclusion is the channel capable of providing students with specific or special needs and the development of their potential, with the understanding that it is necessary a particular and respectful look at their skills and aptitudes, considering the intellectual, social, and physical aspects.

P2 It is an unquestionable right of all students who fit into such group.

P3 School inclusion can be defined as the respectful and dignified insertion of people with some type of disadvantage, limitation, or significant difference who need equitable measures to have access to activities and benefits in the school context.

P4 A possibility to provide students with special needs with the development of their potential, not only in the intellectual aspects but also in the physical

and social aspects.

P5 School inclusion is the opportunity that the disabled citizen has to live with citizens who are not diagnosed with such problems.

P6 School inclusion is to provide opportunities for all students in the learning process, even with their skills and difficulties, with necessary adaptations (material, procedure).

P7 Giving opportunity to everyone, regardless of social class or physical and psychological conditions.

P8 School inclusion means that the student belongs to the school, participating in what the educational system offers, interacting, developing, and contributing with his potential to the institution's projects and programs.

P9 Providing the development of those children and adolescents taking into account their differences and valuing and their special needs.

Even with some possible difficulty in conceptualizing school inclusion, the educational counselor of this research were able to bring the idea of inclusion as being essential to develop the potential of the subject who is a student.

Those answers meet MAZZOTTA's conception of inclusion in "the inclusion, that is, respectful coexistence with each other is essential for each individual to be able to constitute themselves as a person or as a subject and, thus, they are not merely equated with anything" (MAZZOTTA (2008, p.165)). Also, according to the author, inclusion implies the recognition of the value of each one, going beyond the scope of formal equality, as a principle of Law in a democratic society.

Acting in the direction of the widest possible equality of opportunities, bearing in mind that it is only possible in specific socio-historically conditioned and determined situations, school inclusion much more than generating equality, has to enable equity. Man's search for freedom at an individual level, and for equal rights and opportunities in the social spaces, is an essential element in the construction of his personal and social identity. His participation in local and regional communities cannot be ignored or diminished, either in their daily relationships or in the elaboration, discussion, understanding, and application of public social policies (MAZZOTTA, 2008).

According to MAZZOTTA (2008), the main characteristic of the human being is plurality, not uniformity, and, with that, the reminder that each one knows and interprets the world with a very particular look, but there are biopsychological issues that are highlighted due to the existence of significant differences.

Students with disabilities in schools are often identified not by their names, but by nicknames such as: "the inclusion student", that is, by clinical issues that determine how teachers will act before the disabled person. It is up to the educational Counselor to show and reflect with the educator how to act in this situation, leading him to reflect on his practice at school.

Although the educational Counselor may believe that he acts on his own and that he is working in favor of school inclusion, he may be serving to exclude them from society and reinforcing the construction of the type of man that society produces currently, that is, a man with socio-emotional skills capable of masking his feelings in favor of a supposed resilience and false social activism, who only hides the reality that he is

inserted, transforming what is a natural construction into a social one, in other words, reinforcing the ideology and not being empathetic to the significant differences.

School inclusion is present in the imagination of social actors and in the ideology of social groups with the pretense mission of transforming the world into something better. The question is: to include for whom? For the maintenance of a possible slogan that education is inclusive in that school and reifying any form of thinking since radical inclusion dialectically is the cruelest exclusion.

Possibly the ways that the educational Counselor has to act as an agent that facilitates school inclusion is to be aware that being included is the right of every child or adolescent who has a significant difference and clarify it to all the social actors of the school pointing out the contradictions for the emancipation of those subjects who are, at that moment, their students.

3.2. The Educational Counselor in the practice of school inclusion

The category "The Educational Counselor in the practice of school inclusion" sought to elucidate which roles the Counselor should assume to be a facilitating agent for school inclusion since such professional is constantly mediating relationships within the school space between the different actors of the school community: students, teachers, administrators, and families. When asked "what is the place of educational guidance in the practice of school inclusion", they have answered:

P1	Promoting dialogue and partnership with external professionals, aiming at the productivity of the actions taken in favor of the student.
P2	Adequacies to the time of carrying out an evaluation.
P3	Through access to space and similar school conditions.
P4	In the Educational guidance service, the focus is to promote and encourage students with special needs to achieve their autonomy and independence for their practical and daily life.
P5	I see a very difficult, laborious practice
P6	I observe a lot of professionals who are very involved in this practice, being in constant reflections and attempts at more precise adaptations, which accommodate the needs of each of the students.
P7	with goodwill, but without specific training to deal with diversified cases and their specifications.
P8	The EA can contribute to the training of the teacher and other collaborators who work directly with the student about the disability in question, thinking about teaching strategies and behavioral interventions if they are necessary. The EA also contributes to the articulation of the teachers, the family, and the student's specialists.
P9	We carefully analyze the diagnoses we receive, provide care to parents and professionals with great professionalism and we accompany those children in their daily lives. Also, the continuing

> education of educators, who will not treat students directly, but need to know how to work with them, valuing their differences, enabling their development.

The educational counselor of this sample have reported that there is not an effective inclusion of students with disabilities and have pointed out that although the institution can offer the necessary resources for inclusive practice and even continued training, there is still a long way to go to see that the school inclusion happening.

As the educational counselor are fundamental professionals in the articulation between all the actors and in the training of teachers and other members of the school community, who, insistently bring the fact of not having been prepared to work with the various deficiencies, it is up to the educational Counselor as a facilitator of the school inclusion process to try, together with the institution, to create spaces for active and critical reflection involving all professionals working in the school. Along with school management, the educational Counselor can organize a training plan and participate in training meetings with teachers. One of the fundamental points of this process that strengthen mutual respect, and one of the principles of Inclusive Education, is to show everyone that it is not only necessary to know the student's diagnosis but to know about the disability in question. Medical reports and expert reports, in general, are restricted to showing what the subject is unable to do. But one must go further and know the potential, as they always exist so that one can work towards developing them. Thus, educational guidance may develop a methodological repertoire that includes students with disabilities in the development process, which must take into account strategies that allow teachers to recognize the student's (physical and cognitive) abilities. This will allow the creation of a stronger and more cohesive support network since the teachers will be able to act so that the responsible educator for special educational assistance (SEA) is not only the one who prepares small tasks so that the child does not disturb the other students' class, but which are not related to the teaching and learning process. He will be working in an articulated manner based on a conception that takes into account the authorship of these students as fundamental.

Still discussing the role of the educational Counselor as a trainer of the teaching team on school inclusion, it is necessary to foster the discussion about scientific knowledge about disability - and not about the report. According to AMARAL (1995), deficiency is any alteration of the body or physical appearance, of an organ or function, whatever its cause, in principle signifying disturbances at the organ level. Such losses or changes can be temporary or permanent and include the existence or occurrence of an anomaly, defect, or loss of a limb, organ, tissue, or other body structure, including mental function.

People with disabilities have lived, predominantly, under the sign of marginality. Such a condition affects them in the form of prejudice - disrespect, lack of guarantee of rights, and socio-political demotion are strongly present marks, as the attention is turned to what we visualize to be the impediment, the person's incapacity and not to their potentials and capabilities. More radically, attention is taken by fear arising from the perception of what, in us, resembles a significantly different person and, therefore, places us in front of the possibility of social non-acceptance as well (ADORNO, 1995). Hence, we quickly exclude, to guarantee that such similarities cannot be noticed, saving ourselves - always provisionally - from the loss of our so few rights.

In a capitalist society, therefore, the exclusion is part of the movement of its structuring rule: it is excluded and later it is included differently, according to the logic of the market. The educational Counselor must be aware of this contradiction, since education is for everyone, regardless of any other condition.

3.3. Training in school inclusion for its practical performance

The Category 3 - Training in school inclusion for its practical performance

P1	I have already taken some courses, but none that could be applied in practice
P2	The training I had, where tests were suitable for difficulties, use of adaptable sources to diagram evaluations and activities, oral tests, etc.,
P3	I believe that the most significant training was during teaching practice in colleges, as the contact with people who needed inclusive practices made me have this real contact and think about strategies to deal with those situations.
P4	Specialization in Neuropsychology.
P5	there should be specific training for this performance.
P6	constant training is necessary to seek references in various specialties, in addition to searching for courses and readings on the topic.
P7	Knowledge about legislation, pedagogical practices, human development, psychology, neuroscience, and knowledge about disabilities.
P8	Training in Psychopedagogy and Neuropsychology.
P9	I believe that the professional should rush to seek and be interested.

For the participants in this sample, training to work in school inclusion involves technical issues, however, much more than technical training issues, knowledge of the concept of school inclusion is necessary. Inclusion within schools is essential since the school institution is a space for the process of socialization and the transmission of values. In addition to the active participation of educators, the school community must be transformed to meet the special educational needs of the pupils.

The learning environment must be supportive, have audiovisual resources, pedagogical support rooms for stimulation and supplementary monitoring, must eliminate architectural barriers, present a curriculum and teaching strategies that are suitable for the greatest benefit of all, not just people with disabilities, but also of those who do not have any disabilities. The interpersonal differences need space to appear, to be discussed, making students develop a strategy to deal with the different and with different experiences, among others.

For MAZZOTTA (1986), education does not occur only at school, but everywhere where something is learned. However, as the school is the organized institution for education, it is a privileged place that, according to the author, can either block the possibilities of transformation of the individual or allow him

a great opening to the world, whether it is conceived as an organizational superstructure or as the collective will of individuals. The school is an instrument that helps to promote social changes. Only when it is not possible to adequately meet the educational needs of the student, keeping him in the common teaching flow, should one think about a specific curricular organization for his attendance, implying changes in the content, methodology, and learning environment, then you can talk about a specific curricular organization. (MAZZOTTA, 1993).

Inclusion needs to be done to preserve an ethical principle, which is the right of everyone to live. Here we take the meaning of schooling in its most fundamental aspect, which is to place the subject in front of the cultural production accumulated over time, in the socially legitimized institution to carry out this work. Because of this very reason the author states that school attendance, even though this institution deserves criticism and radical proposals for transformation, still produces therapeutic effects for children whose socialization process is determined, most of the time, by the circulation only in family and hospital environments. Such therapeutic effects cannot be confused with health-oriented training, as it was brought up by the educational counselor in this sample in their speeches on the importance of health-oriented training. It is verified, in the education counselor ' statements, the belief in the importance of health issues within the school environment often leading them to forget that the school is a space for education and not for health.

According to CHRISTOFARI, FREITAS, and BAPTISTA (2015), behavioral issues, or so-called misconduct, become pathological symptoms as medical rationality, above all, medical-clinical discourse, is present in all fields of life and expands through different educational practices.

The hegemony of medical discourse within education is reducing human diversity. There are series of labels and classifications inserting them in a network of pathological explanations, the phenomenon of medicalization. Medicalization is a device that transforms political, social, and cultural problems into personal issues to be treated or medicated (MOYSÉS & COLARES, 2010). The individual is isolated from a context to analyze in detail his particularities and make them pathological. A way of looking at the other is produced as if it were a simple sum of biological and behavioral characteristics, both taken as a starting point for defining the presence of possible pathologies (CHRISTOFARI, FREITAS & BAPTISTA, 2015).

According to CALADO (2014), the medicalization of education transfers collective, social, and political issues to the medical field, reducing them to biological aspects, exempting other instances of power from responsibility, resulting in the individualization and blaming of children and adolescents and their families. The educational Counselor must always be attentive to this medicalization process, as this medical discourse becomes an ideology, and it masks the school as an institution that reflects social, economic, and cultural inequalities and also reproduces them. The school, according to PATTO (2008), SOUZA (2009), and CALADO (2014), must be understood from elements such as educational policies, through the local history of its constitution as an institution, as an educational reference by the subjects that constitute it and they are constituted, in addition to social and ideological aspects.

According to MARCUSE (1982), the social and ideological aspects are no longer just in the field of ideas but have become their social order, that is, society itself is its ideology. Thus, when discussing the formation of the educational advisor, the belief of what would be essential to form this advisor, goes through what seems to be indispensable for solving the problems that are medical knowledge.

In this way, educational counselor must be aware of this pseudo-need for health education. School is a non-health education space in its strict sense. Educators and everyone in the school community should be aware of this phenomenon, as it goes far beyond what it is transmitting, that is, it is determining a new way of understanding and acting within the universe of school relationships and learning.

This medicalization of education seems to be becoming the determining order of education. It is also determined by the means of production that determine the cultural industry, and fetishes medical knowledge to the detriment of other knowledge, often determining the way of being, acting, and thinking of men. In this context, it only reproduces current standards previously established, including within schools and as educators.

Within this universe, there is then a constant exercise to decipher the conditions and conditioning that determine the ways of being an advisor. Thus, according to FREIRE (2001), activities in the field of education require that preparation, qualification, and training become permanent processes. Formation based on the critical analysis of the practice.

3.4. Greater difficulties and challenges for school inclusion

The category "greater difficulties and challenges for school inclusion" approaches the way the educational Counselor understands those issues.

P1	Lack of adequate and specific training for the professionals involved, the physical preparation of the school, necessary materials, and public policies focused on the issue.
P2	It would be of utmost importance to engage everyone involved, from the Directorate, encompassing the collaborative way within the school environment team. In this collaborative process, the family needs to actively participate, in some cases TA (Therapeutic Assistance).
P3	The greatest difficulties and challenges in the current context are to understand the need for school inclusion (...) making other school actors understand that school inclusion must also take into account dignified, affective, and social participation in relationships with other classmates.
P4	In my experience, the greatest difficulty is to sensitize society by reducing prejudices and seeking to equate opportunities.
P5	Adequate training, financial resources and family, school, and governmental structure and to work on the awareness of inclusion for the included and the non-included. Human coexistence in a humane and dignified manner is a right of all.
P6	Resistance (teachers, principals, system, and even parents), little specific training (the practice of trial and error), lack of empathy from other families.
P7	To train teachers, especially specialists. The teacher must welcome,

	know and plan to meet the specific educational needs, rescuing the self-esteem of the student who arrives with so many histories of school failure.
P8	Find teaching strategies that are effective, for example, in subjects, whose contents become increasingly abstract, in the case of mental disabilities; motivation and training of teachers to work with inclusion; required work dynamics; acceptance of the group of students and their families (some believe that school inclusion delays the learning process of the class)
P9	In my work, I see misdiagnoses, poorly oriented families, and a partnership work between family and school that needs to be on the same wavelength, otherwise it will not work.

In this category, the educational counselor have brought several difficulties that meet what is brought by the literature, most of the time linked to the issues of specific training to work in this area and not an inclusive attitude as was brought by the participants 2,3 and 4.

LEONARDO *et. al*. (2009) pointed out that both public and private schools do not have adequate infrastructure to develop inclusive projects yet, as most professionals do not have the knowledge and preparation to deal with diversity within the classroom. There is also a lack of adequate methodologies and didactic-pedagogical resources.

According to ENUMO (2005), the difficulties in school inclusion start with the failure to diagnose the students' specific learning difficulties due to little professional training to pedagogically and psychologically assist this population.

SANT´ANA (2005) highlights in his work the lack of specialized training and technical support in working with students with special educational needs in regular classes. MONTILHA (2009) when discussing the school inclusion of children with visual impairment states that for this to occur effectively, professionals need to know the perceptions that those students have regarding their limitations and possibilities. It is also necessary to create a resource room with a specialized teacher and educational environment containing specific materials and equipment that enable the education of those children.

AVILA *et. al*. (2008) state that the inclusion process goes beyond technical information. They also require the creation of emotional care spaces for such professionals since the beginning of their academic training, so that they can get in touch with the various feelings, doubts, and uncertainties that involve the school inclusion process. The creation of group spaces for emotional care allows its members to fragment and integrate the most diverse contents, providing a creative process for the internalization of what was elaborated in a group, that is, the group facilitates and sustains subjectivity (KAËS, 1997)

JURDI and AMIRALIAN (2006) point out the difficulties of establishing, in the school environment, daily quality relationships between students with and without special educational needs that hinder the process of real school inclusion, as such relationships may be permeated with prejudice and ignorance. The school is the place where children socialize, so it is not enough for students with disabilities to be inside the school since the school environment is competitive and tends to deny differences and to value homogeneity. Thus,

there is no room for the different and unique and for establishing a dialogue with diversity (JURDI and AMIRALIAN; 2006)

The lack of adequate infrastructure (resource rooms, specialized teachers and technicians, appropriate didactic - pedagogical materials), fails to diagnose specific learning difficulties, to know the perceptions that these students have regarding their limitations and possibilities, the creation of emotional care spaces for the professionals who work with this population, and mainly, information for everyone involved in the school environment (parents, students, teachers, employees), as a way to reduce prejudice, stereotypes and consequently the difficulties and to establish themselves in the school environment, daily quality relationships between students with and without special educational needs. So, school inclusion must act together with inclusion in the community and the labor market, as a way of inserting and making the person a participative being within our society, because only school inclusion itself, or any other type of inclusion, possibly will not make the disabled person an active being within our society.

Although educational counselor did not bring up the issue of prejudice as a difficulty to include those children and young people, we often face prejudice in subtle ways, which, according to KOEHLER (2003), is psychological violence that leaves no explicit marks. We often find it in ourselves, but it easier to recognize it in the other. It is a phenomenon produced in the tense relationship between individual and society and should, therefore, be understood from the dialogue between the psychological and social dimensions that constitute the processes of humanization. We will use here the concept of prejudice presented by CROCHIK (1997), a scholar from the Frankfurt school, mainly from ADORNO, who highlights the importance of the distinction between prejudice and preconceptions, while relating them. For the author, the pre-concept is present in the conceptualization process of the object, before pure experience, that is, when we face a new situation, we need to make use of past experiences, which will make the unknown familiar. The preconception only becomes, in fact, prejudice, after the possibility of a reflective experience of the relationship with the other. The author shows that prejudice is not innate, as the child perceives the difference from the other concerning him, but this does not prevent him from relating to the different other. Such coexistence is marked by the demotion of the other, who becomes the target of prejudice, precisely because the possibility of reflecting on the experience of contact is prevented. Thus, prejudice is introjected by us, who incorporate it for fear of what would happen if we did not do it. It is the fear of being the next to not be accepted that makes us quickly point to another - belonging to a category that is already socially stigmatized - as an inferior.

Therefore, we can say that prejudice is a way - albeit a precarious one - of dealing with conflicts present throughout our lives. Hence the conclusion that every individual, for going through this process of socialization to adapt to society, is prejudiced. In the Frankfurt perspective, culture is a means for individualization. This individualization can only occur through a collective project that allows differentiation. Therefore, the function of cultural formation is to socialize and then to individualize. In other words, training should be aimed at differentiating the individual concerning his environment, with which he is confused at the time of his birth.

Subjectivity, therefore, is defined by an internal terrain that differs from the external world, but that can only arise from this one. Anyway, such subjectivity is built from the interiorization of culture, which allows expressing individual desires and criticizing the very culture that allowed its formation (CROCHIK, 1997).

In our society, necessarily, the individualization process involves the formation of prejudices that refer to different human categories, such as, for example, women, blacks, homosexuals, the disabled, etc., which denotes that the feeling of prejudice is less involved with the characteristics of the prejudice targets, which are different from each other. It is in this sense that prejudice relates more to the needs of the prejudiced than to the characteristics of the groupings to which it refers.

Each target of prejudice unleashes, in the prejudiced one, different affections, related to different psychic contents for each of them, but brought together by the same impossibility: that of having the experience of contact with otherness.

CROCHIK (1997) reminds us that the prejudiced person bears marks of culture and, precisely because the individual does not exist without culture, we can invest in the possibility that it will facilitate the process of developing less prejudiced subjects. Because it is a social process, that is, built by the action of man, mediated by culture, in its relationship with other men, it is possible and necessary to develop criticisms that can transform culture, thus helping in alienated non-reproduction. from prejudice and stereotypes present in society, but in the construction of a society whose greatest value is human emancipation.

3.5 Knowledge/content needed to work in School Inclusion

This category aims to discuss, through the views of educational counselor, what knowledge/content is necessary to act in school inclusion.

P1	This training covers both the study of the individual's disabilities, as well as knowledge of specific laws for inclusion and the school's internal regulations.
P2	It would be of utmost importance to engage everyone involved, from the Directorate, encompassing the collaborative way within the school environment team. In this collaborative process, the family needs to actively participate, in some cases TA (therapeutic assistance).
P3	The greatest difficulties and challenges in the current context are to understand the need for school inclusion (...) to make other school actors understand that school inclusion must also take into account dignified, affective, and social participation in relationships with other classmates.
P4	In my experience, the greatest difficulty is to sensitize society by reducing prejudices and seeking to equate opportunities.
P5	adequate training, financial resources, and family, school, and governmental structure and to work on the awareness of inclusion for the included and the non-included. Human coexistence in a humane and dignified manner is a right of all.
P6	resistance (teachers, principals, system, and even parents), little specific training (the practice of trial and error), lack of empathy from other families

P7	to train teachers, especially specialists. The teacher must welcome, know and plan to meet the specific educational needs. Rescuing the self-esteem of the student who arrives with so many histories of school failure.
P8	Find teaching strategies that are effective, for example, in subjects, whose contents become increasingly abstract, in the case of mental disabilities; motivation and training of teachers to work with inclusion; required work dynamics; acceptance of the group of students and their families (some believe that school inclusion delays the learning process of the class)
P9	in my work, I see misdiagnoses, poorly oriented families, and a partnership work between family and school that needs to be on the same wavelength, otherwise it will not work.

In the understanding of the surveyed participants, professionals who seek inclusion need continued training to improve their practices, which, despite being recent, are significant and produce paradigm shifts about what they believed to be inclusive practice. Concerning the knowledge necessary for inclusive practice, they have listed knowledge such as didactic, pedagogical, and methodological knowledge consistent, as well as knowledge of practical experience, which will only be built from the work with these students. Besides, experience in the role of educational advisor, to involve everyone working in the school inclusion process.

Concerning the construction/acquisition of knowledge, knowledge, and skills necessary for inclusive practice, they believe that they can originate in courses, seminars, lectures, books, exchanges of experiences between teachers who work with common and special education. Such practices can take place in the school environment as a space for discussion and questioning between school and family, in the university environment, through practices and internships, in families, and even on the internet.

Experience is a possible path to school inclusion. Moments of learning, exchange, and dialogue with students, family, and colleagues, experiences that, according to them, have changed their teaching practices. They have expressed the need for training, studies, and exchange of experiences and constant theoretical-practical construction, which is essential in this inclusive process.

As the educational Counselor is a member of the management, he is a mediator between the different actors of the school community and must try to promote spaces for collective work, since all work within the school is a human production. Thus, work within the universe of education is completely different from the nature of work in general, and in the production of its products.

4. Final considerations

This work had the purpose of discussing the educational Counselor as one of the facilitating agents for the articulation of inclusive actions within the school environment through an interdisciplinary perspective.

Wide-ranging interviews were recorded with educational advisors, participants' perceptions of school inclusion. According to such interviews, it was evidenced that:

- Even with some possible difficulty in conceptualizing school inclusion, the educational advisors of this sample have brought the idea of inclusion as being essential to develop the potential of this subject.
- The educational advisors in this sample have reported that there is not an effective inclusion of students with disabilities and have pointed out that although the institution can offer the necessary resources for inclusive practice and even continuing education, there is still a long way to go before real school inclusion happens.
- The educational advisors of this sample brought in their speeches about the importance of training towards health, and it is verified in their speeches the belief in the importance of issues related to health within the school environment, and many times they have even forgotten that the school is a space for education and not for health.
- The lack of adequate infrastructure (resource rooms, specialized teachers and technicians, appropriate didactic-pedagogical materials), failure to diagnose specific learning difficulties, to know the perceptions that those students have regarding their limitations and possibilities, the creation of emotional care spaces for professionals who work with such population, and mainly to provide information for everyone involved in the school environment (parents, students, teachers, employees), to reduce prejudice, stereotypes and consequently the difficulties of establishing themselves in the environment school, daily quality relationships between students with and without special educational needs.
- In the understanding of the surveyed participants, professionals who seek inclusion need continued training to improve their practices, which, despite being recent, are significant and produce paradigm shifts about what they believed to be inclusive practice. Concerning the knowledge necessary for an inclusive practice; educational advisors have listed knowledge such as didactic, consistent pedagogical, and methodological knowledge, as well as knowledge from practical experience, which will only be built from working with these students.

The social and school inclusion of people with special needs is a challenge to the situation that perpetuated the segregation of these people and prevented their full development. Until the beginning of the 21st century, in the Brazilian educational system, there were two "types" of schools: the regular and the special school and the student could only attend one of them. Over the years, inclusive education/school inclusion is gaining more and more strength and space within school institutions and it is becoming the target of questions and changes.

Given this educational paradigm of inclusion, the educational Counselor has to assist and propose reflections at school, in the development of a new school culture based on human rights, particularly concerning the right of all students to benefit themselves from quality education which aims at the principle of equality.

According to ALMEIDA (2009), the educational Counselor must act as a qualified information agent at school, encompassing the practice of continuous reflection with teachers, students, and parents, as his role is "qualified mediation", acting ethically within limits, helping to find the way out and the resources that are available to help the inclusion of students with special educational needs.

It is noticeable in the school routine the insecurity and fear of the team, in general, when receiving students with different and diverse special educational needs. The advisor, in this context, has to be a foundation on

which the professionals have confidence in asking for help, clarifying doubts, and expanding knowledge to serve those students with dignity.

Therefore, taking into account the aforementioned aspects, the professional who acts as an educational Counselor in the current educational situation and an inclusive education perspective, emerges as a "trainer" in the school environment. The educational Counselor provides assistance and support to all, specifically to the student, gathering in his professional training process knowledge about the conceptual aspects of the teaching-learning process, the different ways of learning and knowing, thinking, and feeling of students with special educational needs, always aware that alone he will not be able to include those students.

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Nonlinear models. An approach to model irrigated and non-irrigated common bean (*Phaseolus vulgaris* L.) growth

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Abstract

Common beans reduce their development and productivity when facing soil water deficit. Comprehension about growth response under this condition can be a tool for cultivar selection and escape from scarcity periods. Therefore, the objective was to characterize bean growth in different water conditions using logistic and chanter models. Two experiments (crop season= EI and fallow season = EII) were carried out in Santa Maria, RS, Brazil in a bifactorial scheme (cultivars: Triunfo, Garapiá, FC104; water condition: irrigated, not irrigated) in a completely randomized design. Fortnightly evaluations of height, number of nodes, stem diameter, root length, aerial part, roots, and nodules dry matter were carried out. The data were adjusted according to the accumulated thermal sum by the logistic and chanter models. From the results, it is noted that there was a dissimilar performance between water conditions, cultivars, and experiments. The best adjustment occurred for stem diameter, node number, and aerial part dry matter. Between models, the logistic is the most suitable to describe common bean growth.

Keywords: water deficit; chanter; logistic; *Phaseolus vulgaris* L.

1. Introduction

The common bean (Phaseolus vulgaris) is a staple food with a high protein and mineral content, consumed daily by the majority of the Brazilian population. Despite its socio-economic importance, the oscillation of its supply is associated with weather conditions, mainly to water deficit (Miorini et al., 2011), which reduces growth and, therefore, productivity. The use of tolerant genotypes to this water condition can be a sustainable alternative. For that, it is necessary to carry out analyzes that explain the genotypes growth in water deficit conditions. Growth analysis makes it possible to measure plants' variable responses during the biological cycle without having to destroy them (Cardoso et al., 2006). Among the methodologies used for this purpose, non-linear models have the advantage over linear models, as they present biological

interpretation parameters, which help explain plants' growth and development cycle (Regazzi, 2003). In annual plants, the growth phases over time or thermal accumulation present a sigmoid curve, with a slow initial growth, followed by an exponential, linear, and again slow growth with variable palsy, due to the plant senescence (Peixoto et al., 2011).

Nonlinear models are used to describe growth curves, which correspond to measurements in sequence over a given time (Fernandes et al., 2014). Growth functions are an applicable alternative to study plants' response and explain complex temporal and spatial interactions, and through computational modeling, it is possible to make predictions that can be used to generate new experimental hypotheses (Chickarmane et al., 2010). Growth models can assist in management planning, by forecasting the phenological stages occurrence time and possible escapes from stress periods, such as water deficit (WD) (Rodrigues et al., 2001). Besides, growth evaluation throughout its cycle makes it possible to identify and select inherent characteristics of each genotype (Deprá et al., 2016).

Among the curves used, Regazzi (2003) surveyed some of the most used models, such as the logistic. The author references that the sigmoid curves are distinctive of phenomena found in agriculture, characterized by a growth until the modulation point when the growth begins to decrease until a final value called an asymptote. The choice of the best model is complex and quality assessments of fit and knowledge about the study object should be considered (Puiatti et al., 2013). In bean cultivars, Martins Filho et al. (2008) evaluated the growth by Bayesian logistic regression models. Another model that has been studied is the chanter, which has the potential to adjust for measurements over time (Silva and Savian, 2019).

Models that simulate plant growth and development are studied to support the new needs of digital agriculture. Studies on common beans growth are rare, mostly in different water regimes. The frequent droughts, and the increasing water deficit periods forecast (Vicente-Serrano et al., 2020) justify this approach. Thus, the objective of the study was to characterize bean cultivar growth under different water conditions using logistic and chanter models.

2. Material and methods

The experiment was conducted at the Federal University of Santa Maria (UFSM) Crop Sciences Department, Santa Maria, RS, Brazil (29 ° 43 'S. 53 ° 43' W. 95 m) in a 150 m² shelter covered with 200 µm low-density polyethylene, with side walls covered with an anti-aphid screen. Climate, according to the Köppen classification, is of the Cfa type, humid subtropical with hot summers and undefined dry season (Kuinchtner and Buriol, 2001).

Two experiments were carried out with Triunfo and Garapiá from the State Agricultural Research Foundation (FEPAGRO), and FC104 from Brazilian public Agricultural Research Corporation (Embrapa) cultivars. The sowing of the first experiment (EI), corresponding to main season, was carried out on 08/31/2019 (Triunfo and Garapiá) and 09/20/2019 (FC104), and the second experiment (EII), corresponding to fallow season, on 27/01/2020 (Triunfo and Garapiá) and 02/16/2019 (FC104). FC104 sowing occurred on a different date because of its very early cycle, so that the pre-flowering of both cultivars concurred.

The experimental design was completely randomized with 6 treatments, in a 3x2 factorial format: 3

cultivars (Triunfo, Garapiá, and FC104) and two water regimes (WR) (irrigated and non-irrigated). Each experimental unit consisted of a vessel with a capacity of 8 L filled with Argissolo Bruno-Acinzentado alítico típico soil (Santos et al., 2018) with one plant. The basic fertilization and nitrogen-fixing bacteria inoculation were following the technical recommendations for bean cultivars (Commission of Chemistry and Soil Fertility RS / SC, 2016).

Water conditions were forced in the pre-flowering stage (R5) (Fernandez et al., 1986) through the fraction of transpirable soil water (FTSW) methodology, in which plants with WD were not irrigated until they presented 10% of transpiration of the irrigated plants that had their daily amount of transpired water refilled, according to the methodology proposed by Sinclair and Ludlow (1986). After the non-irrigated plants reached 10% of the irrigated transpiration, all plants were rehydrated and maintained in field capacity until the end of the development cycle.

The meteorological data referring to the air temperature were obtained in the automatic meteorological station A803 of the Brazilian National Institute of Meteorology (INMET) located 100m from the experiment. The daily thermal sum was determined by the number of degrees days (°C day-1) using the equation (Eq. 1):

$$DD_i = \left(\frac{TM+Tm}{2}\right) - Tb \quad (1)$$

where DD_i is the degree day (°C day^{-1}), TM is the daily maximum air temperature (ºC), Tm is the minimum daily air temperature (ºC) and Tb is the lower basal temperature of the cultivar, 10ºC (Renato et al., 2013). The accumulated DD or thermal sum (DD, ºC) were obtained by the sum of the DD_i (Eq. 2):

$$DD = \sum DD_i \quad (2)$$

For growth analysis, three plants per treatment were collected every 15 days after emergence (dae) (V1) until maturation (R9). In the EI, the harvest started on 9/23/2019 for Triunfo and Garapiá and 10/12/2019 for FC104 and ended on 12/10/2019 for all cultivars. For EII, it started on 02/14/2020 for Triunfo and Garapiá and 03/04/2020 for FC104 and ended on 04/14/2020 for all cultivars. So, for the Triunfo and Garapiá cultivars there were six harvests in the EI and EII, and for the FC104, five harvests in the EI and four in the EII.

Plants were evaluated for: height (H) of the main stem (cm), with the aid of a millimeter ruler from ground level to the last node; the number of nodes (NN), from the node of the unifoliolate leaves to the last node with fully expanded trefoil; diameter of the main stem (MSD) (cm), with the aid of a caliper, measured between the cotyledon node and the unifoliolate leaves node; root length (RL) (cm) with the aid of a millimeter ruler; aerial part (APDM) and roots (RDM) dry matter (g), in which the plants were oven-dried at 65ºC until constant weight; fresh nodules dry matter (NDM) (g); fresh nodules with a diameter greater or equal to 2 mm were oven-dried at 65ºC until constant weight.

These variables were considered as dependent variable Y and the DD (ºC day^{-1}), the independent variable X, in the logistic model (Eq. 3):

$$Y = \frac{a+4b(\exp\left(-\frac{(X-c)}{d}\right))}{(1+(\exp\left(-\frac{(X-c)}{d}\right))^2} \quad (3)$$

The data were also adjusted to the chanter model as described by Silva and Savian (2019) (Eq. 4):

$$Y = \frac{ab}{a+(b-a)\exp\{-\frac{c}{c}[1-\exp(-dX)]\}} \quad (4)$$

where: a, b, c, and d are parameters of the model.

To estimate the model parameters, the Table Curve 2D version 5.01 program was used (Table Curve 2D, 2021), which uses the iterative Levemberg-Marquardt technique for nonlinear least squares. Parameter estimations were compared between experiments for each cultivar and WC, and between cultivars and WC in each experiment, by overlapping the confidence intervals (CI) of the parameter estimates in each model. For this, the lower and upper limits of the 95% confidence interval were calculated. The fit quality of models was evaluated based on the statistics: root mean square error (RMSE), mean absolute error (MAE), Willmott's index of agreement (d), and Pearson's correlation (r) through the hydroGOF package of the R software (R Core Team, 2020).

The highest values of d and r and the lowest values of RMSE and MAE were considered for model selection. The RMSE and MAE express the magnitude of the error produced by the model, values close to zero indicate better models. Index of agreement (d) indicates the agreement of the estimated data with those observed. The r indicates the degree of dispersion and association of the simulated data in relation to the observed data.

3. Results and discussion

From the criteria for assessing the model's quality of fit (Table 1), growth curves that presented satisfactory adjustments with r above 0.70 were selected to be presented in Tables 2, 3, 4, and 5. R values above 0.90, and MEA and RMSE below 5.0 were more frequent in cultivars in WC (Table 1, 2, 3, 4, and 5), while the general curves displayed the worst performances and will not be presented. Like this, the specific curves for each cultivar vs WC are more accurate and indicated.

Table 1. Mean absolute error (MAE), root mean square error (RMSE), index of agreement (d), and Pearson's correlation coefficient (r) of the Logistic (L) and Chanter (C) models for variables as a function of accumulated thermal sum (DD) (°C day-1) of bean cultivars (Triunfo, Garapiá and FC104) in two water regimes (irrigated and non-irrigated) in experiment I (EI) and II (EII).

		EI				EII			
Character	Model	MAE	RMSE	d	r	MAE	RMSE	d	r
		Irrigated Triunfo							
H	L	10.85	13.00	0.98	0.97	13.67	16.30	0.98	0.96
H	C	6.70	10.51	0.99	0.98	44.87	72.55	0.56	0.33
MSD	L	0.03	0.04	0.99	0.98	0.03	0.04	0.99	0.98

MSD	C	0.03	0.05	0.99	0.97	0.03	0.04	0.99	0.98
NN	L	0.56	0.81	0.99	0.98	0.52	0.71	0.99	0.99
NN	C	0.55	0.70	0.99	0.99	0.45	0.60	1.00	0.99
RL	L	5.04	5.71	0.98	0.96	16.61	23.36	0.11	0.12
RL	C	3.55	4.87	0.98	0.97	7.61	10.67	0.94	0.89
APDM	L	2.82	4.28	0.97	0.95	3.04	3.80	0.95	0.91
APDM	C	5.81	8.67	0.85	0.82	2.28	3.22	0.97	0.94
RDM	L	1.62	2.32	0.95	0.91	0.94	1.16	0.98	0.95
RDM	C	2.00	2.98	0.91	0.84	1.34	1.78	0.94	0.89
NDM	L	0.06	0.08	0.95	0.91	0.07	0.19	0.94	0.89
NDM	C	0.05	0.08	0.94	0.89	0.07	0.19	0.94	0.89
Non-irrigated Triunfo									
H	L	6.96	9.77	0.98	0.96	12.92	16.20	0.94	0.89
H	C	6.48	9.51	0.98	0.96	12.13	15.13	0.95	0.91
MSD	L	0.45	0.48	0.10	0.18	0.04	0.05	0.98	0.97
MSD	C	0.02	0.03	0.99	0.98	0.05	0.06	0.98	0.96
NN	L	0.37	0.52	1.00	0.99	0.70	0.93	0.98	0.97
NN	C	0.39	0.44	1.00	0.99	0.66	0.97	0.98	0.96
RL	L	8.03	10.64	0.95	0.91	16.33	20.81	0.48	0.36
RL	C	8.13	11.18	0.95	0.90	7.01	9.51	0.95	0.90
APDM	L	1.38	1.97	0.98	0.97	1.72	2.16	0.98	0.97
APDM	C	4.00	5.26	0.84	0.74	1.81	2.18	0.98	0.97
RDM	L	2.34	4.05	0.89	0.82	1.08	1.29	0.97	0.94
RDM	C	3.36	5.39	0.74	0.64	1.14	1.62	0.94	0.90
NDM	L	0.02	0.05	0.97	0.94	0.07	0.09	0.77	0.66
NDM	C	0.04	0.07	0.91	0.85	0.05	0.08	0.80	0.68
Irrigated Garapiá									
H	L	4.56	7.15	0.99	0.98	12.05	16.01	0.95	0.91
H	C	12.98	17.40	0.92	0.85	9.00	11.48	0.98	0.96
MSD	L	0.04	0.05	0.98	0.96	0.05	0.07	0.94	0.89
MSD	C	0.04	0.05	0.98	0.97	0.03	0.05	0.97	0.94
NN	L	0.67	2.80	0.99	0.98	0.52	0.71	0.99	0.99
NN	C	0.76	1.07	0.98	0.97	0.61	0.78	0.99	0.97
RL	L	6.80	9.34	0.95	0.92	7.18	8.55	0.96	0.92
RL	C	3.55	4.87	0.98	0.97	10.50	13.37	0.82	0.92
APDM	L	2.07	2.44	0.98	0.97	6.83	17.11	0.57	0.54
APDM	C	3.94	5.41	0.89	0.83	6.78	16.23	0.61	0.63
RDM	L	2.23	3.21	0.93	0.87	2.13	3.17	0.48	0.71
RDM	C	2.23	3.48	0.91	0.84	1.20	1.89	0.91	0.85

NDM	L	0.08	0.12	0.94	0.90	0.14	0.17	0.94	0.89
NDM	C	0.09	0.15	0.90	0.83	0.22	0.32	0.65	0.53
Non-irrigated Garapiá									
H	L	9.83	11.95	0.92	0.86	11.61	15.10	0.96	0.92
H	C	9.67	14.38	0.87	0.78	7.70	9.12	0.99	0.97
MSD	L	0.05	0.05	0.97	0.94	0.08	0.09	0.89	0.81
MSD	C	0.03	0.04	0.98	0.96	0.04	0.06	0.95	0.92
NN	L	0.52	0.71	0.99	0.98	0.91	1.15	0.97	0.94
NN	C	0.50	0.71	0.99	0.98	0.93	1.23	0.97	0.94
RL	L	7.11	10.01	0.94	0.90	15.43	20.22	0.49	0.39
RL	C	6.94	9.72	0.95	0.90	9.89	12.14	0.87	0.93
APDM	L	1.52	2.04	0.97	0.94	2.82	3.53	0.93	0.88
APDM	C	1.93	2.58	0.95	0.90	2.25	3.16	0.95	0.90
RDM	L	1.82	2.85	0.96	0.92	1.31	1.90	0.92	0.86
RDM	C	2.57	4.12	0.90	0.83	1.16	1.76	0.93	0.88
NDM	L	0.05	0.10	0.94	0.89	0.17	0.24	0.74	0.62
NDM	C	0.05	0.10	0.94	0.89	0.18	0.26	0.67	0.55
Irrigated FC104									
H	L	8.07	11.42	0.98	0.96	12.05	16.01	0.95	0.91
H	C	9.67	17.43	0.95	0.91	9.00	11.48	0.98	0.96
MSD	L	0.09	0.12	0.42	0.92	0.05	0.07	0.94	0.89
MSD	C	0.04	0.04	0.97	0.94	0.03	0.05	0.97	0.94
NN	L	2.67	3.29	0.59	0.81	0.52	0.71	0.99	0.99
NN	C	0.76	1.07	0.98	0.97	0.61	0.78	0.99	0.97
RL	L	6.80	9.34	0.95	0.92	7.18	8.55	0.96	0.92
RL	C	4.13	5.15	0.98	0.95	10.50	13.37	0.82	0.92
APDM	L	2.95	5.35	0.85	0.72	6.83	17.11	0.57	0.54
APDM	C	3.33	5.03	0.86	0.75	6.78	16.23	0.61	0.63
RDM	L	3.00	4.52	0.89	0.82	2.13	3.17	0.48	0.71
RDM	C	3.40	5.60	0.81	0.71	1.20	1.89	0.91	0.85
NDM	L	0.05	0.09	0.96	0.93	0.14	0.17	0.94	0.89
NDM	C	0.12	0.19	0.73	0.61	0.22	0.32	0.65	0.53
Non-irrigated FC104									
H	L	8.33	10.82	0.98	0.96	6.08	9.00	0.99	0.99
H	C	8.07	10.91	0.98	0.96	6.08	9.28	0.99	0.98
MSD	L	0.05	0.05	0.94	0.89	0.02	0.03	0.98	0.96
MSD	C	0.04	0.05	0.94	0.90	0.04	0.06	0.95	0.92
NN	L	0.52	0.71	0.99	0.98	0.33	0.58	1.00	0.99
NN	C	0.50	0.71	0.99	0.98	1.83	3.06	0.93	0.92

RL	L	5.93	7.21	0.95	0.91	6.58	8.53	0.32	0.29
RL	C	5.20	6.69	0.96	0.92	9.89	12.14	0.87	0.93
APDM	L	0.89	1.24	0.98	0.97	1.62	2.47	0.93	0.88
APDM	C	1.16	1.41	0.98	0.96	2.25	3.16	0.95	0.90
RDM	L	1.04	1.66	0.96	0.93	1.10	1.20	0.92	0.85
RDM	C	2.67	3.76	0.68	0.57	1.16	1.76	0.93	0.88
NDM	L	0.03	0.07	0.86	0.77	0.02	0.03	0.90	0.84
NDM	C	0.05	0.09	0.55	0.47	0.18	0.26	0.67	0.55

Table 2. Parameters estimates a, b, c, and d, lower limit and upper limit of the confidence interval (CI 95%), inflection point (IP), and asymptote (AS) of the Logistic model for variables as a function of accumulated thermal sum (in °C) of bean cultivars (Triunfo, Garapiá and FC104) in two water regimes (irrigated and non-irrigated) in experiment I (EI).

	a	b	c	d	IP	AS
Height						
Upper limit	17.85	153.50	192.35	38.46		
Irrigated Triunfo	-0.61^{ns}	132.57*	184.68*	29.33*	146.05	215.6
Lower limit	-19.06	111.64	177.02	20.21		
Upper limit	17.49	107.10	200.37	41.34		
Non-irrigated Triunfo	3.67^{ns}	91.75*	190.46*	30.33*	150.51	215.6
Lower limit	-10.15	76.39	180.54	19.32		
Upper limit	15.32	108.78	173.47	25.83		
Irrigated Garapiá	6.69^{ns}	96.33*	169.71*	21.11*	141.91	197.50
Lower limit	-1.94	83.88	165.95	16.38		
Upper limit	24.74	81.98	168.74	37.69		
Non-irrigated Garapiá	6.27^{ns}	60.29*	156.84*	24.60*	124.45	189.23
Lower limit	-12.21	38.59	144.94	11.50		
Upper limit	22.47	141.90	142.25	31.36		
Irrigated FC104	0.60^{ns}	118.29*	136.26*	23.51*	105.29	167.22
Lower limit	-21.26	94.69	130.26	15.67		
Upper limit	27.03	135.64	159.38	47.36		
Non-irrigated FC104	-4.26^{ns}	107.30*	148.15*	31.24*	107.01	170.84
Lower limit	-35.55	78.96	136.92	15.12		
Main stem diameter						
Upper limit	0.25	0.63	189.90	47.14		
Irrigated Triunfo	0.17*	0.56*	183.10*	37.58*	133.61	215.6
Lower limit	0.09	0.49	176.31	28.02		
Upper limit	-	-	-	-		
Non-irrigated Triunfo	-	-	-	-	-	-

Lower limit	-	-	-	-		
Upper limit	0.38	0.69	224.38	81.86		
Irrigated Garapiá	0.19*	0.51*	198.52*	50.08*	132.57	215.6
Lower limit	0.00	0.33	172.66	18.29		
Upper limit	0.42	0.68	216.20	90.77		
Non-irrigated Garapiá	0.18 ns	0.46*	190.60*	51.40*	122.90	215.6
Lower limit	-0.06	0.24	164.99	12.04		
Upper limit	62.57	62.83	497.48	11081.96		
Irrigated FC104	0.08 ns	0.43 ns	141.29 ns	132.63 ns	35.78	170.84
Lower limit	-62.41	-61.97	-214.89	-10816.70		
Upper limit	25.21	28.34	175.45	1242.87		
Non-irrigated FC104	-1.34 ns	1.82 ns	141.29*	135.26 ns	35.78	170.84
Lower limit	-27.89	-24.69	107.14	-972.35		
Node number						
Upper limit	1.64	19.18	198.15	71.33		
Irrigated Triunfo	-2.40 ns	15.46*	187.27*	52.65*	117.93	215.6
Lower limit	-6.44	11.75	176.38	33.96		
Upper limit	0.33	17.25	191.45	66.21		
Non-irrigated Triunfo	-2.45 ns	14.70*	184.50*	53.24*	114.39	215.6
Lower limit	-5.23	12.14	177.55	40.27		
Upper limit	2.05	17.50	184.23	622.76		
Irrigated Garapiá	-1.67 ns	14.23*	176.07*	46.82*	114.41	215.6
Lower limit	-5.40	10.75	167.91	30.87		
Upper limit	1.16	19.37	189.73	79.77		
Non-irrigated Garapiá	-3.57 ns	14.95*	180.97*	59.17*	103.05	215.6
Lower limit	-8.30	10.52	79.77	38.56		
Upper limit	13.42	8.75	224.98	75.09		
Irrigated FC104	9.30*	2.41 ns	145.09*	15.96 ns	124.07	166.12
Lower limit	5.18	-3.94	65.20	-43.16		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Root length						
Upper limit	9.65E+05	2.69E+06	1.86E+06	1.63E+06		
Irrigated Triunfo	-5.84E+05 ns	1.18E+06 ns	1712700*	813880 *	64.09	215.6
Lower limit	-2.13E+06	-3.36E+05	1.57E+06	1.75E+03		
Upper limit	5.18E+05	1.50E+06	2.04E+06	1.06E+06		
Non-irrigated Triunfo	-1.61E+05 ns	872460*	1808100*	555640*	107.63	215.6

Lower limit	-8.39E+05	2.44E+05	1.57E+06	5.07E+04		
Upper limit	1.03E+09	1.07E+09	2.22E+06	1.17E+08		
Irrigated Garapiá	-1.84E+07 ns	1.91E+07 ns	1803400*	4.01E+06 ns	37.63	215.6
Lower limit	-1.07E+09	-1.03E+09	1.39E+06	-1.09E+08		
Upper limit	2.10E+10	2.11E+10	2.42E+06	1.20E+09		
Non-irrigated Garapiá	-7.55E+07 ns	7.61E+07 ns	1847800*	8.53E+06 ns	37.63	215.6
Lower limit	-2.11E+10	-2.10E+10	1.28E+06	-1.18E+09		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	2.44E+11	2.44E+11	1.92E+06	7.12E+09		
Non-irrigated FC104	-2.17E+08 ns	2.17E+08 ns	1475300*	1.26E+07 ns	35.78	170.84
Lower limit	-2.44E+11	-2.44E+11	1.03E+06	-7.09E+09		
Aerial part dry matter						
Upper limit	5.43	44.27	258.42	54.07		
Irrigated Triunfo	-0.10 ns	34.34*	218.79*	31.11*	177.82	37.63
Lower limit	-5.62	24.40	179.16	8.15		
Upper limit	2.77	22.05	215.02	38.56		
Non-irrigated Triunfo	0.40 ns	19.17*	202.33*	28.37*	164.97	215.6
Lower limit	-1.97	16.28	189.65	17.18		
Upper limit	4.32	29.57	190.52	19.59		
Irrigated Garapiá	2.16*	25.51*	185.59*	16.35*	164.05	207.12
Lower limit	0.01	21.46	180.65	13.11		
Upper limit	3.75	19.48	215.42	62.53		
Non-irrigated Garapiá	-0.64 ns	15.37*	194.63*	38.90*	143.41	215.6
Lower limit	-5.03	11.26	173.84	15.27		
Upper limit	5.17	23.10	155.34	25.33		
Irrigated FC104	1.95 ns	18.49*	147.49*	18.24*	123.47	170.84
Lower limit	-1.33	13.88	139.65	11.15		
Upper limit	6.88	25.10	204.59	89.99		
Non-irrigated FC104	-2.11 ns	15.95*	167.18*	46.46*	106.00	170.84
Lower limit	-11.09	6.80	129.77	2.92		
Root dry matter						
Upper limit	2.75	18.40	181.66	35.51		
Irrigated Triunfo	-0.29 ns	14.51*	172.57*	24.32*	140.55	204.59
Lower limit	-3.32	10.62	163.48	13.12		
Upper limit	4.63	25.31	194.76	19.57		
Non-irrigated Triunfo	1.22 ns	17.20*	181.67*	12.54*	165.17	198.18

Lower limit	-2.19	9.09	168.59	5.50		
Upper limit	3.41	20.48	196.38	37.86		
Irrigated Garapiá	-0.23 ns	15.33*	183.40*	24.18*	151.56	215.24
Lower limit	-3.86	10.17	170.42	10.49		
Upper limit	3.03	23.88	193.19	21.03		
Non-irrigated Garapiá	0.53 ns	19.14*	185.53*	16.09*	164.33	206.72
Lower limit	-1.97	14.41	177.87	11.16		
Upper limit	6.10	27.63	150.03	30.37		
Irrigated FC104	-0.04 ns	18.75*	136.99*	18.46*	112.67	161.30
Lower limit	-6.18	9.86	123.94	6.55		
Upper limit	2.59	15.94	146.84	15.70		
Non-irrigated FC104	0.79 ns	11.99*	137.49*	11.05*	122.93	152.04
Lower limit	-1.00	8.04	128.14	6.40		
Nodes dry matter						
Upper limit	0.06	0.59	190.25	33.13		
Irrigated Triunfo	-0.02 ns	0.46*	180.68*	23.02*	150.37	211
Lower limit	-0.11	0.34	171.11	12.91		
Upper limit	0.04	208.28	369.64	298.31		
Non-irrigated Triunfo	0.00 ns	1.24	199.44*	4.71 ns	193.24	205.64
Lower limit	-0.04	-205.79	29.23	-288.89		
Upper limit	0.09	0.85	195.05	23.43		
Irrigated Garapiá	-0.01 ns	0.66*	185.94*	17.11*	163.40	208.47
Lower limit	-0.11	0.47	176.83	10.79		
Upper limit	0.08	0.77	210.40	29.69		
Non-irrigated Garapiá	0.00 ns	0.52*	202.48*	14.36*	183.57	215.6
Lower limit	-0.08	0.27	194.55	-0.97		
Upper limit	0.09	1.31	141.84	16.90		
Irrigated FC104	0.00 ns	0.75*	132.44*	9.90*	119.41	145.48
Lower limit	-0.10	0.20	123.04	2.89		
Upper limit	0.07	28350.90	4693.69	10232.16		
Non-irrigated FC104	0.00 ns	2.32 ns	155.44 ns	3.37 ns	150.99	159.88
Lower limit	-0.07	-28346.27	-4382.81	-10225.41		

* Significant at 0.05 error probability by the t-test. ns = not significant. - indicates no adjustment or adjustment with *r* less than 0.7.

Table 3. Parameters estimates a, b, c, and d, lower limit and upper limit of the confidence interval (CI 95%), inflection point (IP), and asymptote (AS) of the Logistic model for variables as a function of accumulated thermal sum (in °C) of bean cultivars (Triunfo, Garapiá and FC104) in two water regimes (irrigated and non-irrigated) in experiment II (EII).

	a	b	c	d	IP	AS
Height						
Upper limit	32.94	197.15	868.53	215.52		
Irrigated Triunfo	-6.01 ns	160.72*	826.08*	154.51*	622.60	973.95
Lower limit	-44.97	124.29	783.63	93.49		
Upper limit	64.19	183.41	955.75	410.37		
Non-irrigated Triunfo	-14.25 ns	110.41*	841.59*	217.21*	555.54	973.95
Lower limit	-92.69	37.41	727.44	24.04		
Upper limit	418.33	810.20	920.61	1011.62		
Irrigated Garapiá	-145.20 ns	255.90 ns	807.44*	385.92 ns	299.20	973.95
Lower limit	-708.72	-298.39	694.27	-239.78		
Upper limit	1148.95	1760.32	954.31	1173.29		
Non-irrigated Garapiá	-256.13 ns	364.12 ns	819.05*	505.22 ns	227.40	973.95
Lower limit	-1661.21	-1032.08	683.79	-762.85		
Upper limit	61.46	184.74	607.50	179.03		
Irrigated FC104	0.85 ns	120.83*	542.90*	101.57*	409.13	657.78
Lower limit	-59.77	56.93	478.31	24.12		
Upper limit	26.33	162.62	613.73	107.08		
Non-irrigated FC104	9.49 ns	139.21*	597.46*	71.03*	503.91	657.78
Lower limit	-7.36	115.80	581.18	34.98		
Mean stem diameter						
Upper limit	0.43	1.23	908.23	415.24		
Irrigated Triunfo	0.01 ns	0.83*	843.79*	273.17*	484.03	973.95
Lower limit	-0.40	0.43	779.34	131.11		
Upper limit	0.59	1.41	1016.68	551.79		
Non-irrigated Triunfo	0.00 ns	0.82*	893.87*	311.30*	483.90	973.95
Lower limit	-0.60	0.24	771.06	70.81		
Upper limit	970861.93	971804.04	897.70	9.93E+06		
Irrigated Garapiá	-470.70 ns	471.45 ns	775.84*	9621.09 ns	227.40	973.95
Lower limit	-971803.34	-970861.13	653.97	-9.91E+06		
Upper limit	3431.67	3882.15	1.74E+06	2.51E+06		
Non-irrigated Garapiá	-4.68 ns	6.67 ns	5263.29 ns	4820.37 ns	227.40	973.94
Lower limit	-3441.03	-3868.81	-1.73E+06	-2.50E+06		
Upper limit	0.77	1.16	638.88	429.08		
Irrigated FC104	0.11 ns	0.53 ns	556.93*	188.22 ns	309.05	657.78
Lower limit	-0.56	-0.09	474.99	-52.64		
Upper limit	0.41	0.45	713.95	275.43		
Non-irrigated FC104	0.25*	0.31*	612.05*	146.54*	419.07	657.78

Lower limit	0.10	0.16	510.16	17.64		
Nodes number						
Upper limit	8.90	45.23	937.90	630.24		
Irrigated Triunfo	-10.88 ns	25.73*	866.12*	384.74*	467.39	973.95
Lower limit	-30.66	6.24	794.33	139.25		
Upper limit	472.04	602.11	1099.76	4587.91		
Non-irrigated Triunfo	-58.74 ns	71.55 ns	898.04*	865.39 ns	227.40	973.95
Lower limit	-589.51	-459.01	696.31	-2857.13		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	1.62E+06	1.62E+06	1185417.02	1.66E+06		
Non-irrigated Garapiá	-3105.54 ns	3119.12 ns	898.97*	6134.43 ns	227.40	973.95
Lower limit	-1.62E+06	-1.62E+06	612519.15	-1.59E+06		
Upper limit	27.78	51.55	681.53	543.12		
Irrigated FC104	-5.17 ns	20.05 ns	570.16*	206.27 ns	298.51	657.78
Lower limit	-38.12	-11.45	458.78	-130.59		
Upper limit	2.85	20.80	645.10	214.77		
Non-irrigated FC104	-0.73 ns	17.44*	609.30*	163.42*	394.08	657.78
Lower limit	-4.31	14.07	573.51	112.13		
Root length						
Upper limit	-	-	-	-		
Irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	7.10E+05	9.45E+09	1.51E+09	3.49E+09		
Non-irrigated Garapiá	542920*	3.41E+05 ns	4.36E+06 ns	1.49E+05 ns	416.71	455.83
Lower limit	3.76E+05	-9.45E+09	-1.51E+09	-3.49E+09		
Upper limit	9.73E+06	9.30E+06	1.56E+07	2.31E+08		
Irrigated FC104	4.26E+05 ns	6.42E+04 ns	3.56E+06 ns	2.58E+06 ns	149.60	657.78
Lower limit	-8.88E+06	-9.18E+06	-8.45E+06	-2.25E+08		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		

Aerial part dry matter						
Upper limit	9.76	39.99	941.45	338.90		
Irrigated Triunfo	-4.31 ns	27.03*	847.20*	195.66*	589.52	973.95
Lower limit	-18.37	10.06	752.95	52.42		
Upper limit	6.48	36.55	1291.29	386.51		
Non-irrigated Triunfo	-0.98 ns	25.21*	1026.56*	213.25*	745.72	227.40
Lower limit	-8.44	13.88	761.82	39.99		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	590.89	749.29	1017.69	3331.91		
Non-irrigated Garapiá	-70.51 ns	89.94 ns	825.43*	608.99 ns	227.40	973.95
Lower limit	-731.92	-569.40	633.17	-2113.93		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	30.17	219227.58	173028.67	3223.96		
Non-irrigated FC104	-0.58 ns	345.79 ns	1788.60 ns	244.99 ns	657.78	149.60
Lower limit	-31.34	-218536.01	-169451.48	-2733.97		
Root dry matter						
Upper limit	2.05	15.57	777.63	199.65		
Irrigated Triunfo	-1.22 ns	12.36*	746.07*	150.31*	548.12	944.01
Lower limit	-4.49	9.16	714.50	100.96		
Upper limit	3.15	14.14	859.51	247.92		
Non-irrigated Triunfo	-0.57 ns	10.65*	806.97*	166.61*	587.54	973.95
Lower limit	-4.29	7.17	754.42	85.31		
Upper limit	10.59	11.70	1506.01	611.97		
Irrigated Garapiá	6.59*	2.60 ns	718.51 ns	57.74 ns	642.47	794.55
Lower limit	2.59	-6.49	-68.99	-496.48		
Upper limit	2.48E+06	2.49E+06	1237.39	2.41E+06		
Non-irrigated Garapiá	-3026.22 ns	3035.72 ns	868.41*	5864.92 ns	227.40	973.95
Lower limit	-2.49E+06	-2.48E+06	499.42	-2.40E+06		
Upper limit	33.53	51.96	616.76	772.92		
Irrigated FC104	-6.04 ns	13.40 ns	533.15*	234.61 ns	224.18	657.78
Lower limit	-45.61	-25.15	449.53	-303.70		
Upper limit	6.52	698090.70	275216.09	1452.41		
Non-irrigated FC104	1.64 ns	421.17 ns	1579.04 ns	159.83 ns	657.78	149.60
Lower limit	-3.24	-697248.36	-272058.02	-1132.75		

Nodes dry matter						
Upper limit	0.19	27.38	2735.15	696.78		
Irrigated Triunfo	0.01 ns	1.11 ns	711.02 ns	31.07 ns	699.95	744.32
Lower limit	-0.18	-25.15	-1313.11	-634.64		
Upper limit	-	-	-	-		
Non-irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	0.26	3.01	662.19	119.01		
Irrigated Garapiá	0.04 ns	1.43 ns	610.73*	60.51*	531.04	690.42
Lower limit	-0.17	-0.15	559.27	2.02		
Upper limit	-	-	-	-		
Non-irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	0.02	9.42	3285.44	2171.32		
Irrigated FC104	0.00 ns	0.10 ns	617.60 ns	31.65 ns	575.92	657.78
Lower limit	-0.02	-0.92	-2050.23	-2108.02		
Upper limit	0.04	5.36	2473.77	1514.32		
Non-irrigated FC104	0.00 ns	0.12 ns	620.31 ns	36.66 ns	572.03	657.77
Lower limit	-0.04	-5.12	-1233.15	-1441.00		

* Significant at 0.05 error probability by the t-test. ns = not significant. - indicates no adjustment or adjustment with r less than 0.7.

Table 4 Parameters estimates a, b, c, and d, lower limit and upper limit of the confidence interval (CI 95%), inflection point (IP), and asymptote (AS) of the Chanter model for variables as a function of accumulated thermal sum (in °C) of bean cultivars (Triunfo, Garapiá and FC104) in two water regimes (irrigated and non-irrigated) in experiment I (EI).

	a	b	c	d	IP	AS
Height						
Upper limit	20.98	124.84	0.00	0.00		
Irrigated Triunfo	8.46 ns	114.41*	0.00 ns	-0.04 ns	137.99	203.46
Lower limit	-4.06	103.99	0.00	-0.08		
Upper limit	20.53	96.91	0.01	0.01		
Non-irrigated Triunfo	7.82 ns	87.44*	0.00 ns	-0.03 ns	143.35	215.6
Lower limit	-4.89	77.97	-0.01	-0.07		
Upper limit	41.73	84.90	0.04	0.40		
Irrigated Garapiá	6.62 ns	70.78*	0.00 ns	-0.04 ns	118.62	182.11
Lower limit	-28.49	56.65	-0.03	-0.49		
Upper limit	35.79	60.33	0.04	0.26		
Non-irrigated Garapiá	6.12 ns	48.68*	0.00 ns	-0.04 ns	111.81	182.11

Lower limit	-23.55	37.04	-0.04	-0.33		
Upper limit	45.31	112.64	0.05	0.12		
Irrigated FC104	7.62 ns	94.45*	0.00 ns	-0.04 ns	96.57	166.84
Lower limit	-30.08	76.26	-0.05	-0.19		
Upper limit	33.34	107.21	0.05	0.08		
Non-irrigated FC104	7.56 ns	95.67*	0.00 ns	-0.03 ns	102.78	170.84
Lower limit	-18.23	84.13	-0.04	-0.14		
Main stem diameter						
Upper limit	0.27	0.73	0.01	0.00		
Irrigated Triunfo	0.19*	0.68*	0.00 ns	-0.02*	124.93	215.6
Lower limit	0.10	0.64	0.00	-0.04		
Upper limit	0.23	0.69	0.02	0.04		
Non-irrigated Triunfo	0.16*	0.64*	0.01 ns	-0.01 ns	115.41	215.6
Lower limit	0.08	0.58	0.00	-0.02		
Upper limit	0.33	0.73	0.01	0.00		
Irrigated Garapiá	0.25*	0.68*	0.00 ns	_0.02*	126.44	215.6
Lower limit	0.16	0.63	0.00	-0.04		
Upper limit	0.34	0.64	0.00	0.75		
Non-irrigated Garapiá	0.28*	0.61*	0.00 ns	-0.12 ns	110.70	139.39
Lower limit	0.23	0.58	0.00	-0.99		
Upper limit	19.03	0.57	2.07	33.64		
Irrigated FC104	0.21 ns	0.52*	0.00 ns	-0.06 ns	73.98	126.51
Lower limit	-18.60	0.48	-2.06	-33.76		
Upper limit	2.48	0.52	0.38	2.39		
Non-irrigated FC104	0.20 ns	0.47*	0.00 ns	-0.05 ns	70.82	138.67
Lower limit	-2.07	0.42	-0.37	-2.48		
Nodes number						
Upper limit	1.68	13.09	0.03	0.00		
Irrigated Triunfo	0.75 ns	12.40*	0.01 ns	-0.01 ns	114.60	215.6
Lower limit	-0.18	11.70	-0.01	-0.03		
Upper limit	1.33	12.01	0.03	0.00		
Non-irrigated Triunfo	0.71*	11.57*	0.01 ns	-0.01*	111.42	215.6
Lower limit	0.09	11.14	0.00	-0.02		
Upper limit	2.67	12.38	0.05	0.02		
Irrigated Garapiá	0.84 ns	11.38*	0.01 ns	-0.02 ns	108.81	215.6
Lower limit	-0.99	10.38	-0.02	-0.05		
Upper limit	1.52	11.41	0.05	0.01		
Non-irrigated Garapiá	0.57 ns	10.77*	0.02 ns	-0.01 ns	102.90	215.6

Lower limit	-0.37	10.13	-0.01	-0.03		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Root length						
Upper limit	12.10	59.02	0.05	0.01		
Irrigated Triunfo	3.62 ^{ns}	55.05*	0.01 ^{ns}	-0.02 ^{ns}	90.60	215.57
Lower limit	-4.85	51.09	-0.02	-0.05		
Upper limit	11.32	84.34	0.22	0.05		
Non-irrigated Triunfo	1.38 ^{ns}	67.60*	0.04 ^{ns}	0.00 ^{ns}	90.73	215.6
Lower limit	-8.55	50.86	-0.13	-0.05		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	4.29	74.59	0.41	0.06		
Non-irrigated Garapiá	0.36 ^{ns}	60.99 *	0.08 ^{ns}	0.01 ^{ns}	71.62	215.6
Lower limit	-3.57	47.39	-0.25	-0.05		
Upper limit	2.21	793.41	8.23	0.76		
Irrigated FC104	0.02 ^{ns}	63.17 ^{ns}	0.30 ^{ns}	0.03 ^{ns}	43.76	170.84
Lower limit	-2.17	-667.06	-7.64	-0.69		
Upper limit	8.64	1474.97	11.97	1.33		
Non-irrigated FC104	0.05 ^{ns}	63.10 ^{ns}	0.25 ^{ns}	0.03 ^{ns}	43.89	170.84
Lower limit	-8.53	-1348.76	-11.48	-1.27		
Aerial part dry matter						
Upper limit	13.54	27.83	0.86	1.36		
Irrigated Triunfo	0.09 ^{ns}	19.36*	0.01 ^{ns}	-0.04 ^{ns}	93.62	148.41
Lower limit	-13.35	10.89	-0.85	-1.44		
Upper limit	7.29	16.85	0.44	0.70		
Non-irrigated Triunfo	0.11 ^{ns}	12.59*	0.01 ^{ns}	-0.04 ^{ns}	94.69	155.41
Lower limit	-7.08	8.32	-0.43	-0.77		
Upper limit	4.33	22.98	0.22	0.15		
Irrigated Garapiá	0.14 ^{ns}	17.60*	0.01 ^{ns}	-0.02 ^{ns}	133.52	215.6
Lower limit	-4.06	12.22	-0.20	-0.19		
Upper limit	5.10	14.67	0.07	0.47		
Non-irrigated Garapiá	0.37 ^{ns}	12.57*	0.00 ^{ns}	-0.04 ^{ns}	110.55	166.09

Lower limit	-4.35	10.48	-0.06	-0.56		
Upper limit	9.17	20.92	0.33	0.30		
Irrigated FC104	2.04 ns	17.34*	0.00 ns	-0.04 ns	115.26	170.84
Lower limit	-5.10	13.56	-0.03	-0.38		
Upper limit	2.42	20.07	0.11	0.03		
Non-irrigated FC104	0.56 ns	14.53*	0.03 ns	0.00 ns	100.73	170.84
Lower limit	-1.31	8.99	-0.05	-0.04		
Root dry matter						
Upper limit	5.37	12.85	0.53	1.15		
Irrigated Triunfo	0.09 ns	10.44*	0.00 ns	-0.03 ns	115.82	185.68
Lower limit	-5.19	8.02	-0.52	-1.21		
Upper limit	-	-	-	-		
Non-irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	3.67	15.89	0.14	0.13		
Irrigated Garapiá	0.18 ns	12.41*	0.01 ns	-0.02 ns	140.31	215.6
Lower limit	-3.31	8.93	-0.12	-0.17		
Upper limit	5.86	18.61	0.04	0.26		
Non-irrigated Garapiá	0.54 ns	14.49 ns	0.00*	-0.03 ns	154.63	215.3
Lower limit	-4.78	10.37	-0.03	-0.32		
Upper limit	4.35E+06	181559.72	2.57E+06	4.76E+06		
Irrigated FC104	0.03 ns	12.27*	0.01 ns	-0.05 ns	73.31	115.71
Lower limit	-4.35E+06	63871.39	-2.57E+06	-4.76E+06		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Node dry matter						
Upper limit	0.09	0.42	0.45	7.71		
Irrigated Triunfo	0.00 ns	0.34*	0.00 ns	-0.05 ns	144.96	185.67
Lower limit	-0.09	0.25	-0.45	-7.80		
Upper limit	0.02	0.34	428.73	1029.77		
Non-irrigated Triunfo	0.00 ns	0.24*	0.00 ns	-0.03 ns	168.84	208.80
Lower limit	-0.02	0.14	-428.73	-1029.84		
Upper limit	0.15	0.64	1.28	4.46		
Irrigated Garapiá	0.00 ns	0.49*	0.00 ns	-0.03 ns	151.07	212.88
Lower limit	-0.15	0.34	-1.27	-4.53		
Upper limit	0.02	0.56	0.97	0.41		
Non-irrigated Garapiá	0.00 ns	0.42*	0.01 ns	-0.01 ns	169.71	37.63

Lower limit	-0.02	0.29	-0.95	-0.43		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		

* Significant at 0.05 error probability by the t-test. ns = not significant. - indicates no adjustment or adjustment with r less than 0.7.

Table 5. Parameters estimates a, b, c, and d, lower limit and upper limit of the confidence interval (CI 95%), inflection point (IP), and asymptote (AS) of the Chanter model for variables as a function of accumulated thermal sum (in °C) of bean cultivars (Triunfo, Garapiá and FC104) in two water regimes (irrigated and non-irrigated) in experiment II (EII).

	a	b	c	d	IP	AS
Height						
Upper limit	-	-	-	-		
Irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	45.81	102.64	0.01	0.03		
Non-irrigated Triunfo	8.56 ns	90.13*	0.00 ns	-0.01 ns	519.07	930.51
Lower limit	-28.69	77.63	-0.01	-0.04		
Upper limit	26.10	113.14	0.00	0.00		
Irrigated Garapiá	8.53 ns	103.83*	0.00 ns	-0.02 ns	449.50	609.49
Lower limit	-9.03	94.52	0.00	-0.03		
Upper limit	22.46	110.06	0.00	0.00		
Non-irrigated Garapiá	8.56	102.67*	0.00 ns	-0.02*	448.69	609.49
Lower limit	-5.34	95.28	0.00	-0.03		
Upper limit	78.86	207.08	0.00	448.22		
Irrigated FC104	11.75 ns	140.00*	0.00 ns	-0.05 ns	489.78	551.98
Lower limit	-55.35	72.92	0.00	-448.31		
Upper limit	-	133.76	-	-		
Non-irrigated FC104	10.50 ns	123.08*	0.00 ns	-0.06 ns	367.42	419.85
Lower limit	-	112.41	-	-		
Main stem diameter						
Upper limit	0.41	0.84	0.00	0.00		
Irrigated Triunfo	0.31*	0.81*	0.00 ns	-0.01 ns	508.73	804.36
Lower limit	0.22	0.78	0.00	-0.03		
Upper limit	0.44	0.84	0.00	0.04		

Non-irrigated Triunfo	0.29*	0.79*	0.00 ns	-0.01 ns	529.92	973.95
Lower limit	0.14	0.73	0.00	-0.02		
Upper limit	486.95	0.75	0.01	51060.51		
Irrigated Garapiá	0.33 ns	0.71*	0.00 ns	-0.05 ns	411.63	490.04
Lower limit	-486.29	0.67	-0.01	-51060.60		
Upper limit	15.29	0.78	0.00	824.55		
Non-irrigated Garapiá	0.33 ns	0.73*	0.00 ns	-0.04 ns	413.32	497.51
Lower limit	-14.62	0.68	0.00	-824.63		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Node number						
Upper limit	2.75	15.04	0.01	0.00		
Irrigated Triunfo	1.40*	14.44*	0.00 ns	0.00 ns	467.39	973.95
Lower limit	0.05	13.83	0.00	-0.01		
Upper limit	3.87	195.82	0.23	0.05		
Non-irrigated Triunfo	0.18 ns	16.54 ns	0.02 ns	0.00 ns	305.01	973.95
Lower limit	-3.51	-162.73	-0.19	-0.05		
Upper limit	5.62	13.85	0.01	0.00		
Irrigated Garapiá	2.68 ns	13.22*	0.00 ns	-0.01 ns	431.30	903.98
Lower limit	-0.27	12.59	0.00	-0.02		
Upper limit	7.33	14.00	0.01	0.01		
Non-irrigated Garapiá	2.20 ns	13.00*	0.00 ns	-0.01 ns	428.44	892.50
Lower limit	-1.90	12.00	0.00	-0.02		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	7.96	20.98	0.00	1.00		
Non-irrigated FC104	3.03 ns	16.06*	0.00 ns	-0.03 ns	488.20	577.38
Lower limit	-1.89	11.14	0.00	-1.07		
Root length						
Upper limit	2.29E+09	72.49	1349.42	8.13E+08		
Irrigated Triunfo	8.17 ns	64.99*	0.00 ns	-0.04 ns	390.32	460.18
Lower limit	-2.29E+09	57.50	-1349.42	-8.13E+08		
Upper limit	8.41E+08	69.15	524.94	3.02E+08		

Non-irrigated Triunfo	8.15 ns	62.47*	0.00 ns	-0.04 ns	391.09	460.18
Lower limit	-8.41E+08	55.79	-524.94	-3.02E+08		
Upper limit	2.78E+10	75.86	139.56	7.12E+10		
Irrigated Garapiá	39.06 ns	66.47*	0.00 ns	-0.06 ns	375.01	437.78
Lower limit	-2.80E+10	57.09	-139.56	-7.12E+10		
Upper limit	-	-	-	-		
Non-irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Aerial part dry matter						
Upper limit	7.33	23.96	0.01	0.03		
Irrigated Triunfo	1.04 ns	21.08*	0.00 ns	-0.01 ns	549.63	938.18
Lower limit	-5.24	18.20	-0.01	-0.05		
Upper limit	3.24	43.26	0.02	0.01		
Non-irrigated Triunfo	0.65 ns	26.74*	0.00 ns	0.00 ns	723.10	227.40
Lower limit	-1.93	10.23	-0.01	-0.01		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	5.48	20.90	0.00	0.01		
Non-irrigated Garapiá	0.74 ns	18.34*	0.00 ns	-0.01 ns	442.13	661.75
Lower limit	-4.01	15.78	0.00	-0.04		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Root dry matter						
Upper limit	3.72	10.40	0.00	0.03		
Irrigated Triunfo	0.91 ns	8.95*	0.00 ns	-0.02 ns	477.89	646.82
Lower limit	-1.90	7.51	0.00	-0.07		
Upper limit	3.45	9.98	0.00	0.03		
Non-irrigated Triunfo	0.83 ns	8.67*	0.00 ns	-0.01 ns	476.46	654.32

Lower limit	-1.78	7.36	0.00	-0.06		
Upper limit	142685.11	9.48	1.01	4731130.00		
Irrigated Garapiá	0.35 ns	8.15*	0.00 ns	-0.05 ns	418.41	502.63
Lower limit	-142684.41	6.83	-1.01	-4731100.00		
Upper limit	2.26	10.45	0.02	0.02		
Non-irrigated Garapiá	0.16 ns	9.02*	0.00 ns	-0.01 ns	435.61	743.87
Lower limit	-1.95	7.59	-0.02	-0.04		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Nodes dry matter						
Upper limit	0.52	0.67	49608.63	3.26E+12		
Irrigated Triunfo	0.00 ns	0.37*	3.40E-11	-0.04 ns	542.82	572.16
Lower limit	-0.52	0.07	-49608.63	-3.26E+12		
Upper limit	-	-	-	-		
Non-irrigated Triunfo	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated Garapiá	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		
Upper limit	-	-	-	-		
Non-irrigated FC104	-	-	-	-	-	-
Lower limit	-	-	-	-		

* Significant at 0.05 error probability by the t-test. ns = not significant. - indicates no adjustment or adjustment with r less than 0.7.

Among the cultivars, FC104 showed the worst adjustment. This result is explained by the fact that the cultivar has a very early cycle, resulting in a lower number of collections over time and greater variability of the data. Poor adjustments reflect the greater heterogeneity of plants in the field, as also observed for creole maize genotypes by Deprá et al. (2016). IP corresponds to the point where the maximum growth rate

occurs. Due to the difference in the growth of the genotypes, this value differs between the cultivars. In EI, the average DD for plants to reach PI in FC104 was lower than in other cultivars (98.27 ºC day^{-1} in logistics and 80.12 ºC day^{-1} in chanter), and the highest values were found in the logistic model for Triunfo (140.49 ºC day^{-1}) and the chanter model in Garapiá (123.90 ºC day^{-1}). In the EII, the water deficit was imposed in FC104 during vegetative growth, which resulted in growth delay and greater DD to reach the IP. In this experiment, the cultivar Garapiá showed the lowest IP (325.38 ºC day^{-1} in logistic and 425.40 ºC day^{-1} in the chanter) and Triunfo the peak IP average (546.52 ºC day-1 in logistic and 490.12ºC day^{-1} in the chanter). Among the variables, the RL required less DD to reach the IP, mainly because this variable is established earlier in the culture. It is important to highlight that the experiment was conducted in pots and to consider greenhouses conditions and pot sizes used before extrapolating the results to field conditions are fundamental (Casadebaig et al., 2008) because the root development in the pots experiments and field conditions can be different. APDM and RDM showed a higher IP, indicating that these variables needed greater DD to achieve maximum growth. Consequently, initially, the RL establishment occurs, and then the maximum H, NN, and MSD are reached to allow the plant to reach the highpoint of APDM and RDM.

The NDM variable also showed high IP values concerning the other variables, indicating that nodulation does not become present at the beginning of the crop growth, weakening the plant nitrogen supply in the initial stages. Common beans have a low capacity for biological nitrogen fixation compared to other legumes (Olivera et al., 2004). Pelegrin et al. (2009) noted that the use of nitrogen fertilization combined with nitrogen-fixing bacteria inoculation at the beginning of the crop cycle is fundamental for this nutrient supply and to reach the maximum genotypes productivity.

The cultivars Triunfo and Garapiá have a cycle of 87 and 86 days, respectively, from emergence to maturation (Fundação Estadual de Pesquisa Agropecuária, 2021 a, b), while FC104, 65 days until physiological maturation (Melo et al., 2017). DD required to reach IP in cultivars shows that the FC104 cycle is shorter than that of other cultivars in EI. Nevertheless, in the fallow season (EII), this cultivar was sown 20 days after the other cultivars, as there was a shortening of the days after December's summer solstice, this may have resulted in intermediate IP to the other cultivars since it took more time to accumulate required DD. The cultivars Triunfo and Garapiá, presented DD to reach the IP and similar cycles in the two experiments. The cultivars Triunfo and Garapiá, presented DD to reach the IP and similar cycles in the two experiments.

Regarding WC, when observing the IP of the irrigated and non-irrigated models, they showed, on average, lower values of 122.83 ºC day^{-1} in the EI and 429.66 ºC day-1 in the EII in the logistic model and of 110.27 ºC day^{-1} in the EI and 454.89 ºC day^{-1} in the EII in the chanter model for the non-irrigated condition and 122.83, 442.38, 111.34 and 467.04 ºC day^{-1}, respectively for the irrigated condition. Plants under water restriction limit their development, firstly inhibiting leaf and root system expansion (Taiz et al., 2017). The short time water deficit exposure can influence a greater roots-related expansion characteristic due to the plant water seeking to maintain its cellular turgor.

Comparing sowing times, the EI had a higher r in most variables compared to the EII (Table 1). The variables presented d and r less than 0.9 and MAE and RMSE above 5.0, mainly in the EII, off-season, in the chanter model, indicating that the logistic was the most accurate model. The EII showed a higher IP

than the EI. This is because the sowing occurred after the summer solstice, with the shortening days and less daily solar radiation supply. After the IP, the plant generally reached the asymptote, which represents the maximum IP of the adjustment curve, and decreased the increment of the variable with the continuity of the plant's development, as observed by Deprá et al. (2016). Plant growth is influenced by photosynthesis and water and nutrient absorption (Taiz et al., 2017), which has a biological limit.

The referenced studies did not seek to adjust growth curves to many variables per experiment, demonstrating the distinction of this research. In common beans, it was adjusted for total phytomass, leaf area, leaf area index, leaf area ratio, and liquid assimilation rate (Nobrega et al., 2001). In garlic, leaf, pseudostem, bulb, and root dry matter data were adjusted (Reis et al., 2014). In corn, the height and number of leaves were evaluated (Deprá et al., 2016). For tomatoes, the weight and number of fruits per plant were studied (Sari et al., 2019). In lettuce, leaves, and shoots fresh and dry matter were adjusted (Carini et al., 2020). From the aforementioned research, it can be observed that the adjustment of growth curves for variables related to the plant stem, such as stem diameter and a number of nodes, and root variables, have not been studied. In general, the response variables that demonstrated the best fit (Tables 2, 3, 4, and 5) and the lowest error (Table 1) were: MSD, NN, and APDM, and should preferably be used to evaluate bean growth. The estimates parameters (a, b, c, d) of each cultivar vs WC were compared between each experiment (Tables 2, 3, 4 and 5) using the overlapping confidence intervals (CI) criteria, used by Deprá et al. (2016) and Carini et al. (2020). It was considered that when one of the estimates was within the CI of the other, the effect was not significant.

In the logistic model, for H, MSDNN, APMD, and RDM, parameters c, and d were the ones that most differed between experiments. In RL, only the c differed and for the NDM, the parameters a, b, c, d differed between the cultivar variations vs WC. In the chanter model, most variations cultivar x WC did not differ between experiments, and when it occurred, parameter b was the one that most fluctuated. These results indicate that the models showed different behavior between the experiments and within each variable. Similar results have also been stated for tomato genotypes (Sari et al., 2019) and lettuce (Carini et al., 2020).Analyzing the response variables within each experiment, it was possible to observe that the logistic model presented a greater number of parameters, differing between cultivars and between WC in the two experiments. In this model, parameter c was the one that most differed between cultivars in the two experiments. For the chanter model, parameter b was the one that most differed between cultivars. Between WC, in both models, in most variables, the parameters did not differ.

The chanter model marginally differed in the parameters by the t-test ($p < 0.05$) (Tables 4 and 5). Significance frequently occurred for parameter b, whereas in the logistic model, parameters b, c, d was more frequently significant (Tables 2 and 3), indicating that the chanter model shows a modest difference between the combinations. In a study with lettuce, Carini et al. (2020) perceived that the Gompertz model showed less difference between some cultivars than the logistic one and observed the need to determine specific models by character and cultivar. The models showed the same behavior for most variables. For example, for the cultivar Triunfo (irrigated) in the EI, both overestimated the value of the asymptote for H, in the logistic, there was an overestimation of 16.17 cm and in the chanter around 15.23 cm. In an experiment with lettuce, Carini et al. (2020) found that the Gompertz model overestimated the values of the variables, dissimilar to the logistic.

From our results, it is perceived that it is not possible to use an equation for different sowing dates, as the parameters differed between experiments. At large, all models tested presented low MAE and RMSE and high d and r for all the observed variables. Conversely, the logistic model was the one that showed the best performance for most of the variables, combinations of cultivars x WC and experiments. Other authors also concluded that the logistic model was the most appropriate, as in lettuce cultivars, Carini et al. (2020) analyzing Gompertz and logistic models for leaves and roots fresh and dry matter, concluded that the logistic better described growth. Seeking to adjust a model that represented the weight and number of tomato fruits per plant over the harvest time, Sari et al. (2019) tested the Brody, Gompertz, logistic, and von Bertalanffy models and concluded that the logistic was better suited to both variables. In garlic, evaluating the mirtscherlich, Gompertz, logistic, brody, and von Bertalanffy models, Reis et al. (2014) concluded that the logistics better adjusted to the data to describe the behavior of the bulb, root, and total plant dry mass accumulation. Instead, to describe the length and diameter of the cocoa fruit over time, Silva and Savian (2019) observed that the logistic models, Gompertz, and chanter adequately represented these variables, nevertheless, the chanter proved to be more flexible and accurate.

From the adjustment indicators (MAE, RMSE, d, and r) (Table 1) and the limitation of chanter model adjustment in the EII (Table 5), it is possible to conclude that the logistic model is the most appropriate to describe different bean cultivars growth within irrigated and non-irrigated WC. To exemplify logistic model growth, three variables were selected from the Triunfo cultivar in the EI Irrigated water regime (Figure 1). The other growth curves can be constructed with the parameters estimates (Table 2, 3, 4, and 5).

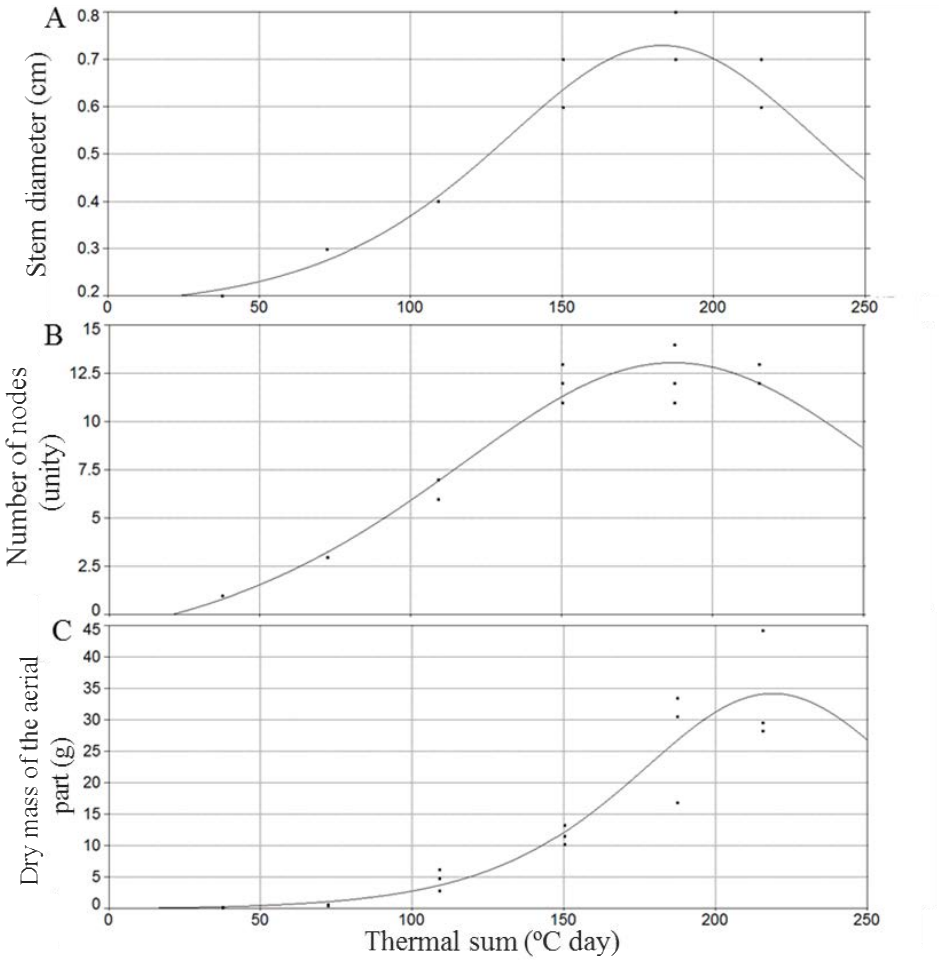

Figure 1. Logistic model for stem diameter (cm) (A), number of nodes (unity) (B), and aerial part dry matter (g) (C) as a function of accumulated thermal sum (in °C day-1) of Triunfo bean Irrigated in experiment I.

4. Conclusions

The results of this study demonstrate that the logistic non-linear growth model can be used to describe the growth of common beans. The parameter estimates (a, b, c, d) can be used to simulate the growth of cultivars Triunfo, Garapiá, and FC104 over irrigated and non-irrigated conditions. Furthermore, due to the lack of studies on the subject of common beans, the general and specific parameters of the irrigated and non-irrigated water conditions can be extrapolated to other cultivars as a reference.

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Violence, trafficking and drug use in public schools in Belém -Pará - Brazil

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Abstract

The research shows how violence, trafficking and drug use has been recurrent within schools, causing directions that are difficult to contour by Brazilian government officials. The research had a qualitative and quantitative character. The method used was interviews with teachers and the use of questionnaires with a group of one hundred and seventy students and sixteen teachers. Among all the problems, misery; the use of drugs; the arrival of adolescence; the insertion of the researched group in risk areas belonging to Perverse Territorialization; the lack of definition of a full and adequate curriculum for our social problems; the lack of adequate punishment; the influence of family habitus has contributed to the spread of violence, stimulating parallel activities with the predominance of drug trafficking and organized crime where it presents a growing approximation with the local community in need of all types of services and improvements not provided by the State, causing the increase in all crime rates, the increase in drug trafficking as well as the increase in cases of psychological disorders. Among these reasons, violence in the school environment has increased. The actions necessary to reduce school violence are pointed out in this article, knowing that for its consolidation, the support of the school community and the creation of internal codes of conduct essential to living in the school environment are necessary.

Key words: School Violence; Psychological Disorders; Habitus; Perverse Territorialization.

1. Introduction

Violence manifests itself in several ways. In traffic when drivers and pedestrians do not respect the laws established by regulatory institutions causing accidents that are often fatal; in the lack of medical assistance, the less favored populations bring suffering and indignation, of those who crowd in the waiting lines for medical care in the vast majority in public hospitals in our country; in the famine that, unfortunately, still affronts thousands of Brazilian homes; lack of basic sanitation; in the use of narcotics, etc.

Our gaze often discriminates against the thief, the drug addict, the drunk, the delinquent student. We forget, however, to reflect the affection-social circumstances that influenced these conducts that we so disapprove of. Nobody is born a thief, drug addict or delinquent. A first view, even if intuitive, on the theme of violence suggests the existence of a feedback principle that, in general, circumscribes the victims. Acts of violence generate acts of violence.

The research was carried out in the city of Belém, State of Pará, Brazil, specifically in the

neighborhood of Pedreira, in two public schools.

Preliminarily to all the movements and episodes described and occurring of violence, there was naturally a historical series of events that follows comment below:

Belém was founded on January 12, 1616, by Francisco Caldeira Castelo Branco and started in the area where today is the current Forte do Presépio going to the commercial center and the Cidade Velha neighborhood, a form that lasted until the beginning of the 19th century, when it was already understood as the Metropolis of the Amazon for its value in the economy of the time, marking the first step of the socio-spatial division of the city. (Costa, 2009).

Around 1910 and 1930 the urban space had a narrow strip of land positioned between the shore and a mangrove that offered a natural barrier to development. From 1940 and 1950 the city reached a considerable expansion, presenting as properties: a) inclusion of lowland areas in the urban structure of the city; b) saturation of central areas with the construction of passages and villages c) foundation of industries, housing estates.

In the 1950s the occupation of the set of institutional areas around the air and naval bases, the Federal University of Pará and the Federal Rural University of the Amazon formed an "institutional belt" that served as an obstacle to urban expansion. Consequently, the contour of the so-called "low areas" brought together an occupation leveraged by the supply of goods, services and jobs that the central region offered. As a consequence, the "lowlands" expanded with a high population density.

The occupation of the "Baixadas" in 1970, imported 40% of the urbanized area of Belém and these development methods with the neighboring municipalities led to the implementation of the federal law, in 1973, of the Metropolitan Region of Belém. In 1980, the occupation of vacuums landowners was encouraged by landowners, covering indemnities and the promise of land tenure regularization for occupants. IBGE data show that the population dynamics from 1991 to 2000 reinforced the growth of peripheral areas. The municipalities of the Metropolitan Region developed significantly in front of the capital, Belém.

The most overburdened areas in population are attached to the Center: Jurunas, Condor, Cremação Pedreira and Umarizal. The analysis of RAIS (Annual List of Social Information) obtained by the Ministry of Labor, for the period between 1998 and 2002, marked that Belém holds about 51% of all employment originated in Pará.

2.Violence, drug use and its different forms

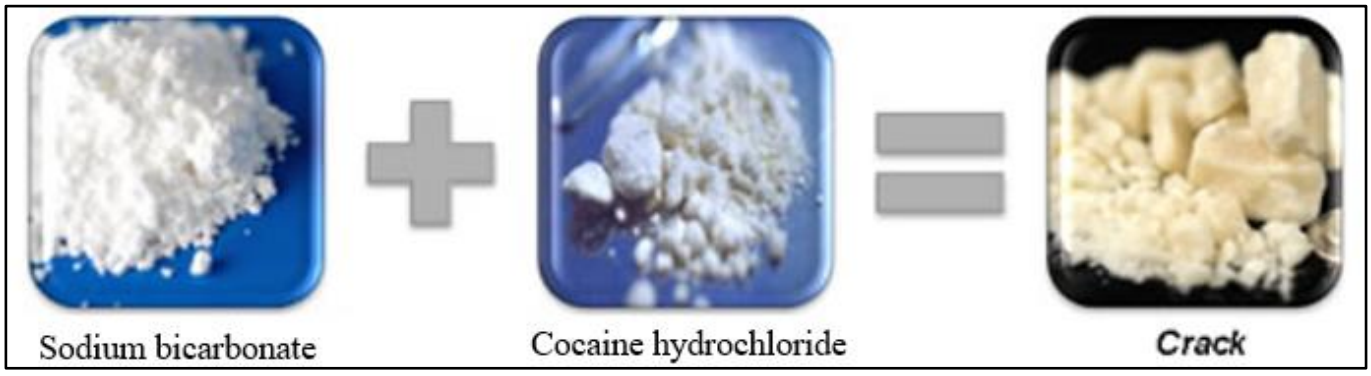
Countless young people who are armed gain respect towards others, presumably because of the representativeness of power expressed by the weapon. Someone entrusted him with the use of that instrument, it was not the government, but the network of criminals in his locality. It often means that he has earned the trust of the head of that group and has become a respected member. Nobody does anything to purge him, because retaliation by part or all of the group of criminals to which he belongs may come to pass.

The networks of criminals are revealed through corruption, drug trafficking, prostitution, smuggling, and arms trafficking. Many young people from violent neighborhoods, due to poor education and the obligation to meet essential survival needs, are attracted by the trafficking that corrupts them, offering drugs, weapons and money. Several young people still enter this perverse network unnecessarily, just to satisfy the "today", without thinking about the consequences arising from this act. The young age favors and interests the trafficking for the certainty of the impunity certified by the Brazilian laws. At uncertain times, it is common to see armed youths walking through the peripheral streets of Belém as in other Brazilian cities and the world. It is a form of intimidation to the local population of the society present at the site and to other factions present at the same location.

Drugs are addicting more and more people in a shorter period of time. Two decades ago, marijuana was offered as a widely used drug. Nowadays, crack has been created, a mixture of several drugs, such as cocaine paste with solvents, which generate a small stone that the consumer smokes like a pipe, producing a devastating effect on the organism and addicting this subject in a much shorter time. . Another drug derived from crack is Oxi, with more devastating effects than the first, but making the subject become addicted in a faster time.

According to Gootnberg (2001), crack is obtained through a mixture of coca paste or cocaine hydrochloride with sodium bicarbonate (NaHCO3). Coca paste is a coarse product, with many impurities, which is obtained in the first stages of extracting cocaine from the leaves of the Erythroxylon coca plant, figure 1, when treated with strong bases, with sulfuric acid and organic solvents. Cocaine hydrochloride is the most stable form of this substance, which can be displaced by weak bases, such as sodium bicarbonate. Crack is sold in the form of small porous stones, figure 2. It is not soluble in water, but users smoke crack by heating these stones in improvised "pipes", since this substance changes from the solid state to the steam at a temperature relatively low, at 95ºC.

Figure 01: Crack components.



Source: (World Health Organization, 2004).

Figure 2: Crack stones on the left crack user smoking this drug with a "pipe" (on the right).

Source: http://www.brasilescola.com/quimica/quimica-crack.htm Accessed on April 27, 2014.

The ox is initially made from the base paste of the cocaine leaves, which are normally obtained in the Andean countries (Bolivia, Peru, Colombia and Ecuador). This base paste is mixed with toxic and corrosive fuels, such as kerosene, sulfuric acid (car battery water) and gasoline; also with quicklime and even cement. Crack also uses the base paste of the coca leaf, however, it is burned and crushed with sodium bicarbonate and ammonia or ether, which are also harmful to health, but which are more expensive and less toxic, lethal and harmful to the body. than the aforementioned components of the ox. It is this crude and cheaper preparation of cocaine that makes it far more devastating than crack. (Oliveira, L. G .; Nappo, S. A., 2008, p. 28).

3. School Violence

The language and codes of education are increasingly inaccessible. It is difficult to put the 12 to 16 year old on the path to study. Their understanding and understanding is much more complicated than before. There are countless variables that have emerged that cause the adolescent's mind to be distracted. A simple cell phone offers more than 10 different games, various types of messages and access to social networks, which provide free access, facilitating emotional lack of control, a problem that already exists in many young people at this stage of life and favoring disinterest in study.

Priotto (2009) calls school violence, all acts or actions of violence, aggressive and antisocial behaviors, including interpersonal conflicts, damage to property, criminal acts, marginalization, discrimination, among others practiced by, and among the school community (students, teachers, staff, family members and outsiders) in the school environment.

Charlot (2002) presents three different types of concepts: i) Violence at school, when it is the place of violence that has an external source. For example, when a group invades the school to fight with someone who is on the school premises, in this case, the school is invaded by violence that previously took place just outside its gates, or on the street. ii) Violence against the school, related to institutional activities and which concerns cases of direct violence against the institution, such as the depredation of property, for example, or violence against those who represent the institution, such as teachers. iii) School violence,

understood as violence where the victims are the students themselves, exemplified in the type of relationship established between teachers and students or in the methods of assessment and grading that reflect prejudices and stigmas, that is, other criteria that not performance objectives.

Abramovay and Rua (2002) affirm that physical violence and against property are prevalent in schools among all types of violence, with several negative consequences on the quality of teaching and learning. These authors affirm that more than half of the students who suffer violence in the school environment, do not obtain the necessary concentration for their studies, also reporting that they are extremely nervous with the situations of violence that they face in their schools, causing them to miss school. classes and subsequently as a consequence the abandonment of studies.

School violence may be due to other factors, such as the implications of learning. Today's society is very different from that found by our parents and grandparents. The role of women has evolved. Today she disputes the same space as man. In the past, a woman's duty and obligation was to provide education and care for her children, with a small collaboration from her husband. Today is very different. The role of parents in submitting to their children is much greater. Today, fathers and mothers do not determine, do not command, do not give orders, no longer have a pulse or property about what they ask and do to their children. We are in a very different context. Everything is questioned by children and society.

Parents offer a child 8 to 14 years old something to educate them. Part of these children are formed in families that have no authority over them. They sleep at the time they want, eat what they want, watch the program they want, go out at the time they want and so on. It is the lack of limit. Many families play education for school. Fathers and mothers work and send their children to school, in order to somehow transfer the homeland to six or seven education professionals in which the child is faced daily. Now the concept of education in these terms is contradictory.

Parents want to transfer all education to school, the role of which is to provide schooling and not education. If parents are unable to educate a child during the 24 hours of interaction, how do they want to transfer this power to only one person, called a teacher, to educate 30 or 40 children simultaneously within 4 hours□. It seems that the relationship between students and students and the time spent is totally disproportionate. The education task belongs to the family in the first place and the public authorities do the schooling in the second place. If the family does not fulfill its duty there is no point in handing the student over to the school. In addition to the problems arising from the family, we also find those arising from the education system, problems beginning in the transmission of knowledge to these students. We can see that the clientele has changed radically from twenty years to the present day. Incoherently, we realize that our curriculum has changed little.

Many teachers still demand absolute silence in almost the whole class, when they pour out all the content and after a few minutes open for questions. The student is intimidated to question a subject that he knows little about and that the volume of concepts is extremely large. And so, according to Paulo Freire, another deposit was made, the content was administered and expired. What is difficult to know is whether the student has learned. And how much of that "deposit" was actually "credited". The conceptions and theories of learning are innumerable, there are several meanings that must be obeyed in order to understand a certain subject; not to mention the differences present in each student.

The division into classes, castes, or social segments still persists, we see this division clearly in our

own classrooms. We want to change, we often fight against discrimination, sometimes we even set up and scale students in teamwork. When we leave it up to them, there are always one or two colleagues left without groups.

Is the way in which knowledge is transmitted perhaps a stimulating factor for the spread of violence among students? Some subjects involved feel victimized, because they are totally excluded from the teacher's lesson plan. Most understand or at least understand something, while some elements do not understand anything, do not understand, do not understand what the teacher wants to say or explain. When activity or exercises are carried out, these subjects, who do not understand the subject taught in the classroom, are absent, or join a colleague who is understanding, their participation being reduced to copying certain concepts, at first without any significance to him. Thus, in the educator's global view, the student fulfilled his activities, copied the subjects and remained silent. We realized then that the participation of this student is similar to that which left the classroom, which despite not having hindered the class, did not absorb anything.

In the conception of (Dias G. N., et al., 2020):

What this contributes to our life in society. The fact that our activities are so intense that we do not have time, even to live with our children and give them the necessary education, or too much time, that due to the fact that on many occasions “doing nothing” leads us to a condition of lost in a world full of injustice. Everything we do or fail to do is important for our daily lives. To speak of the constitution of the habitus, it is necessary first of all to know its history and genesis and all the structures in force in this society and in that specific field. It is common to say that the personal mode or a particular brand that takes all products or practices of the same habitus according to a certain time or class to which the subject belongs. (Dias, G. N., et all., 2020)

The constant opposition of dominated and dominant classes causes an irreversible bottleneck in the current social situation in which we live. There is a dispute between groups that want to excel over others in different ways. The group of young people engaged in the study will only obtain the results and achievements after a long period of dedication and abstinence from various situations that the other group obtains in a short time in the traffic.

Already the group of marginalized students, misdemeanors and often revolted by this waiting policy use artifices and crimes to obtain certain objects that are envied by different groups which make them strong in the face of their causes and motives, thus perpetrating a mistaken idea of early success legitimizing and enlisting several young people to the world of crime and drugs.

Faced with these justifications, the increase in the consumption of narcotics has been directly linked to the increasingly aggressive and uncontrolled behavior of young people in this period of life when they are unable to have the proper stimulus for studies, provided by parents or family and carried out by the government of. each state.

The characteristic attitudes of undisciplined students: i) they need to demonstrate their aggressiveness through their power to strike, annihilate, destroy something or violate people and with these attitudes acquire a form of respect from their colleagues regarding extreme aggressiveness; ii) subduing

any form of scorn about him and making his wishes prevail through brute force and courage; iii) destroy the school's assets; iv) do not worry about denunciations, because whoever makes it will be at risk of facing it.

Considering the student's native environment, originating from risk areas, where poverty prevails, they can perceive certain anxieties, discrimination, different forms of treatment, in general leaving this subject always out of any attitude or pedagogical work in the classroom.

The school starts by reinforcing the pre-existing differences, starting from the beginning of the equity of consideration and treating the students differently in their origins and attributes in the same way, inasmuch as it is evaluated is not always related to learning, but with customs and manners arising from it. of social and cultural capital.

In the neighborhood of Pedreira in Belém, we have some places considered to be extremely insecure or also called "paraense red line". The perimeter of the Humaitá lane, between Rua Antônio Everdosa and Rua Nova, stands out. In this place, in the last twelve months, a large concentration of assailants and addicts in various types of drugs such as marijuana, crack, cocaine, cola, acetone and other solvents were found. There are reports of students, who answered the questionnaire in Annex III, that in some situations between 8 pm and 9 pm, several elements are jumping, dancing, sniffing glue in the street and smoking marijuana in the open, close to the innocent neighborhood to what is happening.

These same students also reported being common in this perimeter, around 13 to 15 o'clock in the afternoon, several criminals between 14 and 20 years get together, to know what they stole, make divisions and plan the next attack. Commerce in this location usually closes its doors at this time, in order not to encounter these young people in the vicinity.

Dowdney (2005) points out that the inclusion of children in the world of crime begins at 10 years of age. And the first activities and involvement take place progressively, that is, the process is slow, taking months or years and even a child can be considered a respected member of the gang.

In Belém, in the regions investigated, young people become criminals from the age of 14. They receive weapons to promote robberies or they also rent weapons for crimes committed in the neighborhood.

One of the main specific behaviors of these young people is that when the police discover the "Boca de Fumo" site, the young person involved admits the entire charge in order to free the giant drug trafficking network present in the neighborhood. It is a strategy of these traffickers, to leave 1 to 2 boys under the age of 18 responsible for their mouths, because by their young age, if they are captured by the police, they are soon put on the street again and if they possibly denounce the group, they will probably be killed in jail even his family will be punished or he will be exterminated.

In the conception of (Dias, G. N. et al, 2020):

The inertial force that prison opposes justice is an old thing. Perhaps it is the effect of sclerosis of the displacement of power. We can say that criminal justice is done to meet the demand of a group of people tied to a means of control plunged into the shadow of delinquency. The deputy arrests and after a few days lets go. Not because he wants to or because he feels like it or is corrupted. He lets go because there is no more space. Another criminal appeared with a greater "weight". He has committed more crimes, even heinous, and it may not be possible to keep the one who has committed a primary crime compared to the last who has committed several crimes. The law holder at this time has to judge by the most appropriate

justice option (Dias, G. N. et al, 2020).

In the perspective of Dowdney (2005), adulthood is not based on a chronological criterion, but on the subject's ability to perform the functions that are considered essential to the group.

The functions within the traffic are as diverse as possible, such as: scout, spy, informant, porter, cleaner and weapons keeper. The activities of the soldiers of the group are generally: bodyguards of the owner of the mouth, defender of the territory against rival groups, patrollers of the region and the surroundings of the mouth, checking that there are no factions trying to infiltrate the drug sales scheme, besides to participate in the armed confrontation with the police.

4. Perverse Territorialization

The term "Territory" is used as a physical space, a place for the base of formation of the group and its network of sovereign functioning of its relations. It is made concrete by the power of power in its domain. In the areas where drug trafficking works in the neighborhoods in question, the low participation of the State is predominant, with a lack of policing. She only appears in search of elements that committed barbaric crimes and that the press reported on the main communication networks. In this situation, the police are obliged to act and appear with great force. The criminal network itself ends up handing over the offender precisely to reduce the number of police in the neighborhood.

The preferred location by criminal networks is favored by the internal spatial organization, marked by the presence of alleys, alleys, narrow streets, with no asphalt, wooden houses and little or no lighting, as they make it difficult for police to access. In general, these areas are the result of irregular occupation, where several families a few decades ago decided to take possession of places unsuitable for housing, coming to form huge slums.

In the conception of Fox, Towe, Stephens, Walker & Roffman, (2011) adolescents became the group most vulnerable to the consumption of psychoactive substances, which probably occurs due to the typical characteristics of adolescence, where we can mention the influence of the group of peers, the need for affirmation and the formation of identity. In addition, adolescence is the stage of human development characterized by the processes of mutation and stabilization of physiological, psychological and social actions.

According to studies carried out by Wills, Mcnamara, Vaccaro & Hirsky (1997), indicate that stress is a risk factor that promotes the consumption of psychoactive substances, while this causes an increase in emotional distress or changes in the subjects' self-control perceptions , making them more susceptible to the consumption of toxic substances.

For Matellanes (1999), the problem of low esteem is among the risk factors that most contribute to the consumption of psychoactive substances, manifested by the insecurity that young people have about themselves, suggesting low control over emotions, leading young people to achieve faster responses to your problem and leading this behavior as a model to the frustration obtained.

According to Dalgalarrondo (2008) several situations such as: feeling of omnipotence, difficulty in obtaining adequate information, anxiety, idleness, precision of breaking standards and norms, search for

the new, precision of being accepted by the group, obligation to challenge the family, low self-esteem, negative family habits such as smoking, alcohol and continued use of medicines.

These are characteristics that, when observed, are translated as factors that can contribute to drug use. It is not imperative to say that all these listed features are necessary for the subject to discover drug use. There are also cases where only the factor, such as idleness, has already led thousands of young people and adolescents to the consumption of narcotics. It is evident that the more problems are added, they are consistent with the prescription of a being potentially predestined to use drugs. Conversely, we can say that only one item, such as negative family habits, smoking, alcohol and the use of drugs, can also lead to drug use.

We can cite as an example, family parties in which drinks are released and we observe that parents, uncles and even grandparents are consuming alcohol, setting a negative example, which the child ends up understanding that later on he will be able to drink as much as his father, his uncles and etc.

In the conception of Campos and Soares (2004), the precaution of drug use is limited to actions in a repressive way, with a moralistic and blaming connotation, benefiting inappropriate interventions by specialists who simplify the problem using the frightening discourse, falsifying scientific evidence, inhibiting school performance as a protective factor against addictive behaviors.

We perceive that young people entering adolescence have natural problems that most individuals encounter at this stage of life, however in these subjects raised in the region characterized as sectors belonging to the perverse territorialization, where we find the places where the drug and substance trade develops psychoactive, this young man ends up yielding to local social pressures and ends up adhering to drug users or trafficking drugs on a small scale. Logically, the contribution of this behavior at school level is possibly the most harmful and likely to happen, where young people use school as a form of barracks and regimentation of new adherents to the use and consumption of drugs.

The drug trafficking developed in the peripheral regions of Greater Belém has shown the best way of distributing its products where the drugs stem from strategies that present themselves in an increasing approximation with the local community, lacking in all types of services and improvements, in the which the State does not support it. One of the services to be implemented, almost free of charge to the local neighborhood, is possibly the supply of free electricity.

The supply of energy, as in the entire State of the Country, is outsourced to an Energy concessionaire. Here in the State of Pará, the company that provides this service is Equatorial. The question is: How do these groups of criminals get free energy for the location they dominate? In fact, these factions are experts in clandestine light connections and even rely on the collaboration of the supplier company's own employees. According to the Brazilian Yearbook of Public Security (2015), individual energy consumption in the State of Pará is higher than in the southern center of the country, generally due to the high temperature that the local population is accustomed to living with where frequent use of fans and air conditioning charge the electricity bill.

These groups of criminals only ask for a collaboration of 20 to 50 reais to turn on the power on the pole. There are places where there are more than 40 residents in this situation. They even use tricks such as connecting some parts of the house to stolen energy and another with energy from the concessionaire so as not to arouse suspicion. Below in figure 3, a typical case in which the official technician of the energy

concessionaire comes to cut the so-called "cats, for being overloading the energy distribution on the street".

Figure 3: Illustrative photo of an employee of Rede Celpa (Equatorial) cutting off clandestine power on Tv. Humaitá corner with Rua Nova, city of Belém, Pará, Brazil.

Source: "O Liberal" newspaper of December 10, 2013.

When the concessionaire decides to cut the power, the so-called "cat", after about 2 hours after leaving the company, clandestine connections are reestablished. For the criminal factions, it is interesting that the concessionaire constantly comes to cut these so-called "cats", as this way the clientele will pay for the same services already performed.

The service provider places the equipment for 50 houses, but in the end it ends up supporting 100 calls, which goes beyond what is required for the families that really contribute, making the environment and local neighborhood always with discussions and confrontations with the energy concessionaire. Those taxpayers who pay energy properly, have their full right to complain, but for the concessionaire who needs to put equipment with double or triple the power, because it has families that divert energy (steal) is also unfair.

Another service that these criminal groups provide to the community is security, with a way to prevent assaults on local residents, working in the trafficking zone, where criminals are persecuted, as a form of reprisal and also a way to remove the police from the place, which can be bad for the drug retailer, giving local residents a false sense of security.

The term "militia" or "mineira" is organized from a specific region acting on a concept of frontier whose area of expansion is illegal subdivisions was coined for the first time in Brazil on the outskirts of Rio de Janeiro, which was formed by military police, retired military personnel, fire brigade and even private security guards.

In the case of the metropolitan region of Belém, apparently, there is no specific type of militia active in any neighborhood in the region. It is not acceptable to confuse these groups of traffickers with militias, since drug trafficking for militiamen is the number one enemy to be fought. What happens with relative

frequency, is the revolt of some policemen with the brazenness, daring and daring of these bandits that no longer respect anything. The policeman does his job, arrests the miscreant, takes him to the police station. Upon arriving there, he realizes that the accused is a minor and therefore responds to the accusation differently.

According to Couto (2013), what happened in this region is the so-called “Perverse Territorialization” and not the existence of a militia that is the setting up of armed criminal groups linked to drug trafficking and which has been expanding to the city center.

In these regions of conflict by drug trafficking groups there is a relative worsening of living conditions, livelihood, economic and cultural growth, as the place is "closed" and private goods and public services are restricted to a certain limit of territory. There is an increase in trafficking, in crime, in the increase in homicide rates, and in all types of crime and, consequently, the increase in drug trafficking.

There are two elements that are essential to the functioning of the smoke vent, the scout and the plane. The first is in the region where the faction works, which over the phone informs the gang about the movement of elements foreign to the local population, where the gang hides weapons or escapes from the place. The role of the “airplane” is the sale of the drug carton, outside or away from the mouth of the smoke, it is the small dealer, so that the consumer is not aware of where the shuttlecocks (small balls of paper) come from, containing a stone crack. It can also be a small amount of marijuana for one or two cigarettes, or a small amount of cocaine, they only know that the dealer (plane) sells, but does not know where he makes it. When the police are able to apprehend a consumer, they immediately want to know where and with whom they bought it, as it is a way of combating the increasing drug trafficking in this region.

The student's social positions in the current context have undergone major changes between the contemporary era and thirty years ago. The “new technologies” have evolved a lot and today it is possible for a person to have a powerful computer connected to social networks in the palm of their hand. This technological artifact is still being called a cell phone. Thirty years ago the cell phone in Brazil was not known. However, today, schools use the same didactic strategies as thirty years ago and are still resistant to the use of new technologies.

The profile of society has changed. In the past, children found part of the education in their own family, where the mother usually monitored the children's activity daily. Today they are created most of the time without any kind of authority. It is the lack of limits. Parents often, due to lack of time and difficulties encountered in their work, want to transfer their homeland power to school, since it is the duty of the family to educate and schooling is the duty of the school.

5. Methodology

The research methodology was of the qualitative-quantitative type with a focus on understanding and the insertion of the researcher in the work environment will be used in this research, with direct observation through continued work for one year using questionnaires to students, interviews with parents, principals , teachers and coordinators.

The research process allowed the contribution of principals, parent coordinators, teachers and students from the Pedreira neighborhood.

The observation was direct and indirect of all the behavior of students, parents and teachers in the three shifts of the school, related to violence and the use of narcotics during twenty months of investigation, covering the period from August 10, 2013 until June 10, 2015.

The interview was conducted with all the subjects involved in the process that is part of the theme of this work: director, vice-director, teachers, parents, coordinators, students. Which was elaborated with the greatest possible care, appropriate to the age group and the group to be investigated.

The first objective was represented by the results presented in the first questionnaire, total of 70 analyzes, which was disseminated and distributed to the students and it was essential to relate the student's involvement with marginal groups in their surroundings, such as intimate coexistence, as siblings parents, or external coexistence, such as friends and acquaintances who have established a position and drive criminal activities and involvement with trafficking.

The second objective was represented by the questionnaire distributed to teachers, in the pedagogical week, which had 15 participations and contributions on the theme that were of fundamental importance to point out possible solutions to minimize the problem of violence in the school environment.

The main research instrument was the questionnaire, as with previously defined fields, many questions were answered quickly, stimulating the interviewed subject to participate more actively. The fact that the instrument already has characterizations and questions previously formulated and answered, if the subject only indicates which option is desired, it may contain imperfections if the original answer does not fit in any of the answers previously presented. To contain and correct this problem, the questions have several answer options, and it was suggested to the interviewee to add the particularities in the field of observations.

As the group researched and involved in violence were formed by young people aged 12 to 22 years and are studying the majority in elementary school, these subjects have a certain shyness to write about their problems directly on paper, possibly attributed to two factors central: fear of writing wrong (don't know how to write right) and fear of putting your real intentions on paper, fearing reprisals.

Regarding the type of questionnaire, it was prepared with questions and answers in alternative ways and the interviewee should indicate the one that most directly relates to his profile. Also to questions contained in the questionnaire that suggest more than one alternative to be checked, according to the profile of the investigated.

To the students, two types of questionnaires were explored. The first one that explored their social situation and social conditions close to the effect of crime, a survey carried out from August 10, 2013 to December 10, 2014, totaling 70 questionnaires.

For teachers, an individual interview was first conducted with a teacher, on December 9, 2014, precisely because of the student's profile of her coexistence, and for the duration of this professional's stay with the research subjects, where the questionnaires destined to students showed essential elements of contour to this specific niche of students, who are allocated at Escola Maroja Neto, study in the afternoon and are student students of EJA (4th Stage).

6. Final Considerations

According to research carried out in schools in the neighborhood of Pedreira, violence spreads more among young people aged 15 to 18, for several reasons:

i) The arrival of adolescence and all the discoveries and the intensity of existential crises, the process of affirming their personality, which according to Marcelli & Braconnier (2007) is formed by a stage of changes that signifies the psychological and cultural transition from childhood to adult life, where the subject undergoes bodily, mental and emotional changes and is a characteristic period because there is a phase, called a `` crisis``, being temporarily momentary of imbalance and momentary circumstances that endanger normal stabilization or pathological condition of the individual.

ii) The use of drugs: that according to the contribution of Matellanes (1999) the problem of low esteem is among the risk factors that most contribute to the consumption of psychoactive substances, and it is manifested through insecurity that the young person perceives of himself, suggesting the low control of emotions, leading the young person to achieve faster responses to his problem and leading this behavior as a model to the frustrations obtained. Dalgalarrondo (2008) also portrays various situations of influence, such as: feeling of omnipotence, difficulty in obtaining adequate information, anxiety, idleness, the need to break standards and norms, the search for the new, the need to be accepted by the group, the obligation to challenge the family, low self-esteem, negative family habits such as smoking, alcohol and continued use of medicines. Also for Fox, Towe, Stephens, Walker & Roffman, (2011) adolescents became the most vulnerable group to the consumption of psychoactive substances, which probably occurs due to the typical characteristics of adolescence, where we can mention the influence of the peer group. , the need for affirmation and the formation of identity.

iii) The insertion of this student in risk areas belonging to Perverse Territorialization: in this research we perceive that school violence is also widespread due to the influence of the students' place of residence, where the preferred place by criminal networks prevails and is favored by the internal spatial organization, marked by the presence of alleys, alleys, narrow streets, with no asphalt, wooden houses and little or no lighting, as they make it difficult for the police to access. In general, these areas are the result of irregular occupation, where several families a few decades ago decided to take possession of places unsuitable for housing, coming to form huge slums. In general, there is a relative worsening of living conditions, livelihood, economic growth and culture, as the place "closes" and private goods and public utility services are restricted to a certain limit of territory. It is observed that trafficking, crime, the increase in homicide rates, and all types of crime increase, which increases the advance of drug trafficking.

iv) The lack of adequate punishment: currently the legislation attributed in Brazil to minors under 18 (eighteen years old) provides that all the infraction acts that they commit, their penalty will have a maximum of three years of imprisonment in the closed or semi-open regime, where due to these perks and privileges, you will probably find support and retribution for the crimes committed, being welcomed in the criminal faction. These penalties proposed by the ECA (Statute of the Child and Adolescent) are totally seductive to young people where the punishment-reproduction of violence actually occurs, so that the small punishment becomes a stimulus to continue in criminal life. According to the Public Security Yearbook (2015), practically 45% of crimes and robberies committed by armed hand, are of minor offenders. And

60% of death crimes are committed by individuals under the age of 18.

vii) The influence of Habitus: in the conception of Bourdieu (1998) we perceive the importance of "Habitus" present in individuals and differentiated and specific in each subject. If this individualized and peculiar characteristic of this individual is compatible with the position of this group to which the habitus is inserted, it is a kind of chain of human actions in daily life.

viii) The schooling of our young people: According to Gimeno (2000) the new concept of schooling believes in the universality of school culture so that the population believes that it is up to the school to transmit to all students the total content of all public knowledge, confusing with the real meaning of education. Parents want to transfer all education to school and the role of the school is to provide schooling and not education. The education task belongs to the family in the first place and the public authorities do the schooling in the second place. If the family does not fulfill its duty there is no point in handing the student over to the school.

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Academic Spin-Offs and the benefits generated by startups developed Through University-Companies cooperation in Brazil

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Abstract

Startups developed through academic Spin-offs foster the development of products and processes inside and outside the innovation ecosystem that originated them and have become an important research topic with regard to Technology Transfer mechanisms and University-Company cooperation. Therefore, the objective of this article was to bring up information that could contribute to the discussion on academic spin-offs, startups and the benefits initially generated by this cooperation. The adopted methodology was the exploratory descriptive, aiming the perception in the literature used in some arguments and data that would help the understanding of this relationship. In view of this, the results

show us that there is a large number of qualified personnel within these firms and that this intellectual capital cooperates with the positive impact on a country's economic and social development.

Keywords: spin-offs; startups; transfer technology; university-companies cooperation.

1. Introduction

The use of technology created in universities represents an important basis for the economic development, therefore the cooperation of the productive sectors with the academy is a source of advantages for all involved (COSTA; PORTO; FELDHAUS, 2010; KAYSER et al, 2018). University-business cooperation is the establishment of relations between universities and companies, so cooperation activities sought promote synergy between organizations, making them more competitive in their respective fields of action. The strategic option for cooperation is interesting for companies that face some type of technological difficulty or that have difficulties to innovate in isolation. Such relations between companies and universities can occur in several ways, including through the transfer of technology (SANTANA; PORTO, 2009; KAYSER et al, 2018).

Technology transfer can be understood as the set of steps that describe the formal transfer of inventions resulting from scientific research carried out by universities and research institutes to the productive sector, it is necessary to emphasize, the importance of such a process is based on the innovation potential it provides (DIAS; PORTO, 2014; STAL et al, 2016).

In the context of university-business cooperation and in technology transfer processes, there are several mechanisms, such as, for example, technology licensing and the creation of technology-based companies, the last example mentioned is related to the so-called academic entrepreneurship that has gained highlighted due to the development of companies from the result of academic research, in this case, startups from academic spin-offs (ETZKOWITZ, 1998; COSTA, TORKOMIAN, 2008; DALMARCO et al, 2018).

In order to contribute to the debate on the topic, this article seeks through a theoretical study to address the conceptualization of technology transfer and its mechanisms, entrepreneurship, startups and academic spin-offs and to present possible contributions in the context of economic development and social for the country, in the search to meet the proposed objectives, two studies referring to academic spin-offs in Brazil were analyzed in an interval of seven years, a study developed by Costa and Torkomian (2008) “An Exploratory Study on a new type of Enterprise: the Academic Spin-offs” and the research carried out by Santos et al. (2015) “Academic Spin-Offs and their Importance in Economic Development”.

2. Technology Transfer

In the context of this research, in order to understand what technology transfer really is, it is necessary to understand what innovation and university-business cooperation is about. Innovation can be defined as an

idea, practice or material good that is perceived as new and of relevant application. The innovation process is defined as the development and implementation of new ideas by people who work involved in transactions with other people within the organizational context and results in the creation of new technologies, products, processes and management models (BENEDETTI; TORKOMIAN, 2011; PINTO et al, 2019).

Innovation can be seen as a competitive advantage, since it reduces costs, through ease of manufacture or simplification of logistics; and increases differentiation, developing new products or improving existing ones (PORTER, 1985 apud MARCHIORI, 2000), in the midst of a global competition context, innovation has a decisive role for the technological and economic development of any country (GARNICA et al, 2009; MIRANDA, 2017).

Despite the fact that many developing countries seek to develop new technologies internally, most of them face difficulties due to social and cultural experiences in using, adapting and disseminating these technologies (COHEN, 2007). In these countries, the control of the technology transfer process has serious limitations and is not so well understood due to its complexity and consequent negative social impacts. On the other hand, in developed countries, the development of technologies can be perceived as a continuous process (BENEDETTI; TORKOMIAN, 2011; PINTO et al, 2019).

The Brazilian environment has historically been characterized by a lack of articulation between industrial and governmental policies on science, technology and innovation (STI). As a result, there is a gap between investments in STI and the demand for innovation in the private sector. There is a concentration of public investments in science and little investment by the private sector in technological development (CLOSS; FERREIRA, 2012).

In this context, the knowledge generated in Brazilian universities is a rich source of information and training for the development of new technologies, since the transfer of technology between universities and the productive sector appears as an alternative and complementary path for the reaching a higher technological level for Brazilian companies (GARNICA; TORKOMIAN, 2009; MIRANDA, 2017).
It should be noted that university-company cooperation is the establishment of relations between the university and the company, so that the activities envisaged promote synergy between organizations, making them more competitive in their respective fields of action, hence the strategic option cooperation is made interesting for companies that face some type of technological difficulty or that have difficulties to innovate in isolation. Such cooperation between companies and universities can occur in several ways, including through the transfer of technology (SANTANA; PORTO, 2009; KAYSER et al, 2018).

Technology transfer can be understood as a process carried out between two entities in which a certain knowledge is acquired, developed and used in order to improve a methodology, a process, a product or an element of that product (LUCATO et al, 2015) . In this context, it is worth mentioning the triple helix model (ETZKOWITZ; LEYDESDORFF, 2000 apud CLOSS; FERREIRA, 2012), being one of the most

referenced in relation to the different agents of the innovation process and, consequently, of the technology transfer processes.

This model characterizes the interrelationships of three major entities: the university, the government and companies, with the aim of exploring ways to create an environment favorable to innovation (CLOSS; FERREIRA, 2012), as shown in Figure 1.

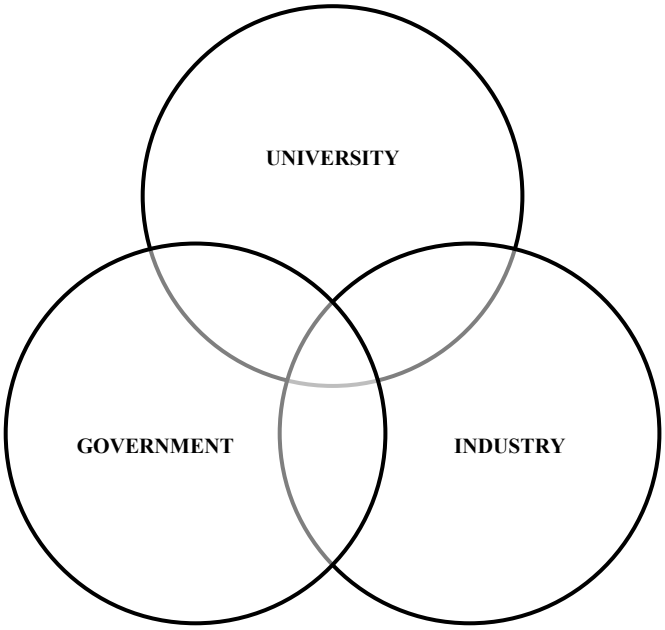

Figure 1. Triple Helix.
Source: Adapted from ETZKOWITZ; LEYDESDORFF (2000) *apud* MIRANDA; SANTOS; RUSSO (2017)

Based on the concepts brought by the triple helix model, universities and companies have a kind of mutual dependence, since companies have a need for innovative products within their commercial environment while universities have the ability to develop such products through of the research (MIRANDA; SANTOS; RUSSO, 2017)

3. Technology Transfer Mechanisms

Based The main means for the transfer of technology have been licensing and the creation of derivative companies through a mechanism known as spin-off. Based on their studies and with a greater focus on communication channels, Rogers, Takegami and Yin (2000) present in a more detailed way what are the mechanisms of Technology Transfer, in this case, publications, meetings / conferences, research projects and cooperative developments, licensing and spin-offs (GARNICA, 2009; MIRANDA, 2017).

Table 1. Technology Transfer Mechanisms

Technology Transfer Mechanism	Definition
Publications	Publications of scientific articles in academic journals.
Meetings / Conferences	Academic events where technical information is exchanged.
Research projects and development cooperatives	Agreements between Research Institutes and private companies focused on research, sharing prediction intellectual property rights, equipment and capable people.
Licensing	Permission of use of Intellectual Property Rights
Spin-offs	Transfer of technological innovation in a process of generating new companies from existing organizations.

Source: Adapted from Garnica (2009) *apud* Miranda (2017)

Historically, universities and other research institutions have fulfilled their basic function of transferring knowledge through publications, extension programs or even courses and training (CLOSS; FERREIRA, 2012). However, in addition to the traditional objectives linked to teaching and research, transferring knowledge to industry arises as a new mission for the university (MUSCIO, 2010).

In this context, mechanisms of technology transfer appear that go beyond scientific conferences and publications, such as technology licensing, R&D projects and spin-offs. In the scope of university-business cooperation, academic spin-offs can be understood as companies derived from an academic institution, in a more exemplified way, if in the midst of research a profitable invention or idea arises, creative teachers and students can develop a company to commercialize his creation, that is, a startup from the spin-off transfer mechanism (CONSTANTE, 2011 apud MIRANDA, 2017).

4. Technology Transfer Mechanisms

The history of Entrepreneurship in the world has no definite date. Studies show that between the years 1271 and 1295, a merchant named Marco Polo tried to develop a trade route to the East and, in an entrepreneurial initiative, signed a contract with a capitalist who started to sell his products. His travels and actions characterized the person who practices entrepreneurship, that is, an entrepreneurial person who takes physical and emotional risks, in order to achieve his goals. Marco Polo became known as one of the first entrepreneurs in world history. According to Matos Brito et al. (2013).

In the medieval period, an entrepreneur was one who managed large projects without taking serious risks. In the 17th century, the first relations between entrepreneurship and assumed risks emerged. It was during this period that the entrepreneur began to establish contractual agreements with the government in order to perform services or provide products. In the 1990s, entrepreneurship became the focus of public policies and studies in institutions of secondary and higher education. This was due to the intense technological advancement, which forced people of the time to prepare to innovate, continuing or

becoming competitive in the market. All of this, even today, is observed through government incentives for new investments, integration of the discipline in school curricula and reducing the bureaucracy of financing for the implementation of new businesses. (Rede E-tec Brasil, 2013)

According to the trajectory of the history of Entrepreneurship, in view of the need to innovate, the idea of entrepreneurship has become indispensable, which can be applied in the most diverse areas, including in the academic sphere, for example, with the expression entrepreneurial university (ETZKOWITZ, 1998; PAVITT, 1998; COLYVAS et al, 2002; SHANE, 2004). In the midst of this context, so-called startups also appear.

The concept of startup has evolved a lot over time. First, these nascent companies were seen as a small company in its initial stage (GITAHY, 2010). Over time, the concept of startups has evolved and what is understood is that these organizations are companies that are born in extremely uncertain environments. They are small civil, commercial organizations or a specific enterprise capable of generating wealth with an accelerating promotion. Steve Blank (2014) a scholar in the field says that "A startup is a temporary organization, designed to search for a repeatable and scalable business model".

The history of startups, innovative environments and entrepreneurship began in Silicon Valley - the cradle of this paradigm shift. Steeve Blank (2014) says that Silicon Valley started its development from the 2nd world war, continuing in the cold war. The American government has invested millions in a secret Harvard laboratory, in addition to encouraging ownership and reducing capital gains taxes, expanding the availability of credit. Hence the promotion of entrepreneurship and its startups, which are temporary companies / organizations and in search of a receptive and scalable business model, started.

According to FONSECA (2016), "The rise of startups reached its peak in mid-2010, where dozens of start-up centers around the world started to be called ecosystems due to the high concentration of elements favorable to the emergence of these companies." Given this statement, it is understood that Startups must have an innovative product or service to transport progressive innovations.

Currently, there are several types of startups, however, this article focuses on a specific type, startups from spin-offs in the university-company axis or also called academic spin-offs. According to Shane (2004), academic spin-off can be conceptualized as a company created to explore an invention resulting from research work produced in an academic institution, in parallel Bigliardi, Galati and Verbano (2013) conceptualize academic spin-offs as a specific type of startup company founded by an academic inventor with the aim of exploring technological knowledge that originated within a university environment with a focus on developing products or services.

According to Sánchez and Pérez (2000), there are three basic types of academic spin-offs, as shown in Figure 2.

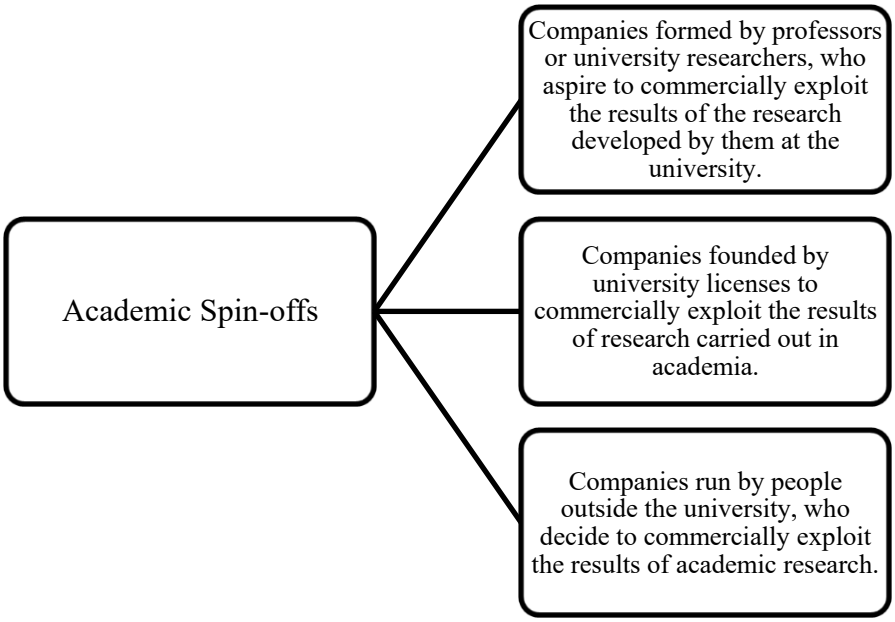

Figure 2. Types of academic spin-offs
Source: Adapted from Pedrosi Filho and De Matos Coelho(2013)

In relation to the theoretical discussions regarding the definition of academic spin-off, some authors conceptualize that a startup company developed by an individual without a link to a university, but as long as the know-how comes from an academic institution, there may also be the consideration that this is an academic spin-off (RAPPERT; WEBSTER; CHARLES, 1999 apud PEDROSI FILHO; DE MATOS COELHO, 2013).

Despite the various definitions available in the literature for academic spin-off, in general, there is a fundamental characteristic of academic spin-off, necessarily its basic product or service was developed from research carried out within the structure of universities.

5. Benefits presented by academic Spin-offs worldwide

In general, there is a consensus among theorists about the benefits achieved through academic entrepreneurship. Startups from the academic spin-off mechanism are usually technology-based companies and according to Monck et al. (1990), these types of companies represent an economic promise, since the technological sector drives the economy in a wide way, either by raising income levels or even by inducing the growth of businesses considered traditional (MONCK et al. , 1990; SANTOS et al., 2015).

Also according to Pedrosi Filho and De Matos Coelho (2013), academic spin-offs have a positive impact on the development of the local economy, since the creation of startups and economic activities related to companies are usually local, in addition to the tendency to form clusters. known clusters, such as, for

example, Technology Parks, once technology companies are established in a given region, they are prone to attract other economic actors, such as service providers or suppliers, which helps to local economy. According to research carried out in several countries, indirect economic impacts may be greater than direct impacts. Still with regard to the economic impacts generated by the spin-offs, Shane (2004) presents relevant data regarding academic entrepreneurship around the world.

USA (1980)	France (1987 - 1997)	England (1985)
• 72% of the Technology-based Companies created in Boston were based on technologies developed in the laboratories of the Massachusetts Intitute of Technology - MIT	• 40% of the technology-based companies created were academic spin-offs.	• 17% of technology companies in Cambridge originated from academic spin-offs.

Figure 3. Academic Entrepreneurship in USA, France and England
Source: Adapted from Shane (2004)

In the specific case of the Massachusetts Institute of Technology - MIT, it is worth mentioning the magnitude of the figures presented by the institution in relation to the impact on the local economy, according to Roberts and Eesley (2009) at the time of their research, there were 25,800 active companies developed by students of MIT, about 3.3 million people were employed in jobs related to the activities of these companies and there was an annual turnover of approximately $ 2 trillion dollars, still according to the researchers, should the MIT academic spin-offs become a independent nation, there would be a great chance that that nation would occupy the position of the 17th largest economy in the world (PEDROSI FILHO; DE MATOS COELHO, 2013).

In the context of a knowledge-based economy, there is no doubt as to the fact that the creation of technology-based companies streamlines the local economy and reduces the dependence on traditional industries, since they favor the diversification of products and services (MONCK, 1990; LEMOS & DINIZ, 2001; SHANE, 2004; PEDROSI FILHO; DE MATOS COELHO, 2013). Based on studies carried out by Pedrosi Filho and De Matos Coelho (2013), academic spin-offs generate the most diverse benefits, however, in addition to the positive impact on the economy, the following main contributions can be pointed out:

- **Strengthening academic entrepreneurship:** academic spin-offs develop a renewal in the research culture, since they increase the involvement of researchers in the mechanisms of commercialization of technologies. The possibility for academics to develop companies and continue their research activities allows new cooperative

relationships to be developed between universities and academic startups, so the entrepreneurial culture in the academic environment allows for a greater production of innovations which benefits the economy as a whole .

- **Commercialization of new technologies still under development:** it is a common behavior in large companies the fear of investing in technologies considered risky or at a very early stage, in view of this, academic spin-offs appear as a marketing tool for technologies still under development and that due to the risk of error could become patent on university shelves.
- **Stops the brain drain process:** startups from academic spin-off processes tend to demand specialized labor, as, normally, they are technology-based companies that present jobs to academics who would otherwise follow the "brain drain" process in looking for opportunities elsewhere. The stagnation of the "brain drain" is extremely beneficial because it allows the developed innovations to remain in their original places, which brings competitive advantages to the region or even to the country.

In addition to the various benefits presented, it should be noted that in the context of startups in general, studies show that academic spin-offs are the most successful startups in relation to the others and in comparison with the transfer of technology through licensing, they generate jobs and superior financial flow (ASSOCIATION OF UNIVERSITY TECHNOLOGY MANAGERS, 1998; SHANE, 2004).

6. Academic Spin-Offs in Brazil

In the search to portray the scenario of academic spin-offs in Brazil, two in-depth studies on the reality of Brazilian academic startups were selected, the first was a study by Costa and Torkomian (2008) entitled "An Exploratory Study on a New Type of Enterprise: the Academic Spin-offs "and the second was a study developed by Santos et al. (2015) called "Academic Spin-Offs and their importance in economic development".

Although it was carried out in 2008, the first article mentioned so far presents the most comprehensive study of the situation of academic spin-offs in Brazil, the research reached the number of 33 spin-offs from 9 Brazilian universities distributed throughout the country, a of the points presented in the survey is the location of the companies surveyed in the country.

FIGURE 4 - Location of Academic Spin-offs in Brazil

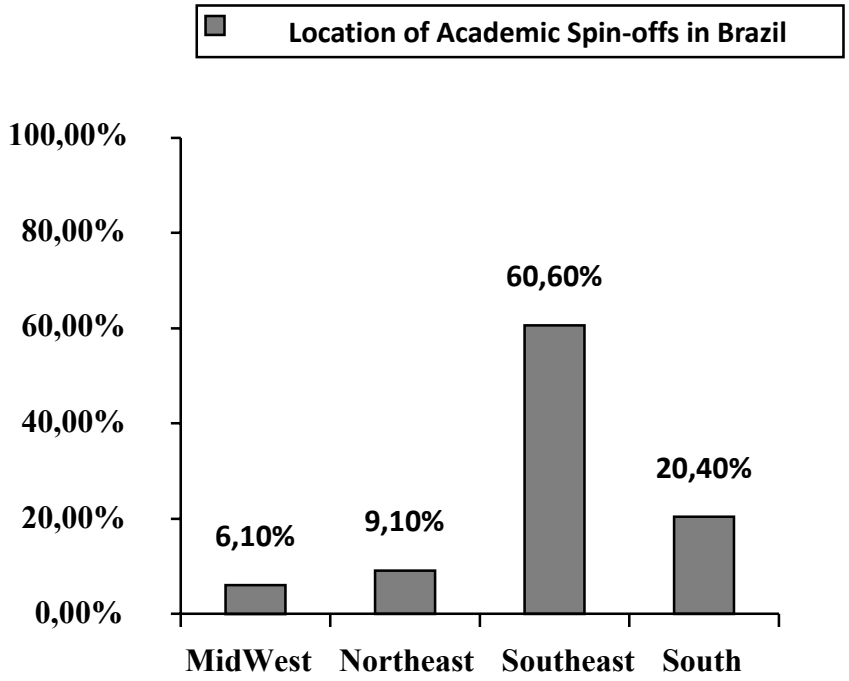

Figure 3. Location of Academic Spin-offs in Brazil
Source: Adapted from Costa and Torkomian (2008)

Although Due to typical research difficulties, the North region of the country was not covered, however, the distribution presented is relevant, the Southeast region holds the largest amount with 60.6% of national spin-offs, followed by the South region with 20 , 4%, Northeast with 9.1% and Midwest with 6.1% (COSTA; TORKOMIAN, 2008). Based on the research, USP and UNICAMP are the Brazilian universities that most presented numbers of development of spin-offs in Brazil, this probably occurs due to the culture of cademic entrepreneurship widespread in these universities, which suggests that the diffusion the entrepreneurial impulse in universities could generate a change in reality.

It is worth mentioning another important point of the research, the academic background of the members of the investigated academic spin-offs.

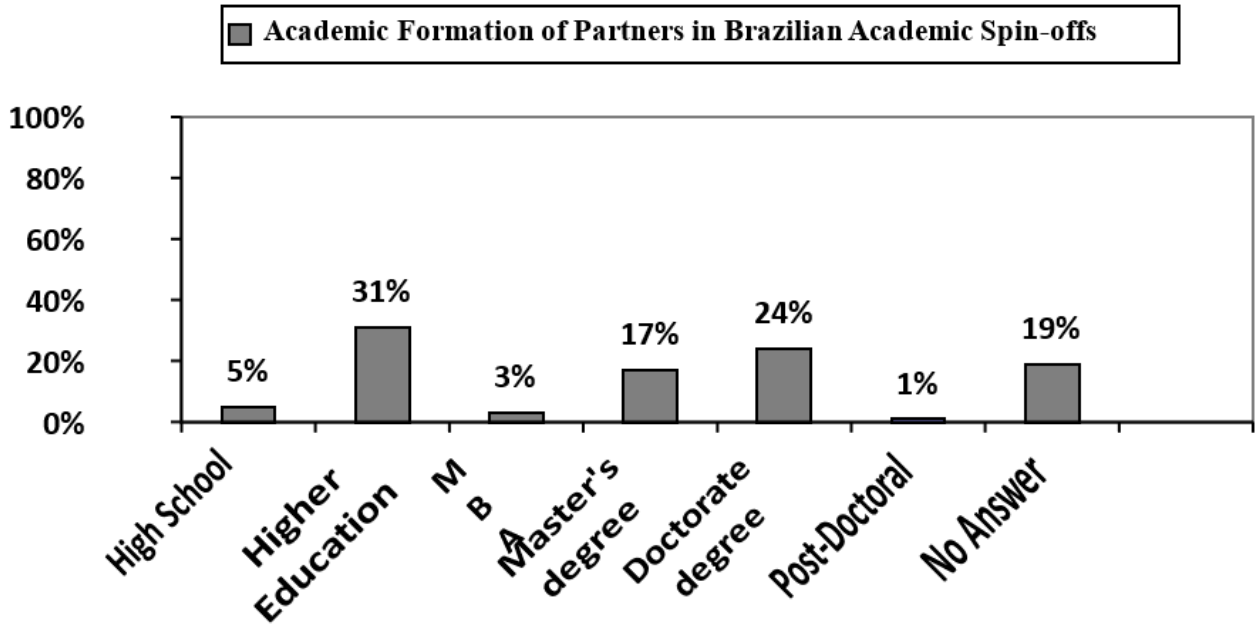

Figure 4. Academic Formation of Partners in Brazilian Academic Spin-offs
Source: Adapted from Costa and Torkomian (2008)

The survey showed a high degree of training of the partners in the surveyed spin-offs as a sample, 31% of the partners had some degree, 24% had a doctorate degree, 17% had a master's degree, 3% had an MBA degree, 5% had complete high school and 1% even had a postdoctoral course (COSTA; TORKOMIAN, 2008). The data collected reinforces the academic profile of most of the members of the national academic spin-offs, presents the possibility of how this mechanism enables university-business cooperation, but also reaffirms the importance of spin-offs as an impediment to "brain drain", since it creates demands that are able to absorb an extremely qualified workforce, such as, for example, doctors in specific areas of knowledge.

The most relevant point presented, as a great benefit of this technology transfer mechanism is the possibility of investment in technology that these startups develop.

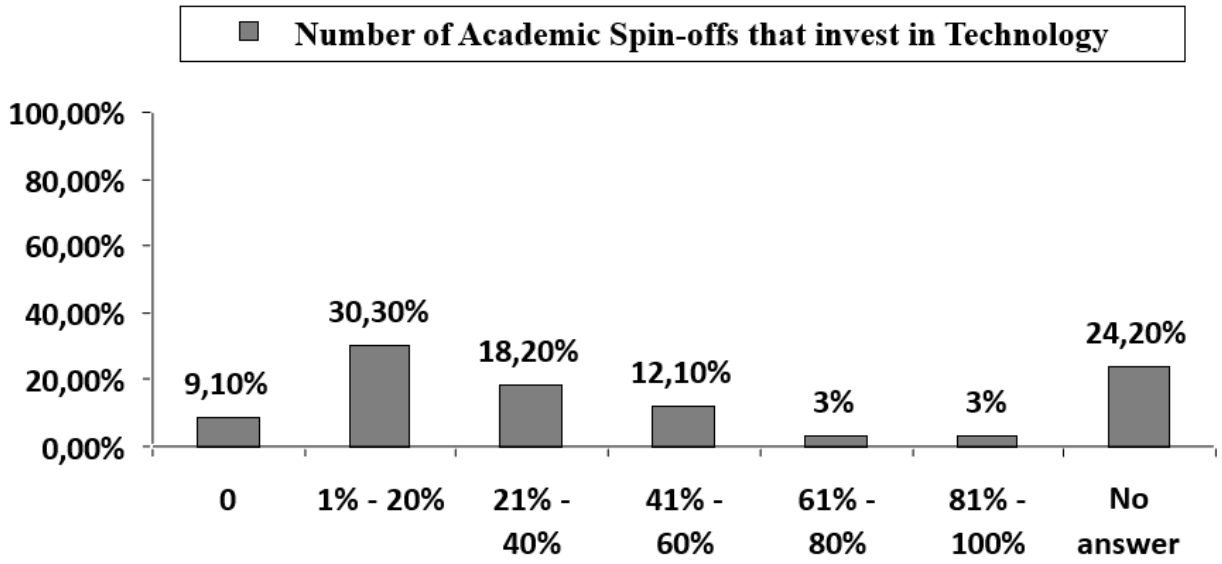

Figure 5. Number of Academic Spin-offs that invest in Technology
Source: Adapted from Costa and Torkomian (2008)

Based on the research developed by Costa and Torkomian (2008), 30.3% of the surveyed spin-offs invested from 1% to 20% of their billing in technologies, 18.2% invested from 21% to 40% of billing, 12 , 1% invested 41% to 60% of revenues, 3% invested from 61% to 80%, 3% invested from 81% to 100% in technology, while in 9.1% they did not invest in technology. The data are relevant because, in general, spin-offs have a concern with the development of technologies, which contributes to the creation of innovations and allows for the increase of the capacity to compete of these companies and the country as a whole.

Following the proposed analysis, produced by Santos et al. (2015) and titled as "Academic Spin-Offs and their importance in economic development", the second article analyzed brings more recent data and based on a research developed with 3 academic spin-offs originating from the Federal University of Minas Gerais and located in the Park Technological BH-Tec.
Regarding the objectives proposed by the research, Santos et al. (2015) present the contributions that the analyzed academic spin-offs produced and divide them into returns to society and returns to the mother university, as can be seen, later in this work.

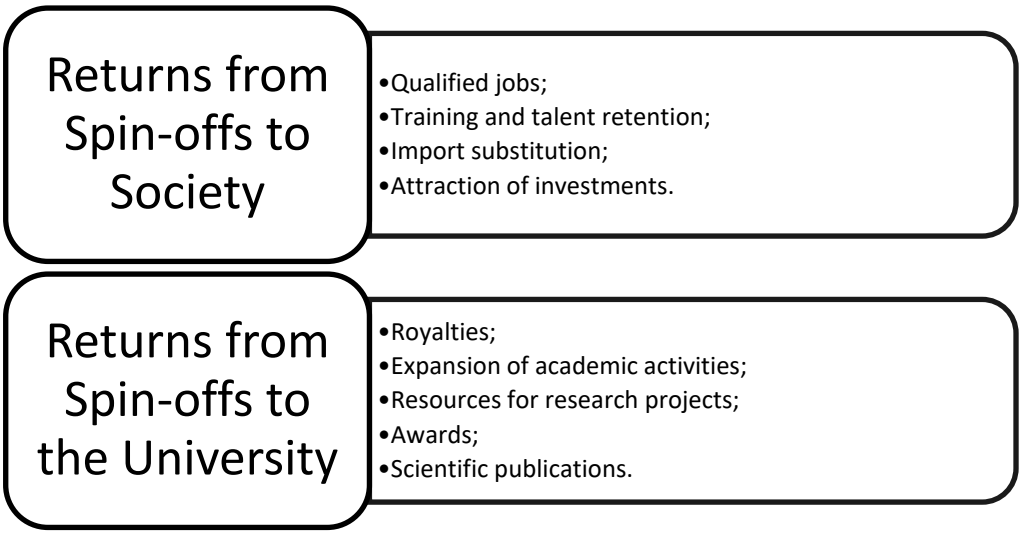

Figure 6. Returns generated by Academic Spin-offs for Society and Universities
Source: Source: Based on Santos et al. (2015)

Among the various returns that these academic startups have presented to society, the most relevant were the creation of jobs for qualified labor and the positive impact on the regional economy; academic spin-offs develop products capable of replacing imports and make it possible to attract investments to the regions where they are located. In turn, this mechanism allows returns to the university, ranging from the possibility of publishing academic papers and obtaining prizes to the payment of royalties that allow the expansion of academic activities due to greater resources at the university.

7. Conclusion

Based on what was discussed in this article, the importance of the innovation process is evident through the survey of companies that were born from University-Business cooperation in Brazil.

According to the proposed objective - which was to raise information for the contribution of the discussion on academic spin-offs, startups and the main advantages generated by the University-Company cooperation. Through the comparative study, we obtained as results the following statements: In the article dated 2008, where 33 spin-offs were raised from 9 Brazilian universities, one of the important points in the research was the location of these innovative mechanisms, the development of research and innovation in Brazil and the biggest highlight of Brazilian spin-offs is found in the Southeast and South regions of the country, followed by the Northeast and Midwest regions.

Another important point was the number of partners of these nascent companies in the Universities. Of the 100% surveyed, 31% of the partners had a degree and 24% had a doctoral degree.

A third point taken into account was the amount of investment by entrepreneurs, owners of nascent companies, in technology, where only 3% of respondents invested from 61% to 80%, 3% invested from 81% to 100% in technology, while in 9.1% did not make any investment in technologies.

In a fourth point - in the second article, we discussed the positive evidence brought by Spin-offs to Society and Universities, such as qualified jobs, talent training, actions to attract investments aimed at society and royalties, promotion for research projects and publications.

With all these benefits created by academic startups, it is necessary to draw attention to the benefits generated by cooperation on the University-Business axis. It is clear that, in the face of a multifaceted and competitive market, cooperation must come combined with the ethics of cooperation and with respect for the environment, with social equity and with the principle of otherness.

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PUBLIC GOVERNANCE FOCUSED ON INTELLECTUAL PROPERTY: A BIBLIOMETRIC ANALYSIS OF NATIONAL AND INTERNATIONAL SCIENTIFIC PUBLICATIONS

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Abstract

This study aims to investigate the main national and international theoretical contributions on Public Governance, with a focus on Intellectual Property. The methodology used involved exploratory analysis, based on bibliometric research. The data were collected through the Capes Periodical Portal, namely in the Scopus databases, consisting of a database of citations and neutral abstracts curated by independent sources of specialists in the subject. The obtained result indicated that the combination of the searched terms, "Public Governance" and "Intellectual Property", as a filter in all fields. As a result, it is observed that there are 15 countries more prominent in research on Public Governance and Intellectual Property, led by the USA, standing out with 22.5% of publications. Of the 13 (thirteen) largest areas of knowledge, it can be seen that the three largest areas represent 78% of the publications in the Scopus database. In relation to the largest universities found among the 15 (fifteen), potentially 3 (three) stand out with greater individual percentage representativeness in the publications on the theme of this research. Finally, it was identified that this research contributes to researchers and the scientific community in general, while allowing the reproduction of future research, using other bases, and thus increasing knowledge.

Keywords: Public Governance; Intellectual property; Bibliometrics.

1. Introduction

Unauthorized public action has high costs for its implementation, therefore, this situation compromises the confidence of the citizen in the public institution, as well as fosters bureaucracy and non-conformity, to avoid situations like these interfering, there is the practice of Governance (GUIA DA POLÍTICA OF PUBLIC GOVERNANCE, 2018).

Decree No. 9,203 of November 22, 2017, establishes that Public Governance involves the mechanisms of leadership, strategy and control adopted by the Public Administration to assess, direct and monitor how public policies and the provision of services of interest to the company are being conducted. society (BRAZIL, 2017).

Governance is considered a dynamic process through which public development takes place, through civil society, state and government, in which they organize and manage public life (PEREIRA, 2001, p.08).

With the proper Governance strategy, citizens' interests and needs will be more adequate and the expected results will have a more positive impact on society (BANCO MUNDIAL, 2017). Due to the variety of strategies associated with Public Governance, it can be deduced that many of them are aimed at improving efficiency in the management of public resources and towards greater economy and sustainability in the use of public resources (RIBEIRO et al., 2020).

Public managers need to seek to boost institutions, so that they can meet the demands for efficiency and effectiveness of services available to the population. Therefore, new measures must be taken in order to modernize management, in this sense, computerization takes on a prominent role as it makes the service more agile (SILVA, 2015).

In this sense, innovation involves the integration of administrative instruments and mechanisms aimed at providing better performance in economic and social relations, privileging the strengthening of government actions through the continuous improvement of the levels of effectiveness, efficiency and effectiveness of public policies, guaranteeing transparency of processes (RIBEIRO; OSCAR, 2017).

The incentive to stimulate innovation and to organize the innovation system, intellectual property emerges in the form of ideas and inventions, being the creative expression that institutions use to encourage technological advancement and the existing legal apparatus (CAMPOS; DENIG, 2011). And intellectual property assets considered as creations of the mind and fruits of knowledge, emerge as goods, which are necessary to ensure economic appropriation, based on an innovation effort, to guarantee and stimulate creativity, thus encouraging studies and scientific research in institutions (TEH; KAYO; KIMURA, 2008).

Given the above, the objective of this study was to analyze articles published on Public Governance and Intellectual Property in national and international journals.

2. Theoretical Foundation

2.1 Public Governance

Governance is of paramount importance to society, as it provides support to promote the economic development and well-being of the population. Therefore, with the use of good governance, it is possible to identify improvements in organizational performance, where conflicts are reduced and government action strategies are directed and aligned (BERLE; MEENS, 1932).

The system that determines the balance of power is Public Governance, since those involved are citizens, elected representatives, senior management, managers and employees, since they allow the common good to prevail over the interests of people or groups (MATIAS-PEREIRA , 2010).

Public Governance comprises the mechanisms of evaluation, direction and monitoring, and the interactions between structures, processes and traditions, which determine as citizens, according to the capacity that political and administrative systems have to act in order to bring solutions, thus resolving problems of a public nature (GRAHN; AMOS; PLUMPTRE, 2003).

In short, Public Governance is focused on a set of good practices that Public Administration entities must adopt, so that their objectives must ultimately be pursued, as in the end a quality service will be provided

to society, whose objective is it is based on delivering excellent public services to the population (BRASIL, 2014).

2.2 Public Governance focused on Intellectual Property

Public Governance is gaining more and more prominence on the world stage, considering that its good practices are essential for efficient administration, in this sense public governance is an essential and indispensable aspect for intellectual property to be better managed. In this context, the insertion of Intellectual Property as an important protection mechanism for intellectual creations, operating as an instrument for the dissemination of scientific knowledge (RIBEIRO, 2019).

National intellectual property policies are fundamental to the exercise of a unified government policy, as this has a greater chance of considering the needs of all sectors of society and deciding what is best for the country, and not only for a specific sector (PORTO; BARBOSA, 2009).

Intellectual Property plays a role in regulating the relationship between moral and patrimonial rights, thus treating the resource of the contemporary economy, knowledge, which has become balanced, as it considers society and public and private organizations (CARVALHO; VERAS, 2008).

For society, the benefits related to the use of Intellectual Property are the increase in employment and income in the public and private spheres, and for the nation, the results are the generation of its own technologies, providing independence in relation to other countries, in addition to development economic (RIBEIRO, 2019).

3. Methodology

This study will be carried out through exploratory, quantitative analysis using the bibliometric technique. Exploratory research has the mission of accessing greater familiarity with the problem, pointing to greater clarity and improvement of opinions or intuitive findings (GIL, 2017). In turn, quantitative research is differentiated by the use of quantification in the collection of information and treatment of data through statistical techniques (RICHARDSON, 2008).

Bibliometrics is known as a quantitative and statistical technique for measuring scientific production and dissemination rates, as well as following the increase in different scientific areas and the models of authorship, publication and use resulting from research.

(LOPES et al., 2012).

The data were collected through the Capes Periodical Portal, namely in the Scopus databases, consisting of a database of citations and neutral abstracts curated by independent sources of experts on the subject, providing powerful analysis tools in the hands of the researchers, provides more than 25,100 titles, from an average of 5,000 international publishers, offering a broad overview of world research in the areas of science, technology, medicine, social, science and arts and humanities (SCOPUS, 2020).

The search was carried out through the combination of the terms: “public governance” and “intellectual property”, covering a time period between the years 2004 to 2020, divided into three search stages, as shown in Chart 1.

Chart 1. *Scopus* Base Searches

Filter	*Scopus*	Publications found
Title	(TITLE ("public governance" AND TITLE ("intellectual property"))	0
Title, summary and keywords	(TITLE-ABS-KEY ("public governance") AND TITLE-ABS-KEY ("intellectual property"))	5
All fields	(ALL ("public governance") AND ALL ("intellectual property"))	166

Source: Prepared by the authors (2021).

The data were measured using the Excel Software, the variables were inserted in a database, allowing the construction of the graphs and the quantitative analysis of the results.

4. Analysis and discussion of results

In the combination of the searched terms, "Public Governance", "Intellectual Property", using as a filter (title, abstract and keywords), resulted in the quantity of 05 (five) documents published in scientific journals, indexed in the Scopus databases. Listed in Box 2, highlighting the need for more research focused on this joint theme.

Chart 2. Synthesis of the 5 (five) articles found in the Scopus database

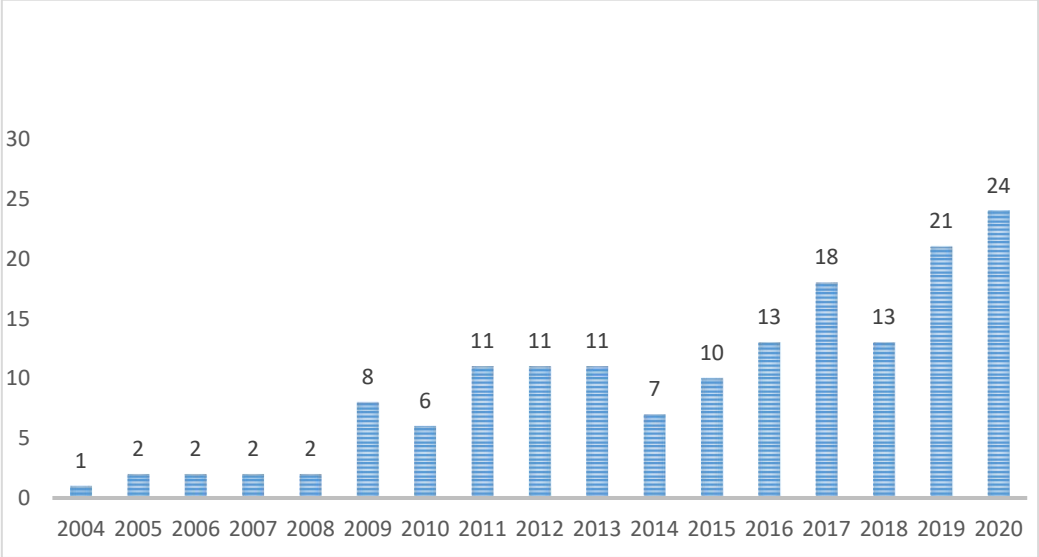
	Authors / Year	Title	Objective	Affiliation	Parents
1	RIBEIRO,P.G;ISHIKAWA,G.; LIMA; I.A.; RASOTO, V.I. (2020)	Application of public governance practices in public universities technological innovation centers	Analyze how Public Governance practices are adopted to manage Intellectual Property	Federal Technological University of Paraná	Brazil
2	MULLIGAN, D.K., BAMBERGER, K.A. (2018)	Saving governance-by-design Mulligan	Detail a framework to save governance by design. Through four case studies, the article examines a series of recent battles over the values embodied in technology design and makes us enter an era of "design war" policymaking	University of California	EUA

3	MONTES, J. (2018)	Risks and regulation of emerging technologies in chaotic and uncertain times the case of 3D printing.	Explain how the scope, scale and speed of emerging technologies (ETs) affect the Public Risk Governance (approaches, structure and tools). It also discusses the main implications of regulating the uncertainty of 3DP, also known as additive manufacturing (AM).	Université du Québec à Montréal	Canada
4	VIDAL, N.H. (2018)	Territorializando STS: an analysis of current discussions about agro-biotechnology governance in Latin America, Europe, and the USA.	Examine current discussions on the governance of agro biotechnology in Latin America, Europe and the USA, based on a comparative reading of critical scholarships on the topic	Loyola University of Chicago	EUA
5	ZAHRA, S.A. (2014)	Public and Corporate Governance and Young Global Entrepreneurial Firms	Analyze two key layers of governance (public and corporate) and how they interact to influence young global entrepreneurial companies, especially those "born global" companies that enter foreign markets from the beginning (for example, internet companies) or shortly after their establishment, also known as first internationalizers	University of Minnesota Twin Cities	EUA

Source: Prepared by the authors (2021).

The combination of the terms searched, "Public Governance", "Intellectual Property", as a filter in all fields, showed a total of 166 documents published in scientific journals, indexed in the Scopus databases. The data represented in the Figures below illustrate the panorama of this research, through the analysis of the variables: year of publication, countries, area of knowledge and universities.

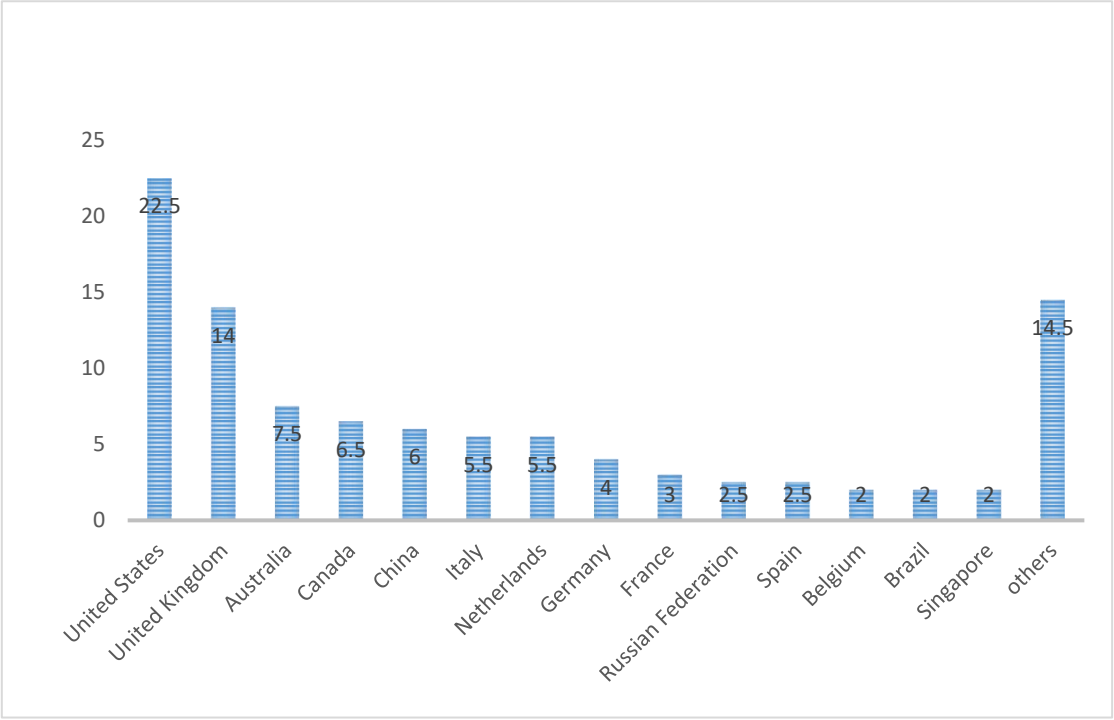
Figure 1. Distribution of publications by year in the Scopus database



Source: Adapted by the authors of the database of the Scopus database (2021).

In the evolution of publications by year, Figure 1 shows the period between 2004 and 2020, with 166 documents found in the SCOPUS database. It is interesting to note that the beginning of research on this theme coincides with the year 2004, when the COSO (Committee of Sponsoring Organizations of the Treadway Commission) published the Corporate Risk Management - Integrated Framework (document) today it is considered a reference in the theme of Governance (TCU, 2014).

Figure 2. Percentage distribution of publications by countries in the Scopus database

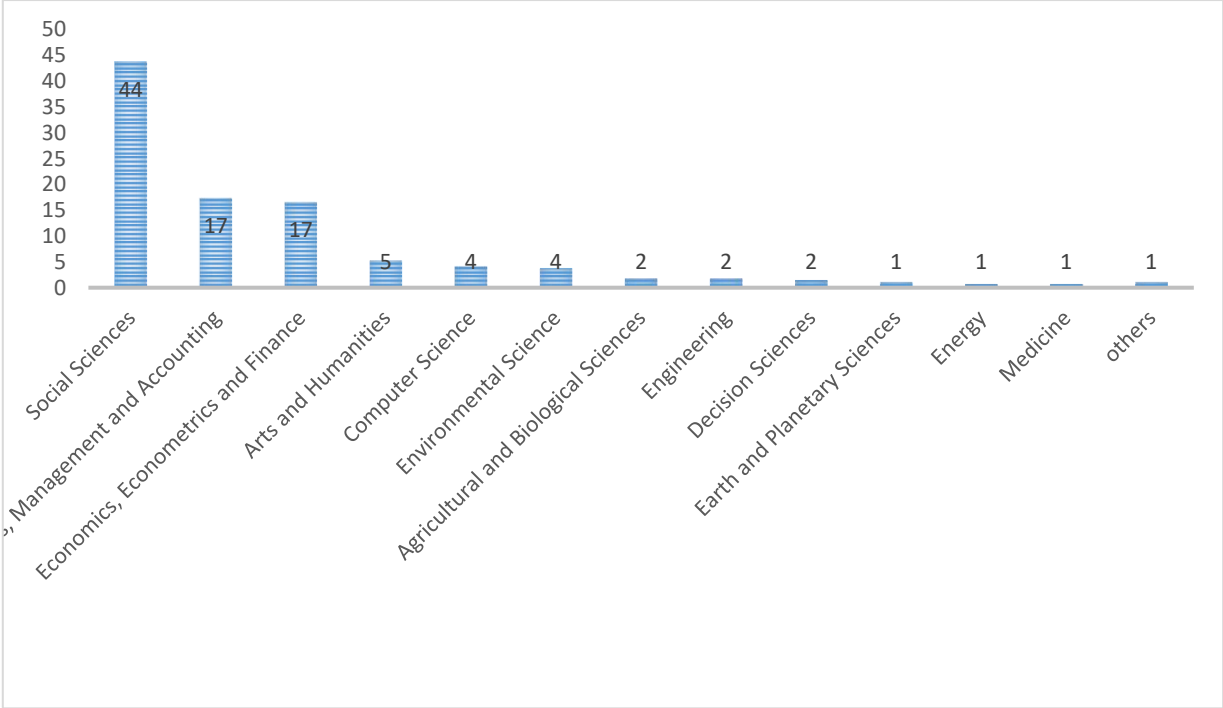


Source: Adapted from the database of the Scopus database (2021).

With regard to the distribution of publications by countries, Figure 2 presents the 15 most prominent countries in research on Public Governance and Intellectual Property. The USA, preliminarily stands out with 22.5% of the publications in relation to the other countries. In sequence with 45% of the other publications, there is the joint block of countries from: United Kingdom, Australia, Canada, China, Italy and the Netherlands. Finally, with a share of 32.5%, Germany, France, Russia, Spain, Belgium, Brazil, Singapore and others are included. The Brazilian presence among the 15 most relevant countries, highlights the efforts of national researchers as promoters of the national and international scientific base in the area of Public Governance and Intellectual Property.

It is interesting to point out that the beginning of research on this theme, previously merges with the foundation of the European Corporate Governance Institute - ECGI in 2002, aiming to support independent research, leading to improved governance, after scandals in the USA, in the mid 2000s. , involving fraud in the financial statements (TCU, 2014).

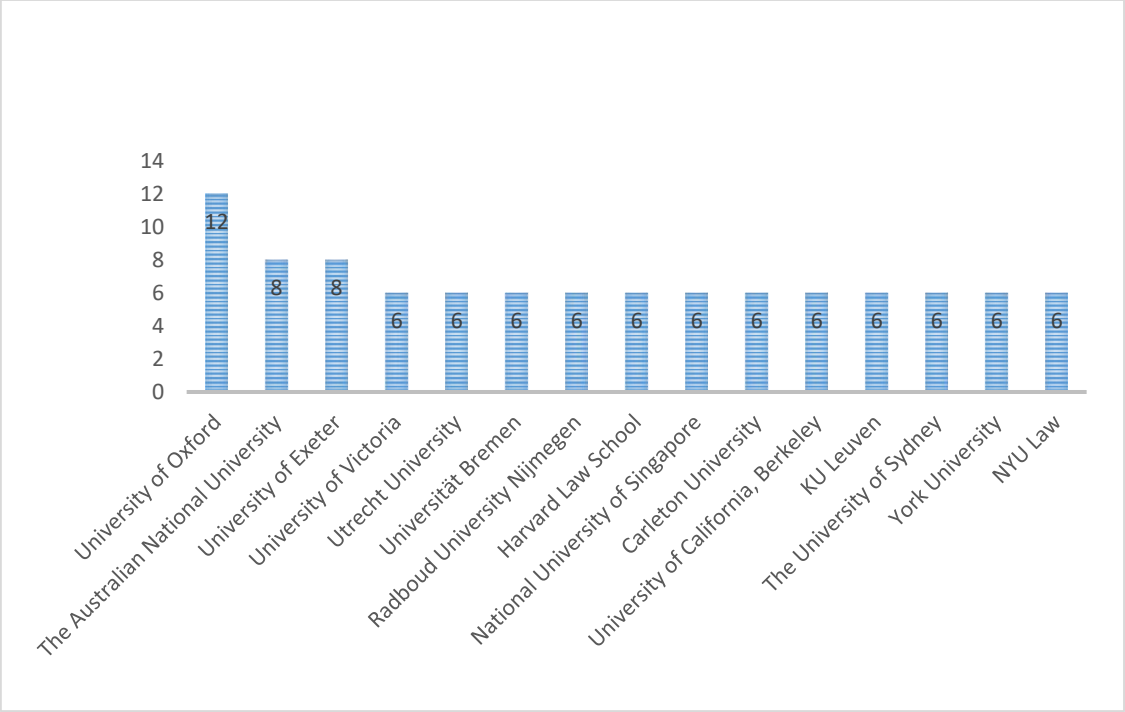
Figure 3. Percentage distribution of publications by area of knowledge in the Scopus database



Source: Adapted from the database of the Scopus database (2021).

Regarding the percentage classification of publications in the 13 largest areas of knowledge, Figure 3 highlights the preliminary highlight for the three largest areas that represent 78% of the publications in the Scopus database: social sciences; business, management and accounting; Economics, Econometrics and Finance.

Figure 4. Percentage distribution of publications by Universities in the Scopus database



Source: Adapted from the database of the Scopus database (2021).

In Figure 4, in the Scopus base, among the 15 (fifteen) universities found, potentially 3 (three) stand out with greater individual percentage representation in the publications of the theme of this research, found in the Scopus base, namely: Oxford University with 12 %; Australian National University and the University of Exeter both with an individual percentage of 8%.

5. Conclusion

The importance of Public Governance and Intellectual Property is the theme that guides all this work of bibliometric survey. It appears that this research relied on the use of a structured process for mapping relevant articles on the topic of interest to the researcher, in the case of the present study of public governance with a focus on intellectual property, it was possible to identify the main characteristics of the bibliographic portfolio .

This study, using the search instrument, was collected through the Capes Journal Portal, namely in the Scopus databases, consisting of a database of citations and neutral abstracts curated by independent sources of specialists in the subject, made possible the verification of: (a) the combination of the searched terms, "Public Governance", "Intellectual Property", as a filter in all fields, showed a total of 166 documents published in scientific journals, indexed in the Scopus databases; (b) the selection of a representative bibliographic portfolio on public governance and intellectual property; (c) a bibliometric analysis of the selected articles and their references in order to identify the year of publication, countries, areas of knowledge and universities.

With this knowledge built throughout the research, it becomes possible to identify that: Regarding the publications by year, it can be observed that in the period between 2004 and 2020, a total of 166 documents found in the SCOPUS database.

Regarding the distribution of publications by countries, it is observed that there are 15 countries more prominent in research on Public Governance and Intellectual Property. The USA stands out with 22.5% of the publications, followed by 45% of the other publications, there is the joint bloc of the countries of the United Kingdom, Australia, Canada, China, Italy and the Netherlands. And finally, with 32.5%, there are Germany, France, Russia, Spain, Belgium, Brazil, Singapore and others.

Regarding the percentage classification of publications in the 13 largest areas of knowledge, it is observed that the three largest areas that represent 78% of the publications in the Scopus database: social sciences; business, management and accounting; Economics, Econometrics and Finance

Finally, in relation to the largest universities found among the 15 (fifteen), potentially 3 (three) stand out with greater individual percentage representation in the publications on the theme of this research, found in the Scopus database, namely: Oxford University with 12%; Australian National University and the University of Exeter both with an individual percentage of 8%.

This study proved to be relevant, despite knowing that all research has limitations, as it presents the mapping of articles available only in the databases of the Capes Journal Portal, even so, it is believed that the knowledge produced during the investigation , by presenting a structured bibliometric process to search for representative scientific articles, it contributes to researchers and the scientific community in general, while allowing the reproduction of future research, using other bases, and thus increasing knowledge.

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E-learning in a pandemic era: Exploring the digital gaps and needs of rural secondary schools and remote communities across 6 Nigerian states.

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Abstract

The COVID-19 pandemic contributed to a digital economy transition by emphasizing the importance of digital infrastructure while exposing the digital gaps between countries and communities. Inequalities in digital access has impeded educational gains made towards achieving the sustainable development goals. While major studies have been carried out on digital learning there is currently a dearth of knowledge on the digital gaps and needs of students in remote communities in Nigeria. To this end, this study explored the digital gaps and needs of rural secondary schools in remote communities and its implications on e-learning across 6 Nigerian states during the COVID-19 era. The study adopted a concurrent embedded mixed method design approach to collect data from rural secondary schools from 6 Nigerian states. Findings from the study identified lack of ICT strategies and policies in Nigeria, socio-economic status, poor internet connectivity, electricity, and a high poverty level as the major drivers of digital gaps in remote communities.

Keywords: COVID-19; digital gaps; digital needs, e-learning; remote communities

1. Introduction

Globally, access to ICTs and digital literacy which is very vital to knowledge empowerment, information generation and utilization is unequally distributed both in terms of access to digital tools and infrastructure (Ifijeh, Iwu-James, Adebayo 2016). The role of information and communication technologies (ICTs) in information generation, processing and use in the 21st century cannot be over emphasized. Global economy thrives on digital innovation which to a large extent leads to advancement in sustainable development. Thus, sustainable development remains a mirage in any country whose citizens cannot effectively and efficiently deploy the use of ICTs to access and utilize quality information (Ifijeh et al 2016). Although Asia has the highest number of people without access, Africa leads the world in the percentage of the population without connection at 88 percent. The 'digital divide' we face globally does not just signify those who have access to the internet and those who do not, the gap also encompasses a number of other discrepancies, including the quality of digital infrastructure in rural communities, the speed of connectivity in remote areas, and the training and skills required to navigate such technology. The digital divide is a complex and dynamic phenomenon, though despite the extensive studies on the digital divide and its impact by many researchers, developing countries in particular, are still searching for sustainable solutions to reduce the digital gap, more specially between urban and rural areas, to leverage their investments in Information Technology (IT) towards the attainment of greater economic and social benefits and increase global competitiveness (Anwarul & Keita, 2010).

A lack of access to the Internet is a major element of the digital divide. Research consistently identifies ethnicity, income, age and education as significant predictors of access to technology, (France and Lemuria, 2006). While all 54 African nations are said to have internet connectivity (Jensen, 2002), a paltry ten percent of the continent's 1.216 billion citizens has access to online activities even though 70 percent of sub-Saharan Africa's inhabitants are mobile phone subscribers (GSMA, 2017). While 48% of Nigerians had an Internet connection in 2011, only 10% from the above figure are connected in rural areas, (Bell, Reddy & Rainie 2014). The majority of children from poorer socioeconomic backgrounds tend to have limited access to internet connectivity, computers, smartphones, functional ICT skills and active parental support. Undoubtedly, exploring digital gaps most significantly in a pandemic context has gained the interest of field experts and development practitioners.

Although COVID19 is a health crisis, the ripple effect on education was unprecedented. According to UNESCO (2020), the closure of schools as a measure to contain the spread of the virus affected 39,440,016 primary and secondary school learners across Nigeria, this population includes those in internally displaced camps (IDPs). School closures at first led to a perceived proliferation of online learning but study shows that the efforts made by the federal and state government to ensure that learning continues for every child has not fulfilled the set objectives. According to UNICEF, the share of students who cannot be reached by digital and broadcast remote learning policies is the highest in the countries of Sub-Saharan Africa: at least 48 per cent in West and Central Africa and 49 per cent in Eastern and Southern Africa. Unanimously, OECD report stated that although many countries have been using digital pedagogical tools and virtual

exchanges between students and their teachers, and among students, to deliver education as schools closed, vulnerable students might however have little access to such tools and require further attention and support. In Nigeria, the TEP Centre (2020) study revealed that more than 70 per cent 34 million children who were out of school due to nationwide school closure at the peak of COVID19 do not have access to basic digital devices. Similarly, not all teachers have the technical capacity required to facilitate eLearning with competence varying across rural and urban locations.

In light of the above, this study is therefore set to explore the digital gaps and needs of rural secondary schools and remote communities across 6 Nigerian states using the New psychological model of e-adoption within the context of the digital divide framework. The study seeks to answer certain research questions as discussed below.

1.1 Research questions

1. What were the causes of digital gaps in rural secondary schools and remote communities across 6 Nigerian states?
2. What are the digital needs of rural secondary schools and remote communities across 6 Nigerian states?
3. What was the effect of digital gaps on e-learning in rural secondary school and remote communities across 6 Nigerian states during the Covid19 pandemic?

This study is divided into five sections. Section one above describes the background, study rationale and research questions. Section two addresses the review of the literature on digital gaps and the theoretical framework situated within Bourdieu's theory of social and cultural re production. Section three discusses the data and methods employed in this study, section four covers the findings, and section five talked about the conclusion and recommendation

2. Literature Review

According to Rozina (2002), modern achievements in the field of computer and communication technologies have offered tremendous opportunities for learning by electronic means. Additionally, with ongoing innovation in the adoption of new multimedia technologies and the internet, learning is seen as a means to improve efficiency, accessibility and quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration.

Hedge and Haywood (2004) defined eLearning as an innovative approach for delivering electronically mediated well-designed, learner centred and interactive learning environments to anyone, any place, any time by utilizing the internet and digital technologies in line with instructional design principles. Parks (2013) posits that the word "e" should refer to "everything, everyone, engaging and easy" in addition to electronic. Modern societies especially, the developed nations use e-learning to extend educational advantages to communities that were erstwhile excluded from it due to the triple problem of time, distance and cost.

E-learning has become a new paradigm for bridging the educational gap within and across societies. Although, the concept of e-learning is considered to be very attractive as a new learning paradigm with positive effect on the development of education in developing countries. Amongst the many positive effects are that it is less expensive to deliver, self-paced, provides consistent content, faster and works anywhere and anytime for the learning. E-learning can improve retention, provide immediate feed-back and allows learners to customize learning materials to meet their individual needs. However, despite the benefits of e-learning not much effort has been taken for its full implementation in Nigeria (Nwegbu, 2011). E-learning when fully implemented in Nigeria educational system will change the concept of digital divide to digital opportunities.

The Term "digital divide" emerged in the 21st century due to innovations in information and communication technology. It is used to define inequality in access to and use of telecommunication infrastructure by citizens to solve personal and societal problems. OECD (2001) defined it as the gap between individuals, households, businesses and geographical areas at different socio-economic levels with regard to their opportunities to access information and communication technology and to their use of the internet for a variety of purposes. These unequal access to ICT is determined by social and physical barriers, from never having seen a computer to absence of electricity infrastructure and cost of internet connectivity. Drori (2010) observed that the causes of the global digital divide depend on income or wealth differential, the complex array of economic, political and socio-cultural matters. Globally, many countries which incidentally are geographically located in Europe, North America and parts of Asia are highly industrialized with an edge in modern Science and Technology, stable governments, have more access to the internet than the countries of the South much of which are poor, emerging democracies and have not shown much improvement on most fronts of development (Ogunsola & Okusaga, 2006). At the national level, the digital divide follows the lines of gender, wealth, education, race, minority designation whereas between countries, it follows the lines of national wealth, literacy and democracy. Though efforts are being made to address the problem of digital divide, it still exists and it particularly affects older people, those with lower levels of education, those with lower income and those who live in geographically remote areas where infrastructure coverage is low. attempt to solve the problem of the digital divide, been the second phase of the World Summit on the Information Society (WSIS) organized by the United Nations Summit in Tunisia as an attempt to solve the problem of the digital divide

The implications of the digital divide are not limited to whether or not individuals have or do not have access to technology. As the 21st century unfolds, having access and being able to use the new technologies also mean being an integral part of society (Shelly, 2006). People with limited access will be out paced by those who are ahead in the ability to select and process information. This was buttressed by Wong (2009) who stated that digital exclusion has become a new form of social exclusion.

2.1 Digital divide and E-learning in Nigeria

Following the outbreak of the COVID-19 pandemic, educational systems transitioned into new methods of learning aided by the internet but children in rural and underserved communities in Nigeria were mainly

left out of this digital transition Amorighoye (2020). Research from the TEP Centre (2020) shows a sizable proportion (28%) of teachers reported that their students were not actively learning during the pandemic as a result of inaccessibility of digital tools for learning.

According to the International Telecommunication Union, internet penetration in Nigeria stands at 42%, implying that more than half of the population are not connected to the Internet, and even fewer if the consideration of multiple devices used by Nigerians is factored in. On the other hand, mobile adoption in Nigeria shows great potential which can also be harnessed for learning (International Telecommunication Union (ITU), 2019b). In Nigeria, the majority of the population with internet access are from richer socioeconomic and urban households who can afford private school education, thereby giving their children a learning advantage over their public-school counterparts (Obiakor & Adeniran, 2020). Children from poorer socioeconomic backgrounds tend to have limited access to internet connectivity, computers, mobile phones, functional ICT skills and active parental support. Moreover, they dwell in rural areas where local languages are dominant and could limit the uptake of ICT-learning. The inequity in access to ICT-based learning has the adverse effect of further intensifying the existing disparities in learning outcomes along socioeconomic and geographic (urban-rural) lines (United Nations, 2020; Rubagiza, Were and Sutherland, 2011; Furuholt, and Kristiansen, 2007). Studies from other African countries confirm these existing divides. In South Africa, students in private or high-fee paying institutions were more proficient in the use of ICT in their learning than their counterparts in public institutions (Gudmundsdottir, 2010). A study by EdQual on the use of ICTs in Rwandan schools, showed how ICT policy initiatives could tend to exclude those in rural areas. Urban schools had more computers, internet, electricity supply and ICT equipment (Rubagiza, Were and Sutherland, 2011). Chair and De Lannoy's (2018) study of Nigeria, Tanzania and Rwanda showed that young people, especially in rural areas, were deprived of internet resources due to low-level of education, low income and lack of digital skills.

As the pandemic led to school closure and forced many children across the world and in Nigeria to learn at home, it is important to understand if children in remote communities accessed learning remotely. This study explored the digital gaps and needs of rural secondary schools in remote communities and its implications on e-learning across 6 Nigerian states during the COVID 19 era.

3. Research Methodology

3.1 Study design

The study adopted a concurrent embedded mixed method design. This is a type of design, were quantitative and qualitative data are analysed at the same time because the quantitative data alone would not be sufficient to answer the research question (Creswell, 2011).

3.2 Study site

This study was conducted in Government-owned secondary schools in 24 communities across the 6 Geopolitical zones in Nigeria

3.3 Data

The Data for this study was obtained from a Foreign Commonwealth and Development Office funded survey conducted by the Aid for Rural Education Access initiative between January 2021- February 2021. The survey sampled 90 respondents from 24 communities in the 6 geopolitical zones of Nigeria. The study used both closed and open-ended questions, to elicit information from students. Informed consent was gotten from each student, and for participants below 18, an assent was gotten before proceeding with the interview.

3.3.1 Sample size determination

3.3.2 Qualitative data

A total of 20 eligible respondents who consent to voluntarily participate in the study were interviewed for the study. As saturation was attained with these numbers (i.e where no new themes emerged).

3.3.3 Quantitative data

A purposive sampling technique was adopted to select a total of 70 participants from 24 rural communities.

3.4 Method for Data Collection

3.4.1 Qualitative data collection

Qualitative data were collected using an in-depth interview guide. All interviews were conducted in English language, the interviews were semi-structured in accordance with the topic guide and included open-ended questions as well as "probe" questions. The IDI guide was used to elicit information on the effect of digital gaps on e-learning in rural secondary schools during the Covid19 pandemic.

3.4.2 Quantitative data collection

A validated, semi-structured self-administered questionnaire was used for data collection. It comprised three sections which were section A: Sociodemographic of respondents, section B: Assessing the level of digital gaps in rural secondary schools, section C- identifying the digital needs of rural secondary schools

3.5 Inclusion criteria and exclusion criteria

3.5.1 Inclusion criteria

The following group of participants were recruited for the study:

- Secondary Students who were between the ages of 16 and above
- Students attending a rural Govt school
- Students who consented to participate in the study.

3.5.2 Exclusion criteria

The following group of students were excluded from the study:

- Students who did not consent to participate in the study
- Students that could not speak English Language

3.6 Data analysis

Data analysis Questionnaires were sorted, collated, serially numbered, and imputed into the computer. Descriptive analysis was done using the Statistical Package for Social Sciences (SPSS) 26 software version Data was cleaned and Descriptive statistics such as frequency, means and standard deviation was carried out.

In analysing the qualitative data, the rigour of the study was ensured by keeping a note of the audit trail on all decisions that were made during the study. Inter-coder reliability was done by involving two or more independent coders using the same coding scheme and then allowing the extent to which they agree on the coding influence the analysis. Using these codes, we then searched for patterns/themes across the qualitative responses and defined them within the context of the theoretical framework. Questions on reflexivity which included reflection on assumptions and preconceptions were considered and stated.

Finally, there was triangulation of both qualitative and quantitative data by gathering using different sources of information in order to increase the validity of the study

4 Results and Discussion

4.1 Socio-demographics of Participants

The study showed the average age of respondents was 17.5 ± 1.5 years with the minimum age being 14 years and the maximum age being 21 years. Majority (89.9%) were within the age group of 15–19 years with a little over half of the respondents being females (52.9%). More than half of the respondents were in SS3 (67.7%) and Christians (62.3%) with a little above one quarter of the participants being Hausa (30.4%).

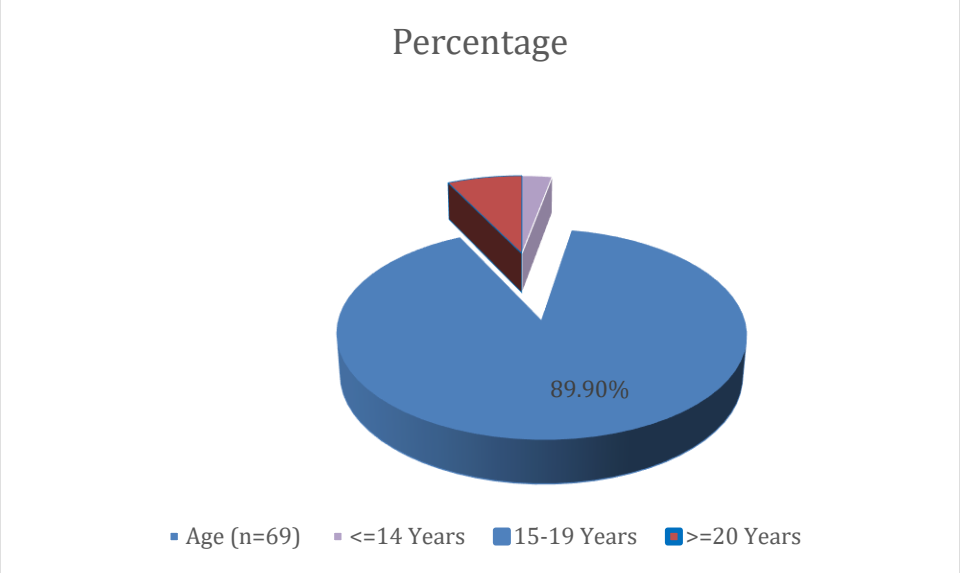

Figure 1. Age of Participants

Table 1: Socio-Demographic Variables

Demographics		Frequency	Percentage (%)
Sex (n=68)	Male	32	47.1

	Female	36	52.9
Religion (n=69)	Christian	43	62.3
	Muslim	26	37.7
Ethnicity	Igbo	1	17.4
(n=69)	Hausa	21	30.4
	Bayelsa	17	24.6
	Fulani	19	27.5
Class (n= 62)	Jss3	5	8.1
	SS2	15	24.2
	SS3	42	67.7
States (n=69)	Kano	20	29.0
	Adamawa	19	27.5
	Bayelsa	20	29.0
	Ebonyi	10	14.5

4.2 Assessing the level of digital gaps in rural secondary schools

Figure 2 showed the level of digital gaps in rural secondary school. A higher proportion (63.1%) of students reported that they do not have access to digital learning tools prior to the pandemic. Majority (61.1%) did not have access to a phone, 84.1% did not have access to a laptop, and 75.4% did not have access to the internet. More than half (53.8%) of the students did not have access to a radio and 66.7% did not have access to a television. Slightly over half (50.8%) of the participants reported that they had their learning disrupted during the school closure. As shown in the figure above, the majority (82.5%) of students that learnt during the pandemic did not have access to any school online management learning system as while 70.7% of the students stated that they did not have access to any radio or television program provided by the Government.

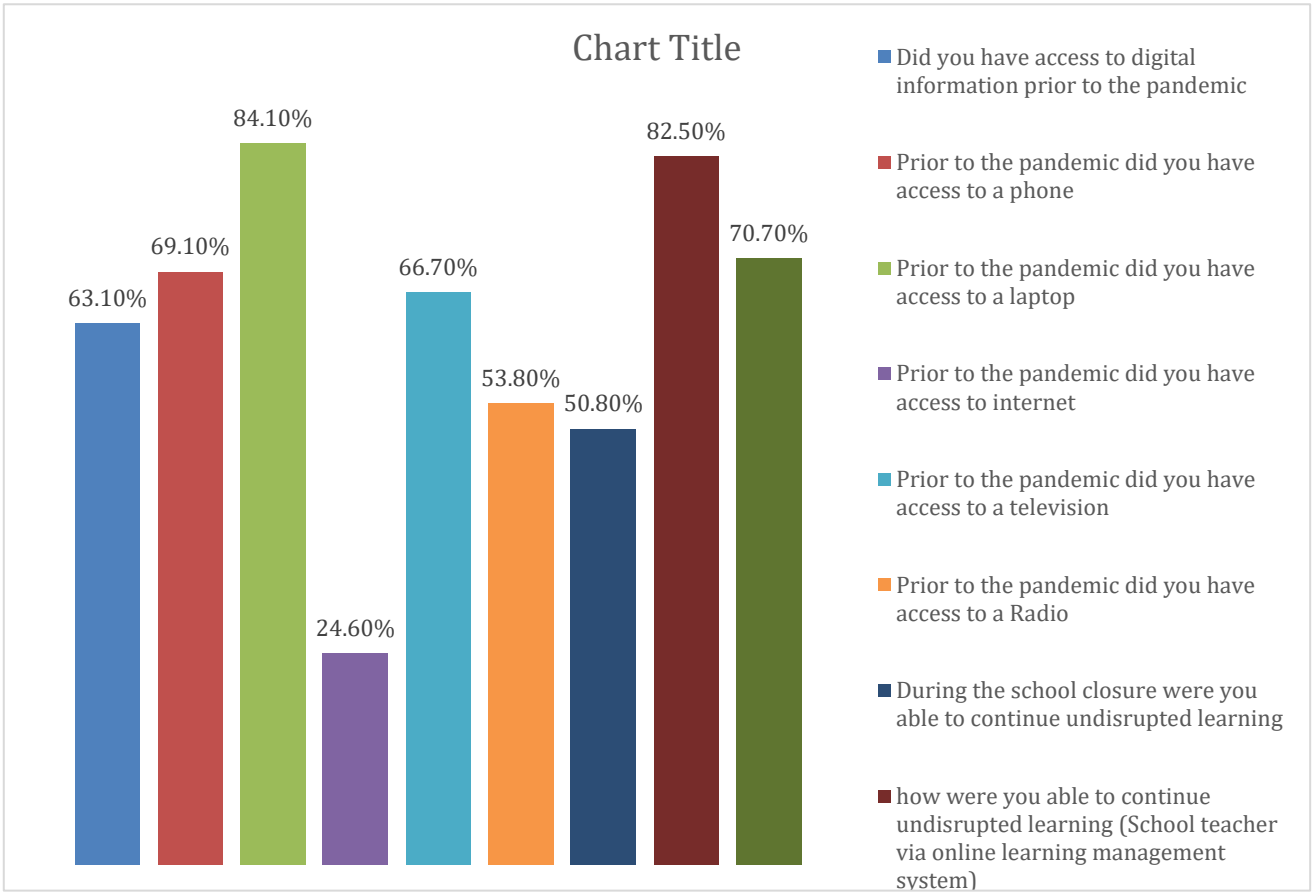

Figure 2. Assessing the level of digital gaps in rural secondary schools

4.3 Identifying the digital needs of rural secondary schools

In identifying the digital needs of secondary school students in rural communities, questions relating to the reasons why students could not participate in the digital learning intervention provided by the government, major factors that impeded their learning and strategies to improve digital learning in their communities were asked.

Finding from the study found that More than Half (54.2%) of the participants were not aware of learning intervention provided by the Govt and for the few (45.8%) that were aware of the programme, majority (71.6%) did not learn via the radio and television programme with a little above half (51%) attributing lack of time as the reason, with a high percentage (74.1%) stating cost and preference for face-to face learning (61.4%)

Table 2: Identifying the digital needs of Rural secondary school students

Reasons for not learning via the Govt digital learning intervention	Freq(%)
During the lockdown did you know about the radio and television programme provided by the Govt	
Yes	27(45.8)
No	32(54.2)
Did you learn via the radio and television programme provided by the Govt?	

Yes	19(28.4)
No	48(71.6)
What were the reasons why you could not participate in the virtual learning provided (Cost)	
Yes	40(74.1)
No	14(25.9)
What were the reasons why you could not participate in the virtual learning provided (preference for face to face teaching)	
Yes	27(61.4)
No	17(38.6)

4.4 Factors Impeding access to digital learning among students

The reported factors impeding digital learning among students were lack of technical knowhow (78%), financial constraints (84.1%), preference for face-to-face learning (72.9%), electricity (85.3%), access to digital learning tools (73%), and cost (88.2%). Only few students stated factors such as internet connectivity (24.2%), and lack of parental support (49%) as a factor impeding their digital learning.

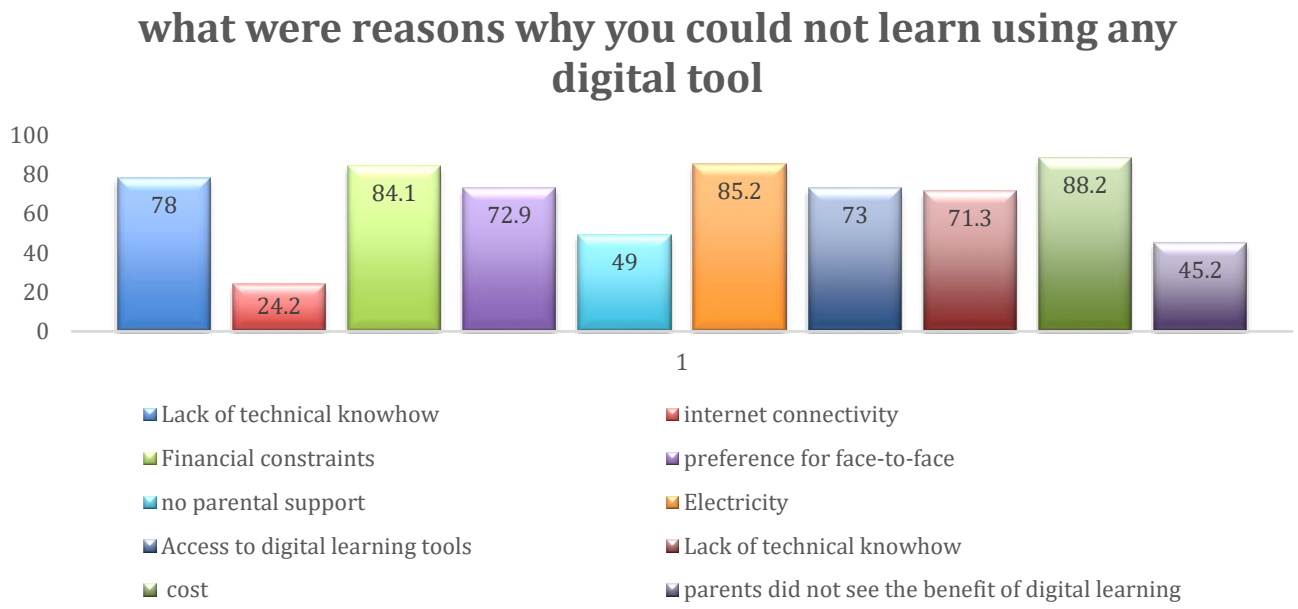

Figure 3. Factors Impeding access to digital learning among students

4.5 Strategies to promote digital inclusion in schools

From table 3, almost all (95.1%) of the students agreed that access to digital information and improve their digital literacy skills. Furthermore, 97.1% of the students suggested the need for having Information and communication technology related subjects in schools. Majority (69.6%) of the students cannot afford the cost of using digital learning tools while 87% are of the opinion that there is a need for a school-based ICT centre. All students mentioned the need for an ICT teacher, with (98.5%) opining the need for students

training on ICT. A higher percentage of students (84.8%) and (93.8%), preferred provision of Phones access to internet connectivity.

Table 3. Strategies to promote digital inclusion in schools

Strategies to promote digital inclusion	Freq(%)
Do you think access to digital information can improve your digital literacy skills	
Yes	58(95.1)
No	3(4.9)
Do you have interest in taking an ICT related subjects if provided	
Yes	66(97.1)
No	2(2.9)
Can you afford the cost of using digital tool for learning	
Yes	21(30.4)
No	48(69.6)
Do you think your school can maintain a school-based ICT centre if provided	
Yes	60(87)
No	9(13)
How do you think the govt can promote digital inclusion in your school (provision of computer)	
Yes	39(59.1)
No	27(40.9)
How do you think the govt can promote digital inclusion in your school (provision of phones)	
Yes	56(84.8)
No	10(15.2)
How do you think the govt can promote digital inclusion in your school (Training of students in ICT)	
Yes	66(98.5)
No	1(1.5)
How do you think the govt can promote digital inclusion in your school (Recruitment and training of qualified teachers)	
Yes	66(100)
No	0

How do you think the govt can promote digital inclusion in your school (Access to internet connectivity)	
Yes	61(93.8)
No	4(6.2)

4.6 Assessing the effect of digital gaps on e-learning in rural secondary schools during the Covid19 pandemic

Majority of the participants had a low level of readiness to e-learning which was largely due to the perceived benefit of digital learning, poor knowledge and low level of awareness of digital learning tools. Almost all students stated that lack of digital devices and infrastructure because of cost and low level of Government support hindered school-based digital support and interventions. All participants reported learning losses, disruption in school timetable and how the long-time school closure could further strengthen the existing systemic barriers to education.

"Even before the lockdown, I had no access to phone, internet. Dont know how to use Google classroom,zoom or WhatsApp" - Female, South West.

"Although teachers have whatsapp group to communicate with one another they did not share this group with us. In fact, we did not have any online lesson, the purpose of not having this online lesson is because we are not in a private school. Schools like REOMICHS had online lessons our teachers were saying there was whatsapp group this whatsapp group cannot help us because if it was that we had a website and all of us can go to that website. The website will show all the subjects that we have and we can learn from it. But having a facebook or whatsapp group cannot help us" - Male, SS3,North Central

"Because of the lockdown we had to just go home and when we resumed there were things we could not recollect, and they had to start all over again" - Female 17,North Central

"yes, because one of the challenges is the teachers are no longer teaching us, I am on my own. the challenges I am even confused whenever I carry my book, I cannot be able to understand everything but with the help of the teachers I can understand it very well" - Female, SS3, South East

"Number 1, learning on my own was boring because if I was learning online, it will not be only me.And two again I might not be able to be exposed to some pictures about the things I might be reading and this pictures and videos will be able to help me" - Male SS2, North Central

"The problem is that in our area now there is no light where we can charge it, that is the problem, and the money for internet we don't even have the money to buy it" - Female SS2, North West

"*Some were learning through radio but as for me I don't have radio, I usually go to my friend's house to learn with them because when lesson will be going on the radio, there are some certain things that you need to jot down in order for you not to forget it the next time but they usually rush the lesson we cannot understand as we should" - Female, SS3*

"Some are hairdressers, the other people I don't know what they are doing because I have not set my eyes on them" - Student, South East Nigeria

5. Conclusion and Recommendations

This study presents findings detailing the various challenges experienced by secondary school students in rural Nigeria in accessing e-learning opportunities during the COVID19 pandemic. We revealed specific contextual factors that exacerbate the digital gaps for students in rural communities as lack of digital awareness, financial constraints, poor internet connection, poor parental support, unstable power supply, lack of access to digital learning tools, and inability to afford usage costs. The statistical analysis of the critical factors concluded that while the significance of remote learning opportunities to students' learning outcomes is well understood, geographical limitations, socioeconomic costs, household dynamics as well as lack of access to digital infrastructure to leverage online learning options remains a huge challenge. We found out a statistically significant relationship between low level of readiness to e-learning adoption in rural communities with perceived benefit of digital learning, poor knowledge and low level of awareness of digital learning tools. The extent of exclusion as shown by the digital needs of our respondents also reflects the degree of marginalization that continues to deepen social and educational inequalities. This study therefore complements existing literature on the state of technology access and usage for learning and teaching in Nigeria, specifically during the COVID-19 pandemic.

The adoption of digital technologies as a major element of remote learning strategies during humanitarian emergencies such as the COVID19 pandemic would require bold commitments from the government to ensure schools, children and/or teachers in rural communities are not left out and can access school-based digital support and interventions. For vulnerable children from remote communities to acquire digital competence, schools must incorporate digital awareness into learning activities. Addressing infrastructural inadequacies is central to maximising the potential of remote learning for rural students. The government should provide amenities such as internet-enabled community e-learning centres and equip them with computers that can ease physical access to technological tools and aid the acquisition of digital literacy skills. As our results demonstrate, internet access and connectivity in Nigeran rural communities is a necessary accessory for social equality and must be prioritized as a developmental necessity. Not only will the availability of internet services at community levels help improve students' attitude toward learning, but it will also facilitate access to educational opportunities for community children, including older learners. More significantly, the role of family members, community leaders and stakeholder groups in fostering access to quality e-learning opportunities can not be overemphasized. Also, as established in the literature on remote learning and e-learning opportunities, an offline learning model can help address the digital divide among students. In rural communities with limited technology access and internet

connectivity issues, governments and schools can leverage the use of home learning kits including printed study guides, reading lists and lesson notes. The use of other low -tech tools such as radio, television and messaging platforms like Whatsapp needs to be encouraged. In conclusion, this study offers clear evidence on how most vulnerable students in rural communities are disproportionately excluded from e-learning during the COVID19 pandemic. Further studies still need to be done to establish how other factors such as gender or disabilities contributed to digital exclusion.

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The Need for Context-specificity in Global Educational Policy Transfer by Non-state Actors: The Case of "Teach for All" to "Teach for India"

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Abstract

The revitalised role of non-state actors such as non-profit organisations and education reform movements in educational provision and delivery has contributed to the global circulation of uninformed transnational adaptation of ideas and practices around educational change. In adapting models in one place for emulation in another place, educational non-profits often lose sight of the local realities, thereby decontextualizing cultural differences and normalizing the language of generalization. Such is the case of the Teach for India (TFI), a non-governmental organization (NGO) working in marginalized districts of India to provide quality education to disadvantaged children through its alternative teacher credentialing program. TFI's theory of change and intervention approach revolves around the model of Teach for All (TFA), an international movement whose model and belief of equitable educational access and opportunity continues to spread on a global scale through transnational actors. Through an extensive literature review, this article analyses critically and discusses how the TFAll's Model is operationalised in India, through TFI that was established in 2009 to promote the universalization of Elementary Education (UEE) in India. While examining the underlying assumptions that inform the de-contextualisation of the globalised and philanthropy backed reform model, it analyses the key features of the intervention approach and presents

the critiques and limitations. Beyond contextualisation, the paper makes a case for the need for non-state actors to take into account significant sociocultural and political differences in voluntary transfer of reform ideas. While acknowledging the significance of policy mobilities in bringing entrepreneurial solutions to educational problems across continents, the article recommends that such transfer must be driven by perceived necessity within local contexts.

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Keywords: Teach for All; Teach for India; Education; Context

1. Introduction and Background Information

Unarguably, the role of non-state actors such as NGOs in championing education reforms and driving educational quality for all through cost-effective and impact-driven programs have become greatly necessitated in various geographical and socio-economic contexts within the global educational discourse. According to Akyeampong (2004), NGOs have greatly enhanced global and national educational objectives in many countries where the government is incapable or failing in its obligation to provide basic education, particularly for highly disadvantaged populations who would otherwise not have access to education to complete primary education and achieve measurable learning outcomes. The concern, however, is that many international non-governmental organisations (INGOs) and *Local Non-governmental Organizations* (*LNGO*) are circulating generic and de-contextualised interventions that do not reflect the specific local realities of the target beneficiaries and that of the contexts in which they are situated. With their inability to leverage contextual understanding for programme delivery, they end up with initiatives that produce short-term results which do not complement mainstream education efforts well and also lack sustainability. As McDonald (2012) confirms, the importation of educational initiatives across borders must incorporate contextualization and local ownership to ensure successful adoption towards promoting intended objectives. While the innovative approaches and models of International education NGOs such as Teach for All is key in delivering educational quality for the poor and underserved, it is of paramount importance to evaluate and understand how this can be adapted into conventional state education systems through partnerships, to enable Governments adapt to their operations and programmes to improve the access to and quality of education in poor and hard to reach communities (Rose, 2009).

Teach for India (TFI), one of many active NGOs in India has attracted attention for playing a crucial role in India's efforts to universalise primary education through an intervention model for improving access to basic education for disadvantaged children. The organisation has improved on the standard models of state schooling by changing the mix of inputs at the school level where state and non-state collaborations now exist with increasing participation of more corporate NGOs in shaping educational planning with municipal school bodies across India. (De Stefano and Moore, 2010). Conversely, due to its indirect role in the advancement of managerialistic ideas of school reforms which are considered neoliberal, questions have been raised on whether TFI's vision is truly transformative or rather, it has become a silent vehicle for vested interests of privatisation.

This paper describes and analyses the activities of Teach for India which was founded in 2009 with the mission to provide teachers to meet the educational needs of disadvantaged children across the various rural districts of India. The analysis begins with a keen overview of the Indian Education Context,

establishing the foundation for understanding the exclusion scenario for disadvantaged children. It then moves to a quick exploration of the Teach for All approach as situated within global context and then, a specific review of Teach for India follows, highlighting its way of working as well as areas of strength. From that point, the discussion proceeds by critically evaluating how TFI delivers its intervention with critiques of its implementation strategies. The core argument of the paper is that while a working partnership between TFI and the Indian government holds great potential to ensure educational opportunities for disadvantaged children, the organization needs to re-evaluate its intervention approach to suit local realities of its beneficiaries and be conscious of the socio-cultural and political economy of education within the Indian society.

2. Contextual Overview of Education Provision in India

Education in India is a joint responsibility of the central and state governments, and educational rights are conservatively enshrined within the Constitution (GoI, 1949). Upon independence in 1947, India made a constitutional commitment to provide free and compulsory education for all children up to the age of 14 years, a salient feature of the national policy, which earmarked the universalisation of Elementary Education (UEE) as a national priority (Government of India, (GOI), 2015). The Constitution of India, adopted by the Constituent Assembly on 26 November 1949, which came into force on 26 January 1950 and as last amended in 2006, enshrines the right to education, the "Universalisation of Elementary Education" in Article 21A (Chandra Pandey, 2012). Across several constitutional, national and policy statements, the Indian state recognises the vital link between education and totality of the national development process and therefore creates a sense of urgency in the need for the state to ensure the universalisation of education provision, enrolment, retention, participation and achievement, especially for children between the age group of 6-14. The importance of the universalization of Elementary Education in India has been emphatically spelt out in several national conventions including in the National Policy of Education (1986), Programme of Action (1992), Unnikirshnan Judgement (1993) and the Education Ministers' Resolve 1998). The reform and restructuring of the Indian educational system have overtime continued to attract attention as an important area of national and state intervention and in 2009, in an attempt to reach India's constitutional goal of universal elementary education, the Indian Parliament enacted The Right of Children to Free and Compulsory Education Act (RTE) Act. The RTE Act, which further guarantees universalisation of quality education at the elementary level in the country, remains the most important development in the Universalisation of Elementary Education in India. Subsequently, this 'right to education' legislation has seen a chequered history in evolving from a directive principle to a fundamental right with both the national government and state governments placing it at the centre stage of public attention (*EFA National Review*, 2015). Its passage has since laid the basis for several constitutional reforms targeted at addressing equity and quality in the UEE implementation drive. According to (GOI, 2015), all states and union territories of India have incorporated the act into the state legislative framework and adopted the norms prepared by the Government of India. Perhaps the adoption of the National Education Policy in 1986 and the Jomtien Declaration in 1990 repositioned the pace of strengthening infrastructure and delivery of public elementary education. The National Government of

India became the prime mover in the design and implementation of several initiatives geared at advancing the goal of universalizing education across India, invested heavily in massive infrastructural projects and teacher recruitment drives with long-term sector plans backed up with substantial financial commitments (Govinda & Bandyopadhyay, 2008). Subsequently, there was a tremendous increase in the accessibility of schools and this led to a corresponding rise in the number of children participating in school, an evidential justification for the large-scale mobilisation that resulted from massive state investments aid by multilateral and bilateral donors (Govinda, 2009). Despite significant progress in enrolment at the elementary stage over a long period as driven through the UEE with widespread operationalization of the RTE Act, in principle, nationally set objectives for education in India remains far from realization due to inadequate teaching provision.

With a rapidly growing population that outstripped the capacity at which schools educate children owing to limited supply of adequate and qualified teachers, India's mission to make UEE a reality became a struggle, a situation fueled by under-planning and over-ambition (Burnett, 2017). Sayed et al. (2007) note that there were substantive policy shifts in the 1990s that targeted the massive allocation of resources to districts with the educationally excluded children from socially, economically and culturally disadvantaged groups with the aim of ensuring equity within the UEE grand plan. But despite the huge traction received by the UEE across the 2000s, Govinda and Biswal (2006) suggest that state planners failed to pay attention to the agency of achieving greater equity in provision and thus neglected targeted reforms to cater for the educational needs of those from marginalized groups excluded from the school system. Recent statistics from ASER (2016) indicates that while participation levels in schools have increased across the board, the opportunity gap between the general population and marginalized social groups and minority communities continues to widen. Marginalization and infringement of children's right and access to elementary education in India are largely determined by the stratifications and social inequalities that permeate the Indian Society (Talukdar & Sharma, 2015). Historically, segregated provision and tribal discrimination have continually influenced educational exclusion, leaving certain groups unable to afford the cost of and access quality elementary education. These include underprivileged children from remote, rural and hard to reach communities, children with special needs and those from scheduled castes, scheduled tribes and other minority groups. National statistics from the India EFA 2015 National Review reveals significant gaps in the enrolment and retention rates especially for children from SC, ST, and Muslim communities against other privileged groups. With India's population of out-of-school children and those not completing primary schooling put at 35 million (UIS, 2016), it is clear the major educational development priority for India is not simply providing inputs and infrastructure, but identifying who and where the excluded groups are, and devising strategies to ensure meaningful access and provide quality basic education for them. This explains the motivation behind how the networked and heterarchical governance of Teach for All seeks to respond and address educational equity in India through its monocultural strategies of teacher reform. Achieving this is dependent on the Teach for India (TFI) outfit who will provide learning opportunities for educationally disadvantaged children by mobilizing elite graduates and professionals as para-teachers to teach in marginalized districts of India.

3. Analysis of the adaptation of the Teach for All Model in India

In critically analyzing the contributions and pitfalls of Teach for India, it is imperative such critique is built on its characterization as an offshoot of Teach for All which operates as a global network of 48 independent, locally led and partner-funded NGOs. These initiatives share a unifying mission to expand educational opportunity around the world by providing teachers to meet the educational needs of disadvantaged children in resource-constrained and marginalised communities. The organisation bears an institutional ideology of "educational leadership" that recognizes effective leadership as a key to resolving the global crisis of education inequity. In that sense, its grand overarching intervention approach dwells on a rubric called Teaching for Leadership, which links leadership theory to teaching practice (Thomas, 2007). This helps frame a notion that motivated teachers, with excellent teaching qualities, are foundational for lifetime leadership and education advocacy at the local and policy levels (TFAll, 2007). In 2009, TFI, the largest of all TFAll's network partners was birthed as a public-private partnership (PPP) in under-resourced municipal schools in Mumbai and Pune, two of India's most populated cities, where the ostracization of street children, SC and ST is conspicuously evident (Subramanian, 2018). As described by the founder, Shaheen Mistri, her interest to address certain inefficiencies in the Indian education system was further solidified when she encountered first-hand how the vast social and economic disparities in Mumbai creates educational exclusion (Blumenreich and Gupta, 2015). Her initial plan of providing after-school support for underprivileged children from low-income communities through Akanksha Foundation led to an expansion that led to the establishment of TFI. This buttresses the standpoint that the expansion of TFAll's theory of change and implementation on a global scale across various local contexts, including India is influenced by the responsiveness of civil society actors to the heightened need to address educational disparities and expand educational opportunities for all, especially for disadvantaged children (TFAll, 2011).

Conceived with an overarching goal of addressing educational disparities, TFAll's theory of change is situated within the ideologies of equality, accountability and measurable impact (Londe, Brewer& Lubeinski, 2015) and this is inextricably linked to Section 12 of the RTE act which identity with children from socially and economically disadvantaged groups (Chandra Pandey, 2012). The cultural and conceptual adoption of TFAll's model in India is framed around the ideology that education is emancipatory for the poor, a "problem solving" narrative which is justified by the rapid population surge, the highly divisive nature of state against non-state education provision and subsequent marginal exclusion of the disadvantaged from educational opportunities (Subramanian, 2018). Therefore, with over 96% of all children in the ages of 4-16 years enrolled as at the end of 2011 not learning, the emergence of the TFI program into the Indian educational landscape was situated within the vision of delivering improved learning outcomes and universalizing the equitable access to quality education (Chandra Pandey, 2012). To achieve this, the objective was to deliver systemic change through effective and adequate teachers' recruitment by providing an average figure of 1000 new teachers per year in at least eight major cities by 2016 (ibid, 2012). To this end, TFI recruited, trained and placed 87 fellows to teach 3000 children in 34 schools across Mumbai and Pune in its first year of operation (Fabel, 2011). This tally has since increased to over 1200 fellows in 350 schools across 7 major cities of India in its 9 years of operations (Teach for India [TFI], 2017).

The scope of the transformational impact TFI hopes to create with its Fellows over time within failing municipal education systems transcend beyond the classroom (Subramanian, 2018). In the short term, Fellows will serve as dedicated teachers in under-resourced government and low-cost private schools across low-income communities to drive significant educational attainment for disadvantaged children. Fundamentally, it is expected that these fellows will form a transformational leadership force of alumni whose experiences and insights of service will inform their willingness to effect systemic, long term changes for educational quality in the context of India's RTE Act (TFI, 2013). As Chrisina, Robison and Spilka (2016) note, the intensity of the experience of being grounded in the inequities faced by their students and communities is expected to inspire a sense of injustice in these Fellows and, subsequently, the development of a personal calling to address the underlying problems of educational inequity. The TFAll's programmatic approach which is replicated by TFI stems from the assumption that high-performing college graduates and brilliant corporate professionals can remarkably improve their students' learning outcomes and close the achievement gap between the rich and poor (Straubhaar & Friedrich, 2015). Conversely, this assumption is strongly contested within the contemporary global educational landscape on whether the TFAll's model is truly effective in delivering high academic achievement (Friedrich, 2015). As a counter-evidence, TFI claims that students in TFI classrooms are "at a skill-level about 2–4 years above their current grade levels," and in 2010–2011, the majority of these students gained more than a year of growth in many subject areas (TFI, 2017). While Heilig and Jeg (2010) argue that students taught by TFI fellows produce lower test scores as compared to those taught by locally trained teachers, several evaluative studies suggest positive results on student test scores at both primary (Decker, Mayer& Glazerman, 2004) and secondary levels (Clark et al., 2013). Despite the inefficacy of student achievement as a sole criterion in measuring its effectiveness or impact, TFI still upholds its belief in measurable impact and continues to evaluate its beneficiaries through standardised tests. The program has become so achievement-driven that it has lost sight of its primary aim of delivering quality learning that addresses teaching quality and achievement gaps, yet it continues to expand to more district schools reaching more disadvantaged children. Beyond students' academic achievement, TFI needs to focus on other indicators such as teacher performance and stakeholders' satisfaction to evaluate the impact of its intervention model.

4. Policy Transfer Limitations: A Critique of "Teach for All" to "Teach for India

The adoption of the Teach for All model, no doubt, has led to the creation and activities of Teach for India has brought about a measurable level of significant educational change. To start with, TFAll's leadership development drive in education has advanced educational progress, both locally and globally. The organization has successfully mobilised over 65,000 para- teachers, produced 40,000 alumni and reached an approximate figure of 6 million students - typically those from the most disadvantaged socioeconomic backgrounds, as seen in India and with other network partners across the world (TFAll, 2017). In spite of this excellent impact record and the resulting recognition as one of the most successful movements in global education (Exley, 2014), TFAll has received huge criticism in recent times over a number of converging issues that points to the flaws in its policy transfer model.

4.1 Circulation of A Decontextualized Intervention Approach

Evidence shows that the TFAll Model explicitly enables the circulation of a generic decontextualized intervention approach across diverse and dissimilar historical, economic and cultural contexts. Specifically, its lack of reference to certain peculiarities and uniqueness of the Indian society like the local purposes of education, multilingualism, cultural values and philosophical ideas embedded within the Indian culture demonstrates the pitfalls of several INGOs that seek to address local education challenges and yet disregards the significance of context-specificity. For example, the emphasis on strong English-speaking abilities as a key recruitment criterion for potential TFI Fellows, in a country that possesses vast linguistic diversity, reflects a crucial component that weakens the broad vision of the organisation. According to Vellanki (2014), the selection of English-speaking fellows by TFI to become English-speaking teachers in Indian government schools where the local and regional languages of communication are the medium of instruction is a case of linguistic imperialism that creates disjuncture with the local context of India's multilingualism. This contravenes the “Three-language Formula" which governs the existing policy on the language of instruction in Indian schools that was adopted by the Education Commission in 1961 which aims to integrate English, Hindi and two other Indian languages into mainstream schools (Blumenriech and Gupta, 2015). Moreover, this reproduces a systemic form of marginalisation as Fellows are specifically trained and placed in government-controlled English-medium classrooms to teach children from socially disadvantaged families and communities who cannot speak English. While TFI is a program aimed at closing teaching gaps, its rigid approach in deploying English Speaking recruits in its strictly English-medium host schools where English is being “taught and learnt by compulsion” has played a role in surrendering control of local forms of knowledge production and contextually pedagogy which could have been a potential strength of TFI (Blumenriech and Gupta, 2015).

4.2 *Neoliberal Interferences with Local Education Governance Structures*

Firstly, since its inception in 2007, TFAll has grown substantially from being an INGO aimed at filling vacant teaching positions in disadvantaged settings to an influential proponent of ‘neoliberal marketised solutions to educational inequality (Londe, Brewer& Lubienski, 2015,p.4). Beyond its superficial two-year teaching intervention approach, TFAll’s growth and influence as a major non-state institution reflect through its key role in large-scale neoliberal education reforms around the issues of school management practices, alternative teacher credentialing programmes, para-teachers training/recruitment, student learning assessment and public-private partnerships for education (Blumenreich & Gupta, 2015). With a presence in over 46 countries, the transnational spread of the TFAll’s NGO model across various political, social and economic contexts exemplifies a “policy borrowing or micro-lending system” (Friedrich, 2014) within its network partners. Undoubtedly, this supposed transformative approach for local education reform is presented as “apolitical” and “simplistic” (Vellanki,2014). However, TFAll’s role in the “uncritical exchange of ideas and educational practices from the West” (Blumenreich & Gupta, 2015), especially in addressing the urgent demand for teachers in disadvantaged settings can be viewed as a form of neoliberal globalization, which is governed by the notions of marketisation and privatization and has evidently empowered traditionally disadvantaged groups which it was targeted at (Gupta, 2012). Additionally, with its imposition of external values and neglect of the significance of implicit beliefs and cultural diversity,

TFAll has propagated a new order of educational colonization within several local educational systems as its western concepts of private schooling and alternative teacher credentialing programmes spread globally (Blumenreich & Gupta, 2015). It is noteworthy that with such marketised solutions for educational inequality emanating from a Western discourse, TFAll's approach ensures the continuous lending of a neoliberal policy that does not only reinforce the marginalisation of disadvantaged groups but is also strategically positioned to benefit the developing world through political and economic means.

4.3 Inadequate Teacher Preparation Model

While TFI's vision of deploying 1000 new teachers per year in at least eight major Indian cities to help advance nationally set educational objectives for disadvantaged children seems laudable (TFAll, 2017), it's teacher preparation model which involves just five to six weeks of residential training presents a great concern. Borrowed from its Western counterparts like Teach for America and Teach First UK, the TFI's short-duration teacher training programme leaves limited time for the fellows to get acquainted with and build their knowledge about the local culture which they can use to contextualise their teaching methods (Thomas, 2007). Furthermore, since most of the selected fellows had no prior training in education, five to six weeks of professional training do not equip them enough to understand and engage with complex social aspects like caste, class and tribes which interacts with the relationship between the teacher, the student and the process of teaching and learning itself which are peculiar to the Indian context. According to Vellanki (2014), TFI's teacher preparation practices are antithetical to the principles and beliefs of the India's 2005 National Curriculum Framework (NCF) and to the 2009 National Curriculum Framework for Teacher Education (NCFTE), both of which underlines the significance for teachers to develop and nurture socio-emotional skills that are vital for a learner-friendly progressive approach to teaching. Drawing on the sociological underpinnings of education which implies that social structures and identities influence schooling and education, he further argued that the minimal understanding of theoretical perspectives and lack of sensitivity towards diverse socio-cultural backgrounds creates a vast socio-cultural gap between TFI's young teachers and their students. Therefore, reflecting on the drawbacks of TFI's teacher preparation model, it can be argued that a grounded understanding and engagement with certain dynamics, such as caste, gender, race, which are peculiar in the Indian context is significant for TFI fellows to maximise learning experiences for its target beneficiaries.

4.4 Deprofessionalisation of Teaching

Conclusively, beyond the limitation of its inadequate teacher preparation model, TFI's approach in tackling teacher gaps faces stiff opposition from professional teachers' associations across India over the de-professionalization of teaching. The employment of contractual or para-teachers with little or no prior training in education has become a contentious issue whose short and long-term effects have a significant influence on the social status and roles of teachers in the society. By employing people without adequate professional orientation, (Talukdar & Sharma 2015) argues that TFI de-emphasizes the professional nature of teacher's work and further demotivates regular teachers especially within the Indian society where teaching is considered a profession of high accountability and teachers perceived as a bank of knowledge. As captured within NCFTE (2009),

"The status of the teacher reflects the socio-cultural ethos of the society; it is said that no people can rise above the level of its teachers". Such exhortations are indeed an expression of the important role played by the teachers as transmitters, inspirers and promoters of man's eternal quest for knowledge. Should this role expectation be not taken as rhetoric but as a goal to be constantly striven for, the urgency is to address ourselves seriously to examining the issues related to the preparation of teachers as well as to prune the theory and practice of teacher education."

This perception of teachers as "professionals" depict the core fundamental issue upon which the NCFTE is built and based on the foregoing, it is arguable that the representation of teaching as "a short-term social work" by NGOs with fast-track teacher preparation and licensure programmes like TFI contributes to the declining reputation of teaching as a worthy profession. There need to be improvement on approaches to teacher preparation with further emphasis on professional training, induction into teaching and other professional development opportunities.

5. Conclusion and Recommendations

This paper underscores the importance of context and culture within the global educational policy transfer landscape. It explores and establishes how the negligence of contextual realities and cultural differences in the adoption of the TFAll model in India comes with grave implications. Major social disadvantages such as castes, tribes, gender, geographical location, uneven development and poverty represent the multiple barriers to education and learning faced by children from disadvantaged groups across India and it takes context-specific interventions to address them.

Firstly, to address teacher gaps with impact and sustainability in sight, TFAll must address its lack of national cultural and policy context in India and the inadequate teacher preparation model. Furthermore, systemic analysis needs to be done to assess various factors that can aid the program's approach in event of any state and non-state collaboration to scale such intervention and to ensure it does not exacerbate exclusion in the longer term. As the central figure of a growing transnational network and its role in the spread of a neoliberal and market-oriented model of education reform, it is also beneficial for TFI to engage in critical reflections of how its organisational design and approach can be improved on to scale its localised and global-level impact.

As Teach for all's intervention model continues to gain widespread attention and attract support from various stakeholders such as national governments, foundations, local and international corporations, localization must be prioritized. Importantly, non-state actors such as local NGOs intending to borrow such ideas of education reforms for local adaptation will need to understand the scope of educational challenges to inform programme planning, design and operations.

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Overview of Student Enrolment, Teaching Faculty and Student-Teacher Ratio of Private and Public Universities in Pakistan

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Abstract

Growth and social wellbeing of a country largely depends on all the activities that require knowledge, expertise and highly qualified individuals to fill the gap between new avenues and job demand. Higher education institutions, number of enrolments in universities and availability of qualified teachers is important for fostering quality of education with a smooth flow of academic activities. This study is an attempt to gauge the situation of public and private universities in Pakistan by focusing on the number of universities, number of teachers and student-teacher ratio in public and private universities of Pakistan. Secondary data has been reviewed and examined from the available source (Pakistan Education Statistic). It has been identified that there is an increase in the number of universities but with a prominent decrease in teaching staff particularly in public sector universities, whereas student-teacher ratio has also been witnessed higher in public sector than the private universities in Pakistan.

Key Words: Student Enrolment, Teaching Faculty, Higher Education Institutions, Student-Teacher Ratio, Public and Private Universities.

1. Introduction

The imperative institutional organization of a nation is education; it plays a substantial role in the progress of any country. It empowers a country to stand on her feet. Nations that care and develop better education values attain success and economic growth. Moreover, talking about the higher depiction, the world is facing a lot of challenges and competition particularly in the education. Economic growth and development fundamentally depends on educated and competent man power and their share in the course

of economic development. A nation cannot pursue accomplishment without strong educational structure, for which professional, capable and satisfied teachers are required who can deliver quality education and can transform individuals into creative, skilled assets who can participate in the economic growth and development of the country. Hence it is an important area for a developing country to look into the education sector, dig down and recognizes lope holes which are blocking growth and development of the country and expand the identified areas so that the country can face challenges of the 21st century.

There are many examples of emerging economies in the world like India and China where education has been given immense importance between 2001 to 2013 as according to The World Bank IBRD- IDA (Gross Enrolment Ratio in Tertiary Education) there is a swift rise in the number of enrolments which justifies a clear picture and shows the prominence given to education by the governments (World Bank). The importance of teachers cannot be neglected as highlighted by (Usop, Askandar, Langguyuan-Kadtong, Usop, 2013; Panda & Mohanty, 2003), that teachers are the pivot of every learning organization.

Moreover student enrolment in educational institutions reflects where the country is leading, according to (ICEF) Monitor "Global economic power projected to shift to Asia and emerging economies" higher education enrolment in India has blasted over the past decade, and it displays the increase from 14 million to 28 million students between 2007 and 2013 particularly which is a double in numbers (ICEF Monitor). Conferring to the report the growth of higher education has been a key emphasis in India. Further in the report it has cited that, India is forecast to have the world's largest population of college-aged students – 119 million – by 2025. The main attention of the government is to encourage higher education and to set out plans for the development of 20 world-class universities, including ten public-sector and ten private institutions. This is one leading example showing how education can improve the standards of growth and development of a country.

Similarly, literacy rate of a country provide a wider picture about the education system of a country and the importance of education in a country. Figure 1.1 shows the literacy rate of Pakistan with a percentage share of male and female including all provinces in Pakistan which has been extracted from Pakistan Economic Survey 2017-18. Female literacy rate is lower than the male literacy rates throughout in Pakistan showing that that government should take measures to improve this percentage share especially the female percentage.

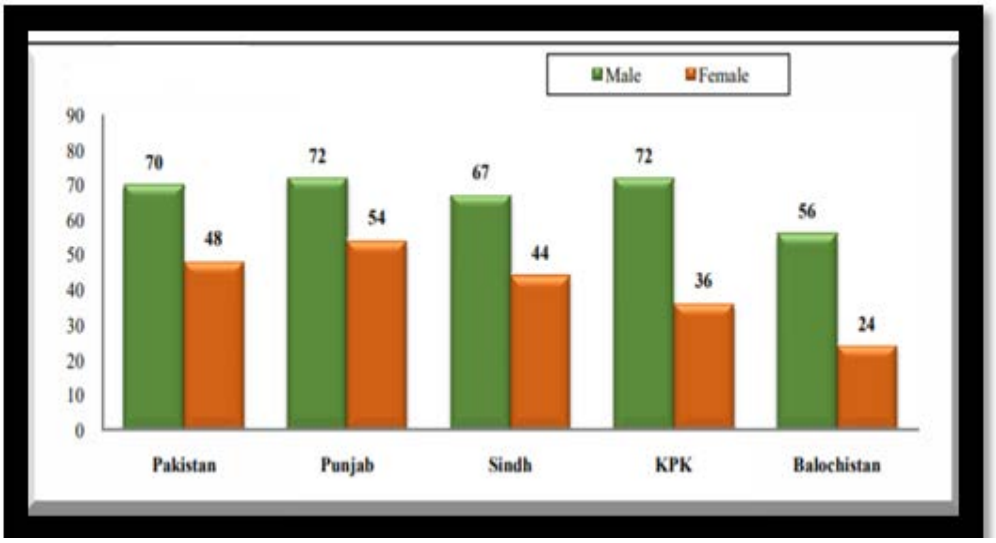

Figure -1Literacy Rate of Pakistan (Male and Female)

Source: Extracted from Pakistan Economic Survey 2017-18

It can be clearly seen that KPK and Punjab shows 72 percent male participation whereas female literacy rate is different. Punjab shows 54 percent which is higher than the literacy rate of KPK which is 36 percent. While Sindh stand at 67 percent male and 44 percent female participation and Balochistan last in the list with 56 percent male and 24 percent female indicating the least literacy rates of Pakistan.

Figure - 2 demonstrates the percentage share of permanent PhD teaching faculty and permanent total teaching faculty in the universities of Pakistan from the year 2012-13 till 2014-15 respectively. The percentage displays that the percentage of PhD qualified teachers is quite small as related to the total full time faculty and it is a big question on the HEC criteria for university teachers.

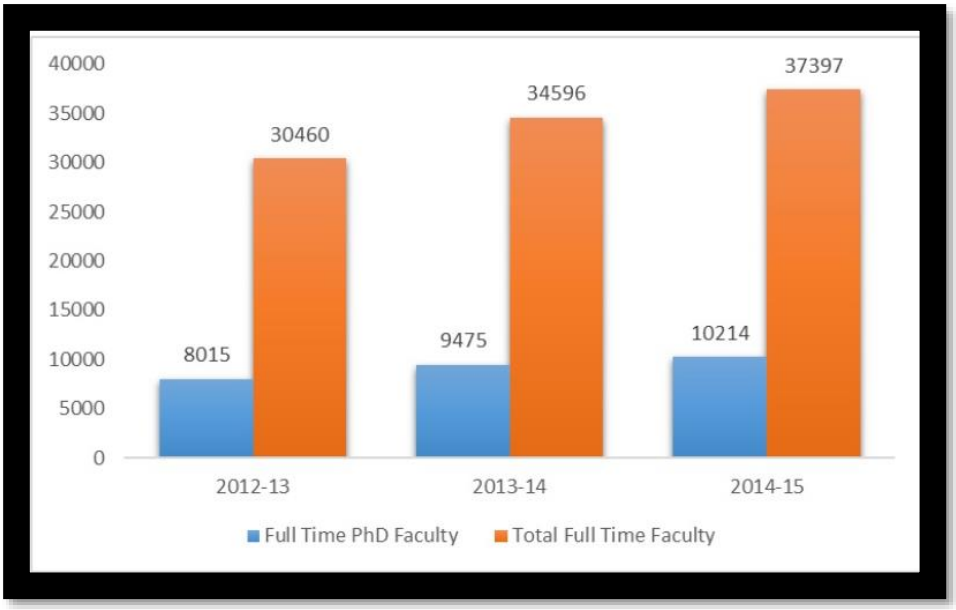

Figure -2 Teaching Faculty of Pakistani Universities/DAIS and Basic Colleges (2012-2014)

(Source: Extracted from HEC website)

Consequently adhering to the Higher Education Commission of Pakistan statistics (2019), there are total 203 universities in Pakistan where 81 are the private universities and 122 are the public in the fields of medicine, agriculture, engineering, veterinary sciences and general disciplines in Pakistan. However 189 are general universities out of which 79 are private and 110 are publicly owned universities respectively (Higher Education Pakistan).

2. Literature Review

The significance of education is not to shape any sole quality in the society but to crop such individuals who understand the significance of healthy life and become a source of fulfillment for others. Also other role of education is also important and that is character building which cannot be ignored. Any society with high moral values harvests such an atmosphere which can effect in healthier, well groomed, and prudent individuals.

Many studies have spotted the importance of education and about the academic profession as it is considered to be the "key profession". Novelty and change has always been acknowledged and appreciated by the university and academics but the academics have never started nor strengthened institutional reforms. Growing knowledge society envisions shift in the traditional academic roles and they are equipped to welcome motivated academic people who are satisfied with work and atmosphere.

Proper and educated society only can contribute in growth and development of a country and for that education of males and females both should be given equal importance. Dalal (2018) specifies in his study that gender discrimination is one of the fundamental purpose why women are not being given the opportunity to get education as given to males. The census study shows that male literacy is more than the women literacy.

Likewise Gupta, (2014) justifies the prominence of female education and the profits of female empowerment. Women also must have a freedom and of healthier and happier life hence this should be enough a reason for encouraging women education. Nevertheless there are more important benefits for society as a whole. Education specially women education in developing countries is essential for the growth and stability (Verick, 2018). Conferring to the importance of women education Lutz, & Kebede (2018) suggests better educated people tend to have higher life probability and so they can provide better out puts. Chatterjee, Gupta, & Upadhyay (2018) also focuses the importance of education more on the female education and justifies that education is transformational which literally can change lives, and so education for both men and women should be encouraged at every level.

2.1 Higher Education

Need of higher education has influenced the world in all dimensions but that change is unique in all countries round the globe. Academic business plays a pivot role in producing skilled cultured work force that leads to economic development and in producing such expert and educated generation there is an important role of skilled, educated and satisfied academicians. Different academicians across the world participated and contributed in a survey which was conducted to find out the imperative aspects of academician's job satisfaction. Extensive range of survey study revealed and showed that job satisfaction

correlate expressively with job performance and the key relation was found between complexity and job autonomy (Judge et al., 2001; Bentley, Coates, Dobson, Goedegebuure& Meek, 2012).

The concept of having competent teachers is important as such motivated people will be able to face challenges of the fast growing society and will be proficient to produce knowledgeable and skilled generations for better required innovations and research work. University officials may it be private or public must give importance to the aspect of drive and job satisfaction of academics for better upcoming results. Person's self-image plays an important role in the performance and educated people must care about their image Danish, M. (2015), so teachers should improve their self-image with higher qualifications.

2.2 Importance of Higher Education

Higher education is an essential and unquestionable area for the economic growth and development of societies but there are reasons on which number of people to attain higher education is low (Kyllonen , 2012). The scholar has specified that several of the students who wish to take admission in higher education found miss fit as linked to the demands of admissions in higher education. Hence here, the study highlights that academicians must pay consideration to advance non cognitive skills of students in their early education so that when they reach higher education, they should feel competent and should be able to meet the demands of higher education. More education reveals more earnings, low crime, better lifestyles, and better civic contribution, with higher job rank and job satisfaction.

Sustainable society needs higher education institution that plays an integral role and act as a transformative agent for the growth and development (Kruss, McGrath, Petersen, & Gastrow, 2015). Higher educational institutions include profession- oriented institutions, traditional universities and vocational institutes which help in the conversion and intend to foster sustainable development of HEIs (Findler, Schönherr, & Martinuzzi, 2019). The importance of higher education cannot be ignored as it vital for socio and economic growth (Prichard & Trowler, 2018 & Dumciuviene, D. 2015). Globally it has been recognized by the authorities like UNITED NATIONS and the importance of HEIs and initiatives have been taken in to account. These measures are shaping and forming the guidelines and framework has also been formulated.

Importance of higher education and its effectiveness has been highlighted by (Reeves, T. C. 2006) who suggests that learning environment shows adequate, aligned factors including content, learner tasks, instructor role, student role, goals, assessment, instructional design and technological affordance which result in achieving success. On the other hand in higher education the most ignorant factor is the assessments and suggests the importance of adequate assessment methods to improve online commencement in higher education. Furthermore, Information Technology (IT) as strategic tool has significant importance is higher education (Khouja, et. al., 2018). Zain, Aspah, Abdullah, & Ebrahimi, (2017) promotes the importance of higher education and its impact on the Malaysian evolution. He has suggested that Malaysian student's growth and employment of graduates increased through properly managed higher education system. The study reveals and connects the importance with the current study

and signifies the importance of higher education in connection with the economic growth and development.

Opportunities in higher education system in India reflects that the government of India has noticed that the economic success of the state is directly determined by the education system of the country and keeping this at top priority, India has given focus in the education system and investing more in the system to achieve fast growth in country. This also validated the current study which is highlighting the importance of education for economic development (Sheikh, 2017).

Higher education and economic value has been studied by Allais, (2017) in her research, which reflects the connection of higher education, society and the economy. The paper questions on the current approaches used in higher education of South Africa and provides a link between higher education system and distinctive candidates who add value in society and in economic development.

2.3 Higher Education in Pakistan

Higher education has been observed in today's time period as of supreme importance and termed as the capital investment for economic development and social wellbeing of the society (Tilak, 2015). One of the simple human rights of every individual is education and out of which higher education is of vital importance for the improvement of a nation (Mohanty, 2000; Nasrin R. Khalilia, 2015). According to Erdkunde (2015), the condition of Pakistan's higher education is quite distressing. The people in Pakistan regard moral values and are not behind any other nation in terms of aptitude or competency perhaps some political differences and uncertainties have ruined the intellectual magnitudes of the people living in Pakistan. In the study conducted by Hanafi, M. R., & Iraqi, K. (2019) it has been highlighted that part time faculty members has reduced in "public sector" with projecting figures while full time (permanent) faculty has increased in Pakistan. This reflects that there is a need to speed up the recruitment processes in public universities so that there would be more permanent faculty members in both sectors respectively.

Pakistan used to have only one university that was "University of Punjab" situated in Lahore at the time it came in to being. Later on Karachi University started giving services of higher education from 1950 onwards till to date. The very first private university was established in Lahore which was "Lahore University of Management Sciences" (LUMS) in the year 1984 followed via "Agha Khan University in 1985" which was the second private university established in Karachi city. According to Hoodbhoy (2009), the noticeable increase in the number of universities was marked in Mr. Zulfiqar Ali Bhutto's regime which was from 1971 to 1977 respectively.

2.4 Student-Teacher Ratio

Koc, & Celik, (2015) suggests that there is a substantial correlation between number of students per teacher and students' achievement hence the importance of student-teacher ratio cannot be ignored as it plays an important role for quality education. Another study has given emphasis on the student-teacher ratio in higher education. Number of students in one class impacts on each individual's learning and

reflects impact on the success of students. It has been suggested that students learn better if the class size is small and teachers can assist student individually with full focus (Jones, Gallagher, & Midraj, 2020).

Students feel more focused and attentive when the number of students is low in the class room and teachers can easily focus on students learning and can keep a check on individual progress. International universities follow standard student-teacher ratio to improve students learning. A study by (Bedard, & Kuhn, 2008) has reinforced the importance of student-teacher ratio and suggests that class size effects on test-based outcomes in higher education.

Student-teacher ratio can be improved if the government appoints more teachers in universities to improve quality of education (Awan & Hussain, 2020). Hence this study justify that a controlled class size directly effect on quality of education so the government must focus on increasing the number of teachers in higher education to improve and advance quality of education which can help achieve sustainable development in Pakistan.

2.5 Student Enrolment in Higher Education Institutions

Study by (Adetula, et. al., 2017) signifies the importance of investment in education sector and suggests that economic development and high gross domestic product (GDP) largely depends on the investment made in education sector of a country. Study also suggests that the government may collaborate more with the private sector through Public Private Partnership (PPP) for achieving fast growth in the country. This will also help to reduce the burden and dependences on aids from developed countries and organizations.

Owens, (2017) suggest the importance of higher education by connecting education with the framework of sustainable development in the study. Higher education plays a key role in the economic development with quality education with the help of more funded research and partnership projects in the country. The study also provided guidelines for ensuring employability in the global market.

3. Research Method

For the current study descriptive research design has been adopted to investigate secondary data available from the website to identify answers for the research questions that have been framed by a through literature review. The data used in the study is from Pakistan Education Statistics, Pakistan Economic Survey, Ministry of Finance (official website) GOP and from HEC official website.

4. Research Objectives

1. To find out the percentage increase/decrease of number of public and private universities in Pakistan.
2. To examine the percentage increase/decrease of student enrolment in public and private universities of Pakistan.
3. To evaluate the percentage increase/decrease of student-teacher ratio in public and private universities of Pakistan.

4. To assess the percentage increase/decrease of teachers in public and private universities of Pakistan.

5. Discussion and Analysis of Education Statistics of Pakistan

A detailed exploration of education statistics of Pakistan will be discusses from the year 2007 till 2017 as per availability and reliability of the data. The data used in the study is from different sources including Pakistan Education Statistics, Pakistan Economic Survey, Ministry of Finance (official website) GOP and from HEC official website.

Following statistical data has been included after a through literature review in the study. The data is from different sources that will provide a wider overview of higher education in Pakistan. The tables are representing educational statistics of Pakistan and include number of public and private universities, student-teacher ratio, number of student enrolment, number of teachers in HEI's, literacy rate, unemployment rate of degree attained individuals and number of PhD produced during particular years in Pakistan.

Table - 1 Public & Private Universities/ Institutions in Pakistan

S. No	Years	Public	Private	Total	Percentage Increase/ Decrease
1	2007-2008	68	56	124	-
2	2008-2009	72	57	129	4%
3	2009-2010	73	59	132	2%
4	2010-2011	76	59	135	2%
5	2011-2012	79	60	139	3%
6	2012-2013	79	60	139	0%
7	2013-2014	91	70	161	16%
8	2014-2015	91	72	163	1%
9	2015-2016	91	72	163	0%
10	2016-2017	110	75	185	13%

(Source: Pakistan Education Statistic 2007-2017)

Table - 1 represents total number of "public and private universities" of Pakistan. The table shows from year 2008-2009 till 2013-2014, there is a slow increase in the number of both public and private universities in Pakistan. However, in the year 2013-2014, the data shows 16 percent speedy increase in the number of universities reflecting growth in the country. But again in the year 2014-2015 and 2015-2016, there is no increase in the number of universities. Perhaps, the year 2016-2017 shows a prominent increase in the number of universities reflecting a good picture of higher education in Pakistan. The data also revealed that since 2007 to 2017 i.e. in about ten years, government has invested more on education than the private sector as public sector universities number raised from 68 to 110 (Total

increase is 42 universities), whereas in private sector the number increased from 56 to 75 means a total number of 19 universities.

Table -2 Teachers in Public & Private Universities/Institutions of Pakistan

S. No	Years	Teachers				Total	Percentage Increase / Decrease
		Public		Private			
		Full Time	Part Time	Full Time	Part Time		
1	2007-2008	13,087	25,179	5,895	2,732		
	Total	38,266		8,627		46,893	-
2	2008-2009	14,540	27,975	7,051	3,267		
	Total	42,515		10,318		52,833	13 %
3	2009-2010	15,774	30,350	7,965	3,691		
	Total	46,124		11,656		57,780	9 %
4	2010-2011	17,188	33,072	9,086	4,211		
	Total	50,260		13,297		63,557	10 %
5	2011-2012	18,753	36,084	10,397	4,819		
	Total	54,837		15,216		70,053	10 %
6	2012-2013	20,525	39,492	11,984	5,556		
	Total	60,017		17,540		77,557	11 %
7	2013-2014	20545	39492	11984	5556		
	Total	60,017		17,540		77,557	0 %
8	2014-2015	30586	39492	12654	5556		
	Total	70,078		18,210		88,288	14 %
9	2015-2016	26,251	40,281	11,177	5,666		
	Total	66,532		16,843		83,375	- 6 %
10	2016-2017	31819	8,439	13420	5055		
	Total	40,258		18,475		58,733	- 30 %

(Source: Pakistan Education Statistic 2007-2017)

Table - 2 is indicating the number of "public and private" academicians in Pakistan. From the year 2008-2009 till 2014-2015 except year 2013-2014, we can see a slow but firm increase in the number of teachers in both "public and private" universities. However, the year 2015-2016 and 2016-2017 reflects a prominent decline in the number of teachers in public sector but there can be seen some increasing trend from 2015-2016 till 2016-2017 in private sector academes specifically.

On the other hand, with the increasing number of universities during the year 2016-2017 and decreasing number of teachers in the same period in public sector, reflects that the teachers were leaving the profession and were not happy with their work and here it shows that the government need to identify reasons of the decline and try to provide avenues of teachers.

Table - 3 University/Institution Enrolments in Pakistan

S. No	Years	Public	Private	Total Enrolments	Percentage Increase/ Decrease
1	2007-2008	637,037	104,055	741,092	-
2	2008-2009	688,138	115,369	803,507	8%
3	2009-2010	801,395	134,204	935,599	16%
4	2010-2011	948,764	158,918	1,107,682	18%
5	2011-2012	1130143	189656	1,319,799	19%
6	2012-2013	1364590	230058	1,594,648	21%
7	2013-2014	1364590	230058	1,594,648	0%
8	2014-2015	1112625	186535	1,299,160	-19%
9	2015-2016	1141219	214430	1,355,649	4%
10	2016-2017	1192535	270744	1,463,279	8%

(Source: Pakistan Education Statistic 2007-2017)

Table – 3 represents total number of public and private university enrollments in Pakistan. The table shows a steady increase in the number of enrolments from the year 2008-2009 till the year 2012-2013 respectively. However, there is no change in the year 2013-2014 as per the data. Besides it can be witnessed through the data that it has been an alarming 19 percent decrease in the number of enrolments in the year 2014-2015 in Pakistan. Moreover, according to Pakistan Education Statistics, a sum of 185 universities are present in Pakistan with 58.7 thousand teachers providing services in higher education in both public and private universities in the year 2016-2017, as represented in Table -2 respectively.

On the other hand, the data reflects an increase of 8 percent in student enrolments which is around 1463.3 thousand in 2016-2017 in contradiction of 1355.6 thousand in 2015-2016 as represented in Table-3. Perhaps, it is likely to foresee a decrease by 2.7 percent in the number of enrolments from 1463.3 thousand in 2016-2017 to 1423.1 thousand in 2017-2018 respectively (Pakistan Education Statistics 2017-2018) which is not represented in the tables as complete data of the year 2017-2018 is not present. This picture reflects serious concerns that the number of enrolment has decreased fast contrary to the population growth in Pakistan.

Table -4 Students -Teacher Ratio in Public Universities of Pakistan

S. No	Years	Teachers	Enrolments	Student-Teacher Ratio
1.	2007-2008	38266	637,037	16.64759839
2.	2008-2009	42515	688,138	16.18576973
3.	2009-2010	46124	801,395	17.37479403
4.	2010-2011	50260	948,764	18.87711898
5.	2011-2012	54837	1130143	20.60913252

6.	**2012-2013**	**60017**	**1364590**	**22.73672459**
7.	**2013-2014**	**60017**	**1364590**	**22.73672459**
8.	**2014-2015**	**70078**	**1112625**	**15.8769514**
9.	**2015-2016**	**66532**	**1141219**	**17.15293393**
10.	**2016-2017**	**40258**	**1192535**	**29.62231109**

(***Source: Pakistan Education Statistic 2007-2017)***

Table -4 represent student-teacher ratio in public universities of Pakistan. According to the data, public universities in the year 2016-2017 present approximately 30 students per teacher ratio which can be improved by recruiting more teachers.

Table -5 Student-Teacher Ratio in Private Universities of Pakistan

S. No	Years	Teachers	Enrolments	Student-Teacher Ratio
1.	**2007-2008**	**8627**	**104,055**	**12.06155094**
2.	**2008-2009**	**10318**	**115,369**	**11.18133359**
3.	**2009-2010**	**11656**	**134,204**	**11.51372684**
4.	**2010-2011**	**13297**	**158,918**	**11.95141761**
5.	**2011-2012**	**15216**	**189656**	**12.46424816**
6.	**2012-2013**	**17540**	**230058**	**13.11619156**
7.	**2013-2014**	**17540**	**230058**	**13.11619156**
8.	**2014-2015**	**18210**	**186535**	**10.2435475**
9.	**2015-2016**	**16843**	**214430**	**12.73110491**
10.	**2016-2017**	**18475**	**270744**	**14.65461434**

(Source: Pakistan Education Statistic 2007-2017)

On the other hand, private universities stand at around 15 students per teacher in the year 2016-2017, which is a better ration in comparison to the ratio of public academes at the same time frame, as presented in Table -5. The difference in the student-teacher ratio in public and private universities is due to the number of enrolments in public universities as compared to the private universities. Government must plan and recruit more teachers in public sector universities to cater student needs and to control student-teacher ratio which effects student learning as reflected in literature review.

Table -6 Unemployment Rate of Degree Attained Individuals in Pakistan

S No	Years	Unemployment Rate Male (%)	Percentage Increase/Decrease	Unemployment Rate Female (%)	Percentage Increase/Decrease
1	**2006-2007**	**4.6**	**_**	**9.7**	**_**
2	**2007-2008**	**3.5**	**-24%**	**12.9**	**33%**
3	**2008-2009**	**4.2**	**20%**	**15.1**	**17%**

4	2009-2010	5.8	38%	19.5	29%
5	2010-2011	6.3	9%	19.3	-1%
6	2012-2013	7.6	21%	22.1	15%
7	2013-2014	10.9	43%	15.5	-30%
8	2014-2015	12.9	18%	21.1	36%
9	2017-2018	7.3	-43%	41.1	95%

Data of year 2015-2016 and 2016-2017 was not available in the report.

(Source: Pakistan Employment Trends 2018)

Table - 6 highlights unemployment rate of degree attained individuals both male and female in Pakistan. Conferring to the data, female unemployment rate is greater than the male unemployment rate in the year 2016-2017 explicitly. The table shows that in the year 2007-2008, 24% decline and in the year 2016-2017 43% decline in male unemployment rate, whereas in the year 2013-2014, as per the table it can be seen 30% decline in female unemployment rates. However, overall unemployment rate does not represent a good picture as the unemployment rates are mostly showing increasing trend in the table.

However, a positive picture is reflected in year 2017-2018 with 43 percent decline in male unemployment rate depicting progress in Pakistan. On the other hand, female unemployment rate continued to increase except in the year 2010-2011 and 2013-2014. The current female unemployment rate is 41.1 percent which is showing alarming picture for the institutions especially educational institutions in Pakistan and a wakeup call for the government.

Table -7 Literacy Rate in Pakistan (Last 10 Years)

S. No	Years	Literacy Rate Pakistan	Percentage Increase/ Decrease
1	2007-2008	56	-
2	2008-2009	57	2%
3	2009-2010	58	2%
4	2010-2011	58	0%
5	2011-2012	58	0%
6	2012-2013	60	3%
7	2013-2014	58	-3%
8	2014-2015	60	3%
9	2015-2016	58	-3%
10	2016-2017	58	0%

(Source: Pakistan Economic Survey (2007-2017)

Furthermore, to make a further contribution in understanding unemployment rates, literacy rate has also been included. Table -7 reflects literacy rates from the year 2007-2008 till the year 2016-2017 respectively. As per the data 3 percent decline can be seen in the year 2013-2014 and 2015-2016. However, there is no change in the literacy rate of Pakistan in the year 2016-2017 specifically. This picture reflects that literacy rate of Pakistan is stable and consistent since years but it needs to be raised and with a little effort by the government, it can be improved in near future. So government must increase number of teachers so that there would be more teachers to teach in universities and should try to improve student enrolment by increasing the public sector universities. This will also improve the student-teacher ratio in public universities and will positively impact on student learning and on quality education.

Table -8 PhD Output 2010-2014 by Pakistan Universities

S. No	Years	Public Universities	Percentage Increase/ Decrease	Private Universities	Percentage Increase/ Decrease
1	2010	775	_	57	
2	2011	952	23%	72	26%
3	2012	1038	9%	80	11%
4	2013	1142	10%	69	-14%
5	2014	1248	9%	103	49%
	Total	5155		381	

(Source: HEC website)

According to the HEC criteria, teaching faculty for higher education must have minimum qualification of MS/MPhil or Ph.D. in relevant subject areas. Keeping the criteria of HEC on priority for higher education faculty, we must see the number of Ph.D. teaching staff in between the year 2012-13 till 2014-15 in Figure – 2 which is very low as per the HEC criteria. Hence it is very important to promote higher education and produce more PhD's and then provide avenues to such qualified people with good opportunities and benefits so that they can contribute in HEI's in Pakistan.

Table -8 signifies the quantity of PhD's produced from both sector academes from year 2010 till 2014. The table show massive variance in the number of PhDs produced by the public universities as connected to private universities in Pakistan. Most progressive year in terms of total PhDs individuals produced by the government sector academes is the year 2011 where there can be seen 23 percent rise in the numbers as compared to the former year. However, rest of the years reflects a slow and constant increase which is an area of consideration for the government. This picture gives a clear picture that how and where the government needs to pay attention and help the country prosper with the help of qualified people.

6. Conclusion and Recommendations

A detailed study has been conducted to discuss the importance of higher education in Pakistan. These discussions have been further modified by a thorough literature review analysis and based on the study and the available statistics, relevant data has been studied and discussed to highlight the major aspects of higher education of Pakistan.

An endeavor has been made to observe the studies carried out nationally and internationally regarding "Higher Education" and HEI's. There is no point to doubt on the importance of education, its requirement in economic development, and in building the moral character of society. Moreover the discussion has made with a comparison of public and private universities in Pakistan.

It has been observed that although the number of universities increased in both sectors of Pakistan, but number of teachers decreased in the corresponding years with noticeable numbers in "public sector universities" only which reflects that the satisfaction level of academicians is low in "public sector" and the reasons could be lack of extrinsic or intrinsic motivation While student's enrolment showed a steady increase in both the sectors respectively.

It has been observed from the data that student-teachers ratio is better in "private sector" which may be due to more enrolment of students in "public universities". A mix trend has been detected in the unemployment rate of degree attained individuals in different years. In some years it reduced and in some years it increased however female unemployment rate remained more than the male though out the period under discussion.

There is not much of variation in literacy rate that has been observed which may increase or decrease due to increase in population. It has been observed that public academes have proved to be more successful in producing PhDs than private academes. Government may promote female employment by increasing female percentage share in employment structure in the country. However there is a great scope to discuss and analyze the available data keeping same variables to improve the literacy rate of country.

An analysis of student enrolment was carried out and showed a steady increase, but a sudden decrease was also observed which needs to be lectured for future. Overall in Pakistan part time faculty is less in "public" sector whereas more in "private" sector respectively but the universities need to follow the HEC criteria of MS/MPhil or PhD set for the faculty respectively. More public universities are required to help control student-teacher ratio, improve quality of education and it will also help produce employment opportunities especially for females to control female unemployment rate.

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How Vietnam is saving lives against Covid-19?

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Abstract

It complements Silva's (2020b) research, which showed that among 108 well–evaluated countries, the top benchmark nations against Covid–19 are Vietnam, Taiwan, and Thailand. For example, on April 16, 2021, around 3,011,574 lives were officially lost by Covid–19, while Taiwan, Vietnam, and Thailand reported respectively only 11, 35, and 97 fatal cases (WORLDOMETERS, 2021). This article's main aim is to investigate the Vietnam performance and management practices used to save lives against Covid-19. The research uses an online questionnaire, which is descriptive with documentary and bibliographic approaches to identify management practices, including Non-Pharmaceutical Interventions (NPIs) adopted against a pandemic. Also, the Fatality Total Index (SILVA, 2020b p. 563) was used to compare Vietnam's performance with 43 countries. Some results are 1) 210 NPIs were identified across the world against coronavirus; 2) Among the 44 countries, Vietnam was the second-best performer, after Taiwan; 3) among 107 respondents living in Vietnam, only 5.61% don´t believe that cultural practices are decisive for the low rate of Covid–19 death, while most (94.39%) believe in that. From those that believe, the most decisive cultural practices were: wear a mask, wash hands, not shake hands, not hug in public and few religious assemblies; 4) for 106 respondents living in Vietnam, the ten main policy measures adopted by the National Government that saved lives against the virus are international travel control, public information campaigns, schools closures, public event cancellations, integration with mass media, restriction on internal movement, effective public-private collaboration, increase the medical and personal equipment capacity, public transport reduction and combat fake news. At the final, ten golden lessons are provided, from 340 policies, measures, programs, projects, actions, innovative products/services identified, with the majority led by the Public Sector (71.2%), followed by Corporations (8.8%), Others (8.8%), Startups (6.2%), and Universities (5%).

Keywords: Covid–19; FTI; Innovation; Management practices; NPIs; Policy; Responses

1. Introduction

On 24th March 2021, Vietnam completed 426 days (1.17 year; 14 months) of intense battle against a virus called by the WHO (2020) Coronavirus disease, popular known as Covid–19.

Even though until 16th April 2021, around 878.92 million single doses of Covid–19 vaccines have been administered globally (OUR WORLD IN DATA, 2021), the world surpasses 3,011,574 fatal cases with no signs of pandemic control in most countries.

Table 1 shows that until 16th April 2021, the Covid-19 mortality is accelerating globally, since one million deaths are happening in less time, taking 267 days to kill the first 1,003,417 people, decreasing to 112 days to surpass 2,013,287 deaths and continuing decreasing to 93 days to surpass 3,011,574 fatal cases, with USA (579,942=19.3%), Brazil (369,024=12.2%), Mexico (211,213=7%), India (175,673=5.8%) and UK (127,225=4.2%) among the most critical countries in terms of total deaths, while Vietnam officially reported only a total of 35 fatal cases, situated in the 177th position when compared against 221 countries (WORLDOMETERS, 2021).

Table 1: World Total Covid-19 Deaths x Vietnam Total Covid-19 Deaths to each one million

World Total Deaths	Dates	Period among dates (Days)	Vietnam Total Deaths
1,003,417	D1=September 23, 2020	267 since December 31, 2020	35
2,013,287	D2= January 13, 2021	D2 – D1 = 112	35
3,011,574	D3 = April 16, 2021	D3 – D2 = 93	35 (177th place)

Source: Worldometers (2021)

In addition, the WHO Report number 39 on Covid-19 Situation in Vietnam (WHO, 2020c p. 7), published last April 29th reveals that: a) the country has passed 31 days from the last locally acquired cases found in Hai Duong province on 25 March 2021; b) among the 63 provinces: b1) there is no large scale community transmission (Stage 3); b2) there is no localized community transmission (Stage 2); b3) 27 provinces (42.8%) have imported transmission (Stage 1); b4) there is not transmission (Stage 0) in most provinces (36=57.2%), reason by which the main question of this research is "**How Vietnam is saving lives against the Covid-19?**"

Taking into consideration the total number of fatal cases of Covid–19 over time, the world surpassed the first one million reported deaths on 23rd September 2020, with the USA, Brazil, India, Mexico, UK, and Italy considered the most critical countries. In that time, Silva (2020b) developed a holistic methodology to identify 20 benchmark countries that are saving lives against Covid–19, and the 15 phases of the methodology showed that among 108 well–evaluated countries, the top six benchmark nations were Vietnam, Taiwan, Thailand, China, Malaysia, and Singapore. That research did not focus on the innovations, measures, policies, projects, or cultural aspects that were adopted by each country over time, **reason by which further research was recommended to identify, and disseminate them** (SILVA 2020b p. 568).

On November/20, an article (GOMES DA SILVA, 2020) was published focused on Thailand's performance and the best management practices adopted to save lives against Covid–19, during the first 180 days facing the pandemic. Another (Silva, 2021) was published on January/21 to investigate the performance and the best management practices adopted in Taiwan to save lives, during the first 300 days facing the pandemic.

In short, these studies are part of a research package that is investigating the performance and management practices adopted by each country considered as a benchmark by Silva (2020a, 2020b). To continue, this article aims to investigate the Vietnam performance and management practices used to save lives against Covid-19. The specific goals are: a) propose a new classification method for management practices (including Non-Pharmaceutical Interventions-NPIs) adopted against Covid-19; b) to present the first measures of Vietnam National Government and main partners against the Covid-19; c) to compare Vietnam´s performance with 43 semifinalist countries identified by Silva (2020b); d) to identify management practices (including NPIs) adopted in Vietnam, taking into consideration cultural practices, main policy measures, programs, projects, strategies, and innovative solutions.

The research is relevant for Presidents, Ministers, Managers, Policy Makers, WHO, and Centers for Disease Control and Prevention (CDC), since they will know management practices developed not only by the National Government of Vietnam but Corporations, Start-Up, and other stakeholders, before 2020 and during the first 14 months fighting the pandemic. Furthermore, it can be useful for benchmark studies or for the development of strategies to prevent or control similar pandemic episodes in the future.

Finally, it contributes to the teaching process and development of new research, especially related to NPIs on Covid–19. Although authors have published relevant information about Coronavirus (COWLING et al., 2020; CUI et al 2003; CHUANG et al, 2020; FLAXMAN et al., 2020; GOMES DA SILVA 2020; HA et al., 2020; LA et al., 2020; LE, VODDEN, and ATIWESH, 2021; JIAN et al 2017; JIAN et al 2020; NGUYEN, 2020; SILVA, 2020a; SILVA, 2020b; PANG 2003; ZAMBRANO–MONSERRATE, RUANO, AND SANCHEZ–ALCALDE, 2020**;** SVOBODA et al. 2004; VAN NGUYEN et al, 2020; YEH AND CHENG, 2020; YEN et al 2011; YEN et al 2014**;** WANG, NG, AND BROOK, 2020), there are needs to: a) better classify the responses/measures; b) to compare the performance evolution of a benchmark country against other well–evaluated nations, taking into consideration the real estimated number of Covid–19 fatal cases by one million population during the first 14 months facing the pandemic; c) to provide a more complete study on cultural aspects, policy measures, programs, projects, strategies, and innovative solutions adopted over time.

2. Endemic, Outbreak, Epidemic and Pandemic

According to Intermountain Healthcare (2020), an endemic is something that belongs to a particular area. An outbreak represents a greater number of endemic cases, if it's not quickly controlled, an outbreak can become an epidemic, which is a disease that affects a large number of people within a community, population, or region. A pandemic is an epidemic that's spread over multiple countries or continents.

Throughout history, as humans spread across the world, infectious diseases and pandemics have been a constant challenge, with at least 29 mortal pandemics recorded over time, with The Black Death, Smallpox, Spanish Flu, and Plague of Justinian (Table 2) among the most notorious cases.

According to Oswalia and Vasdev (2021), in the last 20 years, the world has seen the emergence and re-emergence of both bacterial, viral and vector transmitted diseases, such as Ebola, MERS–Cov, SARS, and Covid-19, due to the following factors: a) overpopulation with poor sanitation; b) movement of humans all over the globe; c) experimentation of some foods; d) destruction of the natural ecosystem, etc.

Table 2: Seven example of worst epidemics and pandemics in human history

Name	Period	Origin	Deaths toll	Cause
The Black Death	1347–1351	China	200 M	Yersinia Pestis
Smallpox	1492–1980	China	56 M	Pox Virus
Spanish Flu	1918–1920	Spain	40–50 M	Influenza virus/H1N1
Plague of Justinian	541–542	China/India/Ethiopia	30–50 M	Yersinia Pestis
Aids (HIV)	1981–Present	Congo	25–35 M	Chimpanze virus–HIV
Third Bubonic Plague	1885–1960	China/India	15 M	Yersinia Pestis
Cocoliztili	1545–1448	Mexico	15 M	VHF and Salmonella C

Source: Oswalia and Vasdev (2021).

In addition, Lepan (2020) presents a good visualization of a brief history of the pandemics since Antonine Plague (165–180) until Covid-19 (2019 – present) and argues that there is a trend over time concerning a gradual reduction in the death rate (Figure 1), from 51% of the population reported during the Black Death to less than 1% when compared with the most recent pandemics such as Covid-19 or HIV/Aids, probably because of healthcare improvements, reduction of vaccine development lead time, standardization of NPIs, measures, responses, international new rules created by WHO, development of global prevention network, surveillance system, and new technologies solutions such as apps, artificial intelligence, big data, IoT, telehealth, robots, autonomous cars, etc.

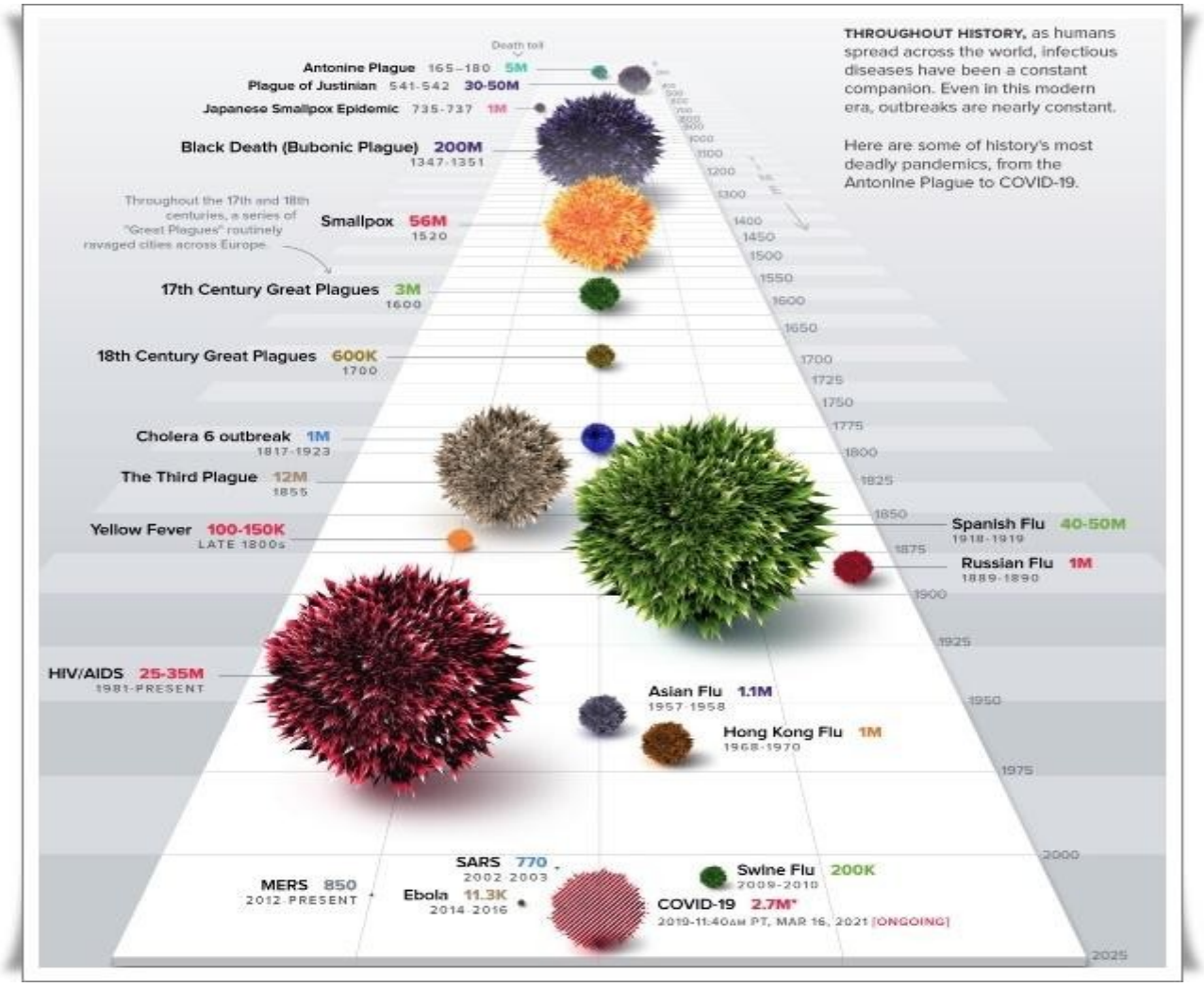

Figure 1: History of Pandemic
Source: Lepan (2020)

Concerning the last coronavirus pandemics, much progress have been made by organizations such as WHO (PACIFIC, 2020; WHO, 2019) and Centers for Disease Control and Prevention (CDC, 2019a) to provide guidance, standards to face them, with several authors and other organization (FLAXMAN et al, 2020; HOLMES, 2003; PANG, 2003; WATTS, 2003; BELL, 2004; INSTITUTE OF MEDICINE, 2004; YEN et al, 2011; YEN et al, 2014) also providing information or lessons about Non-Pharmaceutical interventions necessary to prevent, control, and respond to future global outbreaks.

3. Management Practices (MPs)

For this research, Management Practices (MPs) are defined as management instruments developed to achieve the goal(s). The instrument could be classified into 3 levels: International, National, and Regional/Local, as shown in Figure 2.

Figure 2: MP classification related to Health and/or Covid–19
Source: improved from Gomes da Silva (2020 p. 124)

According to Gomes da Silva (2020 p. 124), at the International level, there are international evaluation systems such as the Global Health Security Index (NTI, JHU, and EIU, 2019), Legatum Prosperity Index (LEGATUM INSTITUTE, 2019), The Sustainable Development Goals Index (GBD 2017 SDG Collaborators (2018), NUMBEO Health Care Index (NUMBEO 2020), Covid–19 Regional Safety Assessment (DEEP KNOWLEDGE GROUP, 2020), all related to Health or Covid–19. In addition, International Cooperation or networks can be considered at this level.

At the National level, there are Government or Legislative acts, laws, regulations, policies, measures, programs, projects. At the Regional/Local level, there are also active, law, regulations, policies, measures, programs, projects, campaign, a set of values, culture, methodology, method/technique, innovation or process, developed by Local Governments, Companies, Universities, Startups, Foundations, Institutes, and NGOs. In addition, at the National, Regional and Local Level, NPIs can be considered also Management Practices, as explained ahead.

4. NPIs and a New Classification Method

NPIs are all measures or actions, other than vaccination or medicines, that can be implemented to slow the spread of influenza in a population, playing an important role to combat the pandemic, while vaccines and drugs are developed, tested, and approved (WHO, 2019 p. 8).

To ECDC (2020), NPIs are public health measures that aim to prevent and/or control SARS–Cov2 transmission in the community. Until a safe and effective vaccine is available to all at risk, NPI will continue to be the main public health tool against SARS–Cov–2.

For this research, NPIs have a broad scope, means public, private and individual measures, projects, actions or responses aimed to support the prevention or control of a pandemic, while effective vaccine, drugs or medicines are not available to the population. Under this concept, NPIs are part of Management Practices, not limited only to public health, but also to other public and private areas necessaries to prevent and face the pandemic over the time.

After investigate several examples of measures, actions or responses mentioned by authors and organizations (ACAPS, 2020; ASKITIAS et al, 2021; BELL, 2004; BO et al, 2021; CDC, 2019a; FLAXMAN et al, 2020; GOMES DA SILVA, 2020; HA et al, 2020; IMF, 2020; IMF 2021; JONES, 2020; KANTOR and KANTOR, 2020; OCDE, 2020; OUR WORLD IN DATA, 2020; PANG, 2003; POLICY, 2020; SILVA, 2021; START UP BLINK (2020); SVOBODA et al, 2004; WHO, 2019; WHO, 2020b), it is possible to identify at least 210 NPIs and also propose a new method to classify them into eight categories as shown in Figure 3.

The Figure 3 shows that:

1) Economic/Fiscal/Support category is related to money and support program/projects/actions, it is the main category with 74 examples of NPIs (36.2%) measures such as allowance, bonus, costs, donations, funds, grants, income, tax, loan, employment, pension, purchase, relief, prices, rent, etc;

2) Health is related to Prevention, Diagnostic or Treatment program/projects/actions, it is the second category with 47 NPIs (22.4%) such as disinfection, distribution of freehand sanitizers, masks, gloves, gown, sample and testing, sanitary protocols for hotels, non–urgent surgery canceled, etc;

3) Movement Restrictions is concerning to reduce people movement, it is the third category with 21 NPIs (10%) such as border close, border check, curfews, suspend flights, etc.

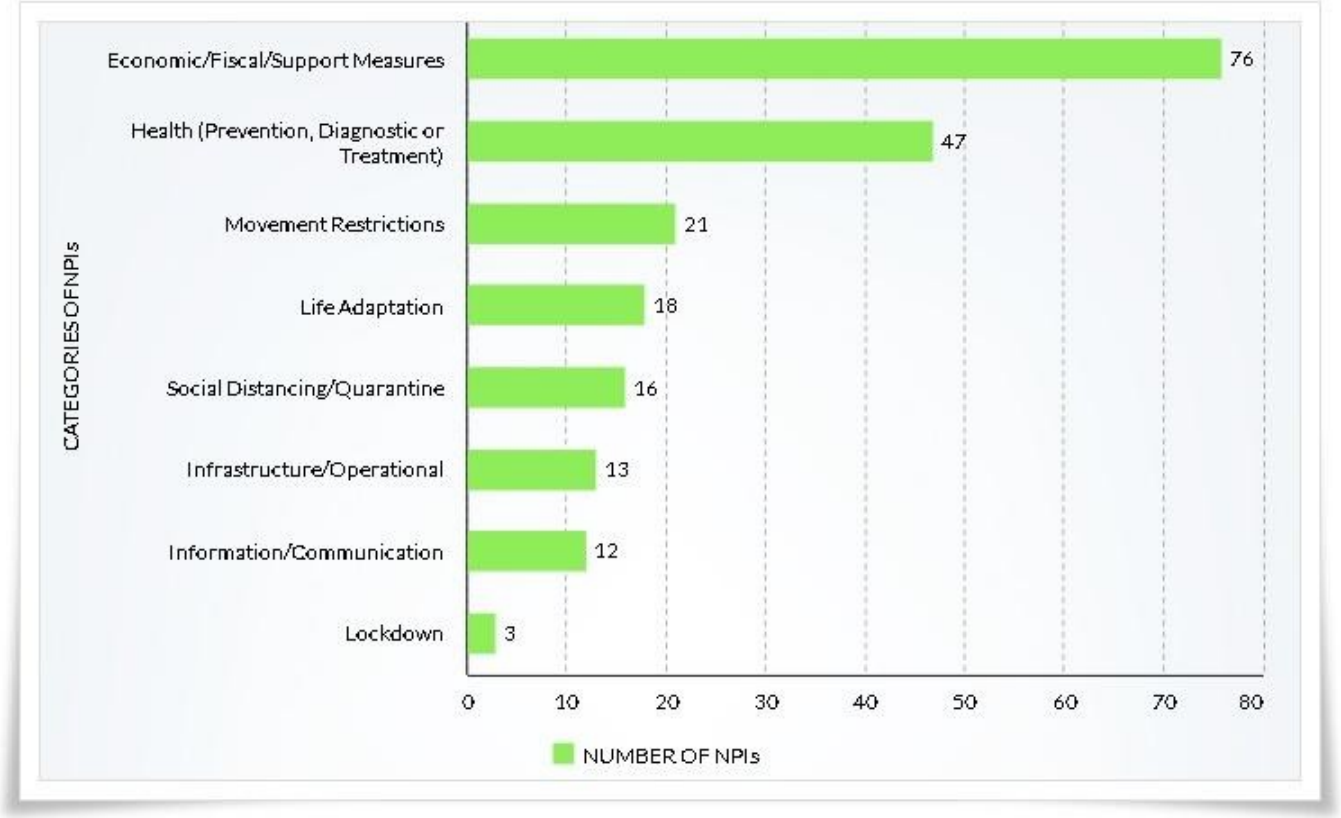

Figure 3: Number of NPIs types found around the world organized by Categories
Source: Author (2021)

4) Life Adaption focus on measures that change people routine lives to reduce the risk of infection of the virus, it is the fourth category with 18 NPIs (8.6%) such as act, law, regulation, application of fines/penalties, development of effective public-private partnership, flexible work hours, postponement local government elections, etc;

5) Infrastructure/Operation is a concern to provide the necessary infrastructure and operational support for other categories, it is the fifth category containing 17 NPIs (8.1%) such as construct field hospital, modular swab unit, set up national teams, strengthen smart labs, improve intensive care unit structures, increase ventilation, etc;

6) Social Distance/Quarantine is the category to keep people isolated, respecting social distance and quarantine actions, it is the sixth category with 16 NPIs (7.6%) such as isolation of sick persons, quarantine hotels, avoiding crowding, distance learning, school measures/closure, etc

7) Information/Communication helps the society to be correctly informed and develop correct behavior to support government and partners or other stakeholders actions, it is the seventh category containing 12 NPIs (5.7%) such as combat fake news, declare a state of emergency, mask map, general recommendations, public awareness campaigns, etc

8) Lockdown is the most severe way to isolate people, especially in an area where occurs many cases of infections. This category is the last with 3 types of NPIs (1.3%) such as full lockdown, partial lockdown, lockdown of refugees, camps, or other minorities.

It is important to notice that each NPI does not work alone, but together with others from the same category or not, depending on the pandemic level in the region. The proposed classification is not perfect, some NPIs could be classified in more than another category, but in general, it can help decision-makers to have a more broad, diverse, and organized view of potential NPIs solutions, which are in constant updating since more Management Practices are found over time.

Chart 1 to Chart 7 shows the 210 NPIs organized by categories and alphabetic order.

CATEGORY	NPIs	NPIs
Economic, Fiscal and Support Measures	1 Additional funding to strengthen the aged care system.	38 Grant for public health workers
	2 Asset purchase	39 Income tax amendment
	3 Banks to defer loan repayments for SME	40 Income tax exemption for SMEs
	4 Bonus for Start–up contract unemployed	41 Interest rate subsidies
	5 Bonus for affected education staff	42 Lay–off prohibition
	6 Budget plan for Covid-19	43 Low interest loans
	7 Campaign to raise donations	44 Payments by credit card or on line
	8 Care allowance to who can not work because they need to care children	45 Price cap on face masks, thermometers and hand sanitizer
	9 Cash and raise minimum pension 10 Cash transfers for low income families	46 Program to help people to find job; 47 Reduce import costs to facilitate access to critical goods
	11 Compensation scheme for the cancellation or postponement major events	48 Purchase emergency supply (mask, gloves, etc)
	12 Consumption coupons for the poor, emergency family care support, and support for business re–opening	49 Postponement of social security contributions and tax payment for companies.
	13 Compensation to quarantined individuals	50 Rescue package for the arts/culture sector
	14 Control of prices (food, medicine and critical equipment)	51 Relief with monthly payments, food and medicine

	NPIs	NPIs
Economic, Fiscal and Support Measures (Continuation)	15 Corporate solvency support	52 Reduction of electricity/gas/water fee
	16 Debit relief of hospitals	53 Reduce road tax rate for vehicles
	17 Economic package to support transport and travel adaptations	54 Research grant to support vaccine, drugs or test kit development
	18 Distribution of Donations	55 Rent payments suspended
	19 Economic support for sport clubs	56 Rent subsidy or reduction
	20 Emergency family allowance	57 Simplification of credit for companies
	21 Equity Injections	58 Subsidies for agricultural producers
	22 Financial aid for low income householders	59 Support to refugees and returnees
	23 Financial aid for unemployed 24 Financial aid for business re–opening	60 Subsidies and capital transfers to medical establishments
	25 Financial fund to help companies to grow the production of Covid-19 related supplies 26 Financial support for exporters	61 Subsidies for companies use digital technologies to grow their businesses and create jobs as part of economic recovery
	27 Financial fund to help companies to shift production toward Covid–related supplies	62 Suspension of toll collection 63 Tax payment deadline extended
	28 Financial support and liquidity measures for the agricultural sector	64 Tax cut; 65 Tax reliefs; 66 Tax system amendment
	29 Financial support for remote education	67 Tax breaks for trade centers and cinema
	30 Financial support for SMEs	68 Temporary suspension of all lotteries
	31 Fund to expand the number of hospital beds, medical staff & equipment	69 Temporary stop of loan payment 70 VAT reduction
	32 Financial grants for Startups 33 Fund to increase testing for Covid	71 Unemployed person do not need to pay gas, electricity or water bills
	34 Fund to increase tracing for Covid 35 Fund to support online training programs	72 Universities to cut prices on courses to help re–skill workers after coronavirus
	36 Fund to help new graduated students to find job	73 Wage incentives (bonus) for front line workers
	37 Grant for R&D to improve medical devices /serv.	74 Wage subsidies for workers

Chart 1: Examples of Economic/Fiscal/Support NPIs adopted by countries against a pandemic

CATEGORY	NPIs	NPIs
Health (Prevention, Diagnostic or Treatment)	1 Avoiding face touching 2 Avoiding handshakes 3 Conduct risk assessment;	27 Policy to ease access to testing; 28 Protection for front–line workers and service personal
	4 Disinfection of markets 5 Disinfection gateway; 6 Distribution of face masks	29 Psychological assistance 30 Pulse oximeter use and improvements
	7 Distribution of food packs to underprivileged	31 QR Code System implementation
	8 Distribution of free hand sanitizers	32 Reschedule non–urgent health or medical care
	9 Ensure availability of personal protective equipment	33 Robots to support medical actions
	10 Face shields with characters from cartoons, games and sci-fi movies; 11 Frequent hand hygiene	34 Sanitizing public spaces 35 Smart care system implementation 36 Smart Epidemic Prevention Door

	NPIs	NPIs
Health (Prevention, Diagnostic or Treatment) (Continuation)	12 Guidance for the reopening of Daycares and Pre–Schools;	37 Smart Temperature Measurement Systems
	13 Guideline for employers/employees in both public and private sector; 14 Guidelines for hair & beauty salons; 15 Guidelines to protect aged care residents 16 Hand sanitizers at any shop entrance	38 Students must bring a packed lunch 39 Surface and object cleaning 40 Temperature checks at shopping malls
	17 Health & Safety Protocols for The Tourism; 18 Health screenings in airports and borders	41 Temperature checks at airports, ports, stations, ferry terminals
	19 Home delivery of medicines to elderly persons; 20 Lung Care application; 21 Mass population testing; 22 Non-urgent surgery canceled	42 Use of Thermometers 43 Training of health safety measures for children in schools
	23 Obligatory medical tests not related to Covid–19; 24 Pharmacy Delivery Service; 25 Respiratory Etiquette (Tissue/Elbow Sneeze, etc); 26 Sanitary Protocols for Hotels;	44 Use of Negative Pressure Cabinets For Specimen Collection 45 Use of Covid–19 detection reagents 46 Village Health Volunteer Program 47 Wear mask, gloves or eye protection

Chart 2: Examples of Health NPIs developed around the world against a pandemic

CATEGORY	NPIs	NPIs
Movement Restrictions	1 Additional health documents requirements upon arrival	12 Public transport service to be limited to seated passengers only
	2 Border checks	13 Public transport reduction
	3 Border closure	14 Restrict visit to hospital
	4 Checkpoints within the country	15 Restriction on internal movement
	5 Complete Border closure	16 Surveillance and monitoring
	6 Curfews	17 Temporary ban of immigration services
	7 Domestic travel restrictions 8 International flights suspension	18 Temporary ban of international cruise ship from calling at ports
	9 International travel control	19 Temporary close of international airport
	10 Movement Control Order (MCO) 11 Public event cancellations	20 Temporary road block 21 Visa restrictions

Chart 3: Examples of Movement Restrictions NPIs developed around the world against a pandemic

CATEGORY	NPIs	NPIs
Infrastructure / Operational	1 CDC	10 Modular Swab Unit
	2 Close field hospital	11 Quarantine camps
	3 Construct field hospital	12 Set up National Teams
	4 Emergency administrative structures	13 Strengthen Central and Local Gov. Care Centers
	5 Improve Intensive Care unit Structure	14 Strength National Inf. Disease Statistic System
	6 Increase the medical personal equip	15 Strengthen SmartLabs
	7 Increase ventilation	16 Strengthening the Public Health System
	8 Laboratories 9 Mobile Test Station	17 Turns places into field hospital (Stadium, University, School, etc)

Chart 4: Examples of Infrastructure/Operational NPIs developed around the world against a pandemic

CATEGORY	NPIs	NPIs
Social Distancing / Quarantine	1 Avoiding crowding	9 Public workplace measures and/or close
	2 Business workplace measures and/or close	10 Quarantine
	3 Contact tracing	11 Quarantine hotels
	4 Distance learning	12 Schools measures and/or closure
	5 Isolation of sick individuals	13 Stay at Home
	6 Limit public gatherings	14 Suspend mass gathering
	7 Promote Telehealth	15 Teleconferences or Virtual meeting
	8 Promote teleworking from home	16 Universities measures and/or closure

Chart 5: Examples of Social Distance/Quarantine NPIs developed around the world against a pandemic

CATEGORY	NPIs	NPIs
Information / Communication	1 Combat fake news	7 Integration with Mass Media
	2 Declaring State of Emergency	8 Mask map
	3 Digital Fencing Tracking System	9 Public Awareness/Information campaigns
	4 Flu Forecast Map	10 Travel advice
	5 General recommendations	11 Use of chatbots to inform, combat fake news
	6 Installation of Hotlines or Call centers	12 Use of PTT Bulletin Board System
Lockdown	1 Full Lockdown	3 Partial Lockdown
	2 Lockdown of refugee/idp camps or other minorities	–

Chart 6: Example of Information/Communication or Lockdown NPIs applied during a pandemic

5. Methodology

The study uses a qualitative and quantitative approach, is descriptive, applied, based on bibliographic and documentary research, involving the study of articles, technical reports, official sites, guidelines, standards, manuals, collected from the internet.

To reach the specific objectives, the collection and data analysis were made in four mains phases:

Phase 1) propose a new classification method for Management practices

It was described in sections 3 and 4.

Phase 2) to present the first measures of Vietnam National Government and main partners

The investigation focus on the first measures adopted by Vietnam National Government and main partners to prepare, prevent, and control the Covid-19, before WHO declare it a pandemic on March 11, 2020. The WHO and Vietnam National Government sites, articles, technical reports, and others are the main sources used to collect data (ACAPS, 2020; HA et al 2020; IMF, 2020; IMF, 2021); LA et al 2020; LUATVIETNAM.VN, 2020; THE GOVERNMENT OF THE SOCIALIST REPUBLIC OF VIET NAM, 2020; THE GOVERNMENT OF THE SOCIALIST REPUBLIC OF VIET NAM MINISTRY OF HEALTH, 2020; TRAN et al 2020; VAN NGUYEN et al 2020; WHO, 2021).

Phase 3) to compare Vietnam´s performance against 43 semifinalist countries

Silva (2020b) developed a holistic methodology with 15 phases divided by rankings to identify the best 20 benchmark countries that are saving lives against Covid–19. In that research, Vietnam was the best country and the reason to make a new comparative analysis against the 43 semifinalists, is to check the performance evolution of this country over time when 426 days (14 months) are considered. The period of 426 days was chosen because it is the maximum number of days observed for each country until the conclusion of this article.

In addition, to reach that result, it was also used the Fatality Total Index (FTI; SILVA 2020b p. 563), an indicator that estimates the real number of fatal cases by one million population during the same period (example 426 days=FTI426) applied to each country facing the pandemic.

The data were collected daily from the worldometers site, from December 31, 2019, until April 30, 2021. For each country, the official date of the first case of Covid–19 was identified, and also the date when completed 426 days facing the pandemic (DTFC426). After that, The FTI Formula (SILVA 2020b p. 563) was applied for each country, and they are ranked in ascending order by using the FTI426.

Phase 4) to identify management practices adopted in Vietnam

In June/20, an on–line Survey <https://ufam.typeform.com/to/UL7R8M> was developed with 9 questions related to Q1) the country: with 15 benchmark countries (including Vietnam) listed, selected by the author in that time taking into consideration the FTI100; Q2) eleven cultural practices that the respondent believes were decisive for the low rate of death, with one option for those that don´t believe culture practice were decisive; Q3) how much (0–10) the respondent trust in official statistics released by the National Government about the number of deaths cases by Covid–19; Q4) what are the main policy measures (18 options, multiple choice) adopted by the National Government that saved lives against the Covid–19; Q5) an opened question to inform (if know) the name of the most innovative product or service that are protecting people against Covid–19. It aims to identify some tips for the researcher to intensify the search on the internet; Q6) the age; Q7) if the respondent is native or not; Q8) The time (years) living in the country; Q9) an open question for suggestions or to inform email, just in case the respondent is interested to receive the scientific article.

The questionnaire's main aim is to identify the perceptions of people living in Vietnam and the respondent must have more than 17 years old and living in the country for at least four months. The pilot test was from June 21st to July 21th, after that, some improvements were to make it easier to answer. The survey continues from the beginning of August until the 9th of November, 2020. Because the difficulty collecting data, it is worth noting that from 26/October to 09/November/20, another questionnaire was crated in the Vietnamese language to run together with the English version.

Facebook service “Bost a post” was contracted, invitations with the link of the questionnaire were written in English and Vietnamese, and send to the audience of Vietnam. Due to Covid–19 and cost limitations, it was tried to carry out sampling for convenience, where the researcher depends on the availability of the respondent to contribute in a volunteer way for the survey. As a result, a confidence interval or margin of error was not adopted, but it was hoped to get at least 100 correct answers.

Finally, from June 2020 until end April 2021, parallel to the online questionnaire, several searches on articles, sites of government, universities, journals, startups, associations, and companies located in Vietnam were realized to identify more responses (including innovative products and services) adopted to protect and save lives against the Covid–19.

6. Results

6.1 At least 86 MPs taken before the Covid–19 was declared a Pandemic by WHO

According to WHO Report number 24 on Covid-19 Situation in Vietnam (WHO, 2020c p.10), between January to 31 December 2020, Vietnam faced four waves of Covid-19 and around 33 Key public health interventions were implemented as shown in Figure 4.

Among the key interventions are: wear a mask, hand hygiene, respiratory etiquette, school closure, workplace closure, mass gathering ban, stay at home, restriction on internal movement, restrictions on international travel, communities/hospital lockdown, and quarantine.

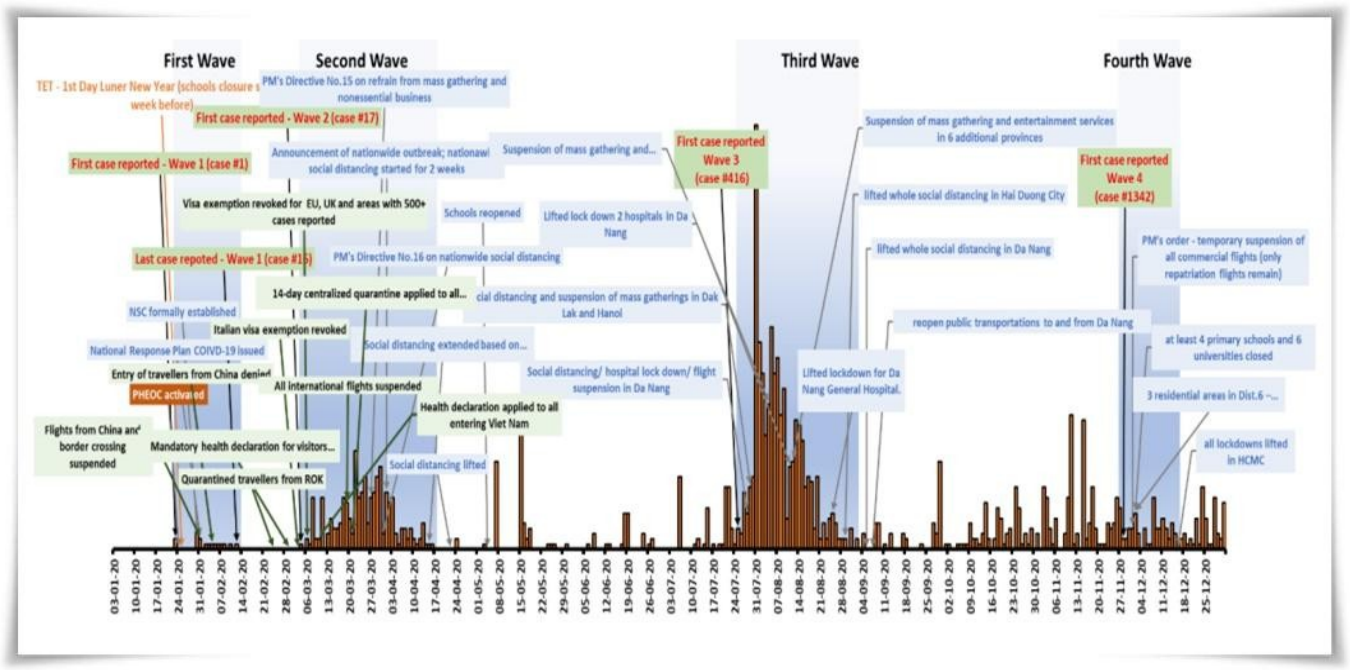

Figure 4: Key public health interventions adopted in Vietnam against Covid (January to Dec./2020)

However, when applying the concepts of sections 3 and 4 and search to Management Practices adopted by National, Local Government and main partners, the number of responses is much higher.

For instance, Chart 7 (from next page) shows that before March 11, 2020, when the Covid-19 was declared a pandemic by WHO, Vietnamese National Government leaders and main partners adopted at least 86 measures/solutions against the Covid-19. In general, among them, most (18=20.9%) is related to Life Adaptation category, followed by Health (15=17.5%), Information and Communication (16=18.7%), Infrastructure/Operation (10=11.6%), Social Distance/Quarantine (10=11.6%), Movement Restrictions (10=11.6%), Economic/Fiscal/Support (4=4.6%) and Lockdown (3.5%) categories.

It is worth noting that 13 (15.7%) measures/solutions were developed before 2020, most (7=54%) related to Legal measures such as law, decrees, circulars, and directives concerning Health issues that are valuable to prepare, prevent and control a pandemic.

In a country with few resources, another interesting case is the combination of new technologies (Apps, Lotus Platform, Zalo Platform, Facebook platform, mobiles, SMS, Youtube, etc) with the old Public LoudSpeaker System, available in every community across the country, focusing on how dangerous is Covid-19, how to mitigate the risks, the importance of participating in the Government efforts (DANG, 2020). The Public Loudspeaker System is an important technology for the older generation and those living in places without good internet access. According to Dang (2020), against the Covid-19, this system is low-cost, easy, and effective, normally operates twice a day during the early morning or in the late afternoon, depending on each community.

Finally, the two decisions taken by the Prime Minister and Ministry of Health, on 30 January 2020, to establish a National Steering Committee, as well as to set up 45 Mobile teams, seems to have contributed for the acceleration of measures necessary to guide, prevent and control the Covid-19 across the country.

FIRST MEASURES/SOLUTIONS USED	CATEGORY	WHEN
1 – Public LoudSpeaker System, Mini Cars and Motorbikes with loudspeakers	Inf/Com.	Before 2020
2 – Law 03/2007/QH12: Prevention and Control of Infectious Diseases	Life Adaptation	Before 2020
3 – CDC Vietnam's Global Health Security Program	Infra/Op	Before 2020
4 – Decree No. 101/2010/ND–CP: Medical examination & treatment in terms of implementation of isolation measures, etc	Life Adaptation	Before 2020
5 – Decree No: 75/2017 / ND–CP: Regulations on Functions, Duties, Powers and Organization Structure of the MoH	Infra/Op.	Before 2020
6 – Decree No. 176/2013/ND–CP: Penalties for Administrative violations against medical laws)	Life Adaptation	Before 2020
7 – Decree No. 89/2018/ND–CP: Implementation of the law on infectious disease prevention and control regarding border health quarantine	Life Adaptation	Before 2020
8 – Decree No. 107/2018/ND–CP: Simplify the rice export business)	Life Adaptation	Before 2020
9 – Decree No. 115/2018/ND–CP: Penalties for administrative violations against regulations on food safety	Life Adaptation	Before 2020
10 – Directive No. 12/CT–BYT: Intensifying the implementation of Non–cash payment for medical and health service	Ec/Fisc/Sup	Before 2020
11 – Circular No. 28/2019/TT–BYT: Guidelines for notification and reporting of medical quarantine activities at border	Inf/Com.	Before 2020
12 – National Network of Emergency Operations Centers (EOCs)	Infra/Op.	Before 2020
13 – Thong Tin Chinh Phu Facebook / MoH Zalo/MoH Lotus /SMS	Inf/Com.	Before 2020
14 – Public information warning about strange pneumonia	Inf/Com.	Jan/09/20
15 – Assess the epidemic situation, review response activities and propose appropriate disease prevention measures	Health	Jan/10/20
16 – Decision No: 125 / QD–BYT: Guideline for diagnosis & treatment of coronavirus infection	Health	Jan/16/20
17 – Decision No: 137 / QD–BYT: Issuing the plan for the prevention and control of the infectious epidemic in 2020	Life Adaptation	Jan/17/20
18 – Dispatch No: 62 / KCB–NV: Guidance for early detection and good preparation for disease prevention and control by nCoV	Inf/Com.	Jan/17/20
19 – Directive 03 / CT–BYT: Strengthening prevention and control of acute respiratory infections caused by a new strain of Coronavirus	Health	Jan/22/20
20 – Isolation of suspected passengers	Health	Jan/23/20
21 – Screening on passengers at airports, seaports, and land crossings	Health	Jan/23/20
22 – Suspend flight to Wuhan	Mov . Restriction	Jan/23/20
23 – Compulsory health declaration at all international ports	Inf/Com	Jan/25/20
24 – Directive 05 / CT–TTg: Prevention and Control of Covid-19	Mov . Restriction	Jan/28/20
25 – Clarifies responsibilities of ministries, agencies and localities	Infra/Op.	Jan/28/20
26 – Directive No. 05 / CT–TTg: Suspend flights from Vietnam to infected areas of China	Mov. Restriction	Jan/28/20
27 – Twenty two Hospital Hotlines free of charge to share information on Covid-19	Inf/Com.	Jan/29/20
28 – Refuse entrance of foreigners coming from China	Mov . Restriction	Jan/30/20
29 – Suspend visa issuance to Chinese tourists	Mov . Restriction	Jan/30/20
30 – Decision No. 170 / QD–Ttg: Establishment of a National Steering Committee	Infra/Op	Jan/30/20
31 – Decision No: 225 / QD–BYT: Set up 45 Mobile teams	Infra/Op	Jan/30/20

FIRST MEASURES/SOLUTIONS USED (CONTINUATION)	CATEGORY	WHEN
32 – Isolate suspected cases and Inspect the prevention actions in Nha Trang	Health	Jan/30/20
33 – Orientation to not travel to China	Inf/Com.	Jan/30/20
34 – Directive 06 / CT–TTg: Strengthening Prevention Measures	Health	Jan/31/20
35 – Regular information system with leaders of 63 departments of educ./training	Inf/Com.	Feb/ 01/2036
36 – Installation of Hotlines 19009095 and 19003228	Inf/Com.	Feb/01/20
37 – Suspend flight to China, HK, Macau, Taiwan	Mov . Restriction	Feb/01/20
38 – Decision No. 173/QD–Ttg: Declare nCoV as epidemic in Vietnam	Inf/Com	Feb/01/20
39 – Temporary School close (63 provinces)	SocDist/Quar	Feb/02/20
40 – PM/MoH alert of punishment to units that does not send report	Inf/Com	Feb/02/20
41 – Building two field hospitals with 500 beds in HCM province	Infra/Op	Feb/03/20
42 – Decree No. 15/20/ND–CP: Fake news penalties	Life Adaptation	Feb/03/20
43 – Mandatory 14 days quarantine to travelers from China	SocDist/Quar	Feb/03/20
44 – Dispatch No. 156/CD–Ttg: Restrictions of large gatherings and festivals	Mov . Restriction	Feb/03/20
45 – Official Telegraph No. 396/CD–BVHTTDL: Suspension of festivals and activities at historical monuments and sites	SocDist/Quar	Feb/03/20
46 – Building two field hospitals with 500 beds in HCM Province	Infra/Op	Feb/03/20
47 – All localities delay school reopening due to Covid-19 (until Feb 29 2020)	SocDist/Quar	Feb/05/20
48 – Preparation of 3 isolated zones in Lang Son Province	Health	Feb/06/20
49 – Decision No: 332 / QD–BYT: Update Diagnosis and treatment of acute respiratory infections caused by new Corona virus strain (2019–nCoV)	Health	Feb/06/20
50 – Directive to boost face mask production	Life Adaptation	Feb/06/20
51 – Decision No. 155/QD–BTC: List of goods eligible for import tax exemption	Ec/Fisc/Sup	Feb/07/20
52 – Exemption of Tax for medical suppliers	Ec/Fisc/Sup	Feb/07/20
53 – Decision No. 344/QD–BYT: Guidance on the health quarantine at quarantine establishments	SocDist/Quar	Feb/07/20
54 – Decision No. 345/QD–BYT: Guidance on medical isolation at home and places of residence	SocDist/Quar	Feb/07//20
55 – Launch Website <https://ncov.moh.gov.vn/> and App named 'Vietnam Health' to provide information on nCoV infection.	Inf/Com	Feb/08//20
56 – Disinfect villages at Vinh Long Province (sprayed within a radius of 300m from people infected)	Health	Feb/09/20
57 – Suspend and Fine pharmacies that increased prices in Nghe An DoH, Thua Thien Hue and Ha Long Provinces	Life Adaptation	Feb/11 to 13/20
58 – Representatives of supermarkets/distributors signed commitments to buy agricultural products that are piling up	Ec/Fisc/Sup	Feb/13/20
59 – Lockdown and quarantine in Vinh Phuc Province Son Loi Commune in Binh Xuyen District, where seven people have contracted the new coronavirus.	Lockdown	Feb/13/20
60 – Delay the end of the school year to prevent COVID–19	SocDist/Quar	Feb/14/20
61 – Extend the time of absence from students to the end of February/20	SocDist/Quar	Feb/15/20
62 – Orientation to not travel to South Korea	Inf/Com	Feb/15/20
63 – Lockdown and quarantine in Hai Phong Province	Lockdown	Feb/13/20

FIRST MEASURES/SOLUTIONS USED (CONTINUATION)	CATEGORY	WHEN
64 – Application of fines to people that were disseminating fake news in Quang Ninh, Hung Yen, Hanoi and Thanh Hoa Provinces	Life Adaptation	Feb/20 to 26/20
65 – Guidance on prevention and control of Covid–19 in medical examination and treatment establishments	Health	Feb/19/20
66 – The national intelligence management force checked and supervised 73 medical equipment manufacturing and trading establishments; handled 17 violating establishments with a fine of 16.8 million VND.	Health	Feb/22/20
67 – Directive No.10/CT-TT: Entry bans to people coming from SK	Mov . Restriction	Feb/25/20
68 – Disinfection and cleaning of buses and railways stations in Hanoi Province	Health	Feb/27/20
69 – Fine company for 30000 fake masks, detention of masks and machines in Nghe An Province	Life Adaptation	Feb/27/20
70 – Resolution No. 20 / NQ–CP of 2020: Application of export licensing regime for medical masks	Life Adaptation	Feb/28/20
71 – Mandatory 14d quarantine to travelers from SK	SocDist/Quar	Feb/29/20
72 – Suspend visa waiver program for SK people	Mov . Restriction	Feb/29/20
73 – Mandatory 14d quarantine to travelers from Italy & Iran	SocDist/Quar	Mar/01/20
74 – Fill Medical declaration upon arrival (China, Korea, Italy, Iran) in Vietnam	Health	Mar/01/20
75 – Partnership with IMPACT–MED Alliance to support the Vietnam MoH efforts in the prevention and management of Covid–19. In 2020, they trained 963 healthcare workers from 194 healthcare facilities, improved epidemic control performance of 30 hospitals across the country, and facilitated 12 online training sessions for 3400 health professional participants on COVID care and treatment	Health	Start Mar/01/20 Until Dec/31/20
76 – Fine more than 300 in Bac Giang Province for violating regulations	Life Adaptation	Mar/03/20
77 – In partnership with VMED Group the MoH launched the Vietnam Telemedicine Centre to use 4.0 digital healthcare solutions to combat Covid–19	Infra/Op.	Mar/05/20
78 – MoH launched On Line Management and Administration Center for diagnosis and treatment of COVID–19 infection	Infra/Op.	Mar/05/20
79 Lockdown in Truc Bach Street, Ha loi Village and Bach Mai hospital	Lockdown	Mar/06/20
80 – ASEAN Economic Ministers: Four days workshops to work together to deal the novel coronavirus	Life Adaptation	Mar/8 to 11/20
81 – In Partnership with Hanoi Radio and TV: The Hanoi DoE provide broadcast classes on TV for students in grades 9 and 12	Life Adaptation	Mar/09/20
82 – Suspend visa–waiver program for 8 European countries	Mov . Restriction	Mar/09/20
83 – Launch Vietnam health declaration app for foreigners	Inf/Com.	Mar/10/20
84 – MoCST & partners: Public Campaign Awareness “Joining hands to put back Covid-19”	Inf/Com.	Mar/10/20
85 – Suspend and Fine pharmacies that increased prices (Nghe An DoH Province)	Life Adaptation	Mar/11/20
86 – Fine pharmacy that increased prices in Thua Thien Hue	Life Adaptation	Mar/11/20
WHO announced Covid–19 as a pandemic	–	**Mar/11/20**

Chart 7: Example of first measures taken by Vietnam National Government and partners against the Covid–19 until March11, 2020

6.2 Vietnam is the second best performer against 43 semifinalist countries

Vietnam is a country with an intense flux of people coming from abroad. In 2019, Vietnam reported a record number of international arrival, 18 million, a rise of 16.2% when compared against 2018, with 5.8 million (32.2%) visitors coming from China (XINHUA, 2020). The proximity to China has made Vietnam (around 1357 Km from Hanoi to Wuhan, one of the first focus transmission of Covid-19), a popular destination for thousands of people traveling between these countries, especially during the Lunar New Year Holiday, celebrated on January 25, 2020, reason by which, it was a source of high concern and the adoption of rapid several measures taken by the Vietnam National Government, as shown in Chart 7.

It is worth noting that among the 44 semifinalist countries identified by Silva (2020b), Vietnam was among the first ten countries affected by Covid–19: 1) China (31th/Dec/19); 2) Thailand (13th/Jan); 3) Japan (16th/Jan); 4) SK (20th/Jan); 5 and 6) Taiwan and USA (21th/Jan); 7 and 8) Vietnam and Singapore (23th/Jan); 9) France (24th/Jan); 10 and 11) Malaysia and Australia (25th/Jan/2020).

In terms of the number of Total Fatal Cases (TFC) of Covid–19 officially reported by each 44 semifinalist countries, during 14 months (426 days), Vietnam is the fifth-best performer: 1st) Taiwan (TFC426=10); 2nd) New Zealand (26), 3rd) Iceland (29), 4th) Singapore (30), 5th) Vietnam (35). On the other hand, the USA (TFC=558321), UK (126764), Italy (109847), France (93912), and Germany (76468) are the most critical countries. However, the result changes when is used the concept of Fatality Total Index (FTI426) to estimate the real number of total fatal cases by the one million population during 426 (14 months) days facing the pandemic. Table 3 and 4 show the basic profile and performance (FTI426 in ascending order) of the 44 countries and the main results are:

a) Taiwan is the best country (Table 3), with FTI426 (last column) equal to 0.0020, followed by Vietnam (0.0025), Thailand (0.0037), China (0.0094), Singapore (0.0129), New Zealand (0.0220), Malaysia (0.0997), South Korea (0.1044), Australia (0.1134) and Hong Kong (0.1308), all considered the top ten benchmark nations, 80% from Asia and 20% from Oceania. It is important to note that a) all the ten countries reported at least one case of SARS2003; b) except New Zealand (0), South Korea (0), and Australia (0), the seven other countries reported at least two fatal cases of SARS2003, with the highest cases reported in China (349), Hong Kong (299 fatal cases), Taiwan (37), Singapore (33) and Vietnam (5), which indicate that they have learned lessons and are more prepared to face a pandemic.

Table 3: Twenty two best countries profile & performance in ascending order of FTI426

R	COUNTRIES	CONTINENT	SARS2003 TD/TC	START	P2020 (Mil)	PD20	AGE>65(20)	HBED/100K	DTFC366	TFC366	FTI366	DTFC396	TFC396	FTI396	DTFC426	TFC426	FTI426
1	TAIWAN	Asia	37 / 346 = 10,7%	21/01/20	23,82	673,00	14,00	6,98	21/01/21	7	0,0016	20/02/21	9	0,0019	22/03/21	10	0,0020
2	VIETNAM	Asia	5 / 63 = 7,93%	23/01/20	97,34	308,13	7,90	2,60	23/01/21	35	0,0029	22/02/21	35	0,0027	24/03/21	35	0,0025
3	THAILAND	Asia	2 / 9 = 22,2%	13/01/20	69,80	135,13	13,00	2,10	13/01/21	67	0,0034	12/02/21	80	0,0037	14/03/21	86	0,0037
4	CHINA	Asia	349 / 5327 = 6,55%	31/12/19	1439,32	147,67	12,00	4,34	31/12/20	4634	0,0109	30/01/21	4636	0,0101	01/03/21	4636	0,0094
5	SINGAPORE	Asia	33 / 238 = 13,87%	23/01/20	5,86	7915,73	13,40	2,40	23/01/21	29	0,0145	22/02/21	29	0,0134	24/03/21	30	0,0129
6	NEW ZEALAND	Oceania	0 / 1 = 0%	28/02/20	4,82	18,21	16,40	2,61	28/02/21	26	0,0256	30/03/21	26	0,0236	29/04/21	26	0,0220
7	MALAYSIA	Asia	2 / 5 = 40%	25/01/20	32,38	96,25	7,20	1,90	25/01/21	689	0,0640	24/02/21	1088	0,0935	26/03/21	1249	0,0997
8	SOUTH KOREA	Asia	0 / 3 = 0%	20/01/20	51,28	527,97	15,80	12,27	20/01/21	1300	0,0932	19/02/21	1550	0,1027	21/03/21	1696	0,1044
9	AUSTRALIA	Oceania	0 / 6 = 0%	25/01/20	25,50	3,20	16,20	3,84	25/01/21	909	0,1320	24/02/21	909	0,1220	26/03/21	909	0,1134
10	HK	Asia	299 / 1755 = 17,04%	23/02/20	7,50	7039,71	18,20	-	23/02/21	197	0,1435	25/03/21	204	0,1374	24/04/21	209	0,1308
11	ICELAND	Europe	NO CASE	28/02/20	0,34	3,40	15,60	2,91	28/02/21	29	0,2667	30/03/21	29	0,2465	29/04/21	29	0,2292
12	JAPAN	Asia	NO CASE	16/01/20	126,49	347,78	28,40	13,05	16/01/21	4380	0,1670	15/02/21	6952	0,2449	17/03/21	8678	0,2842
13	UAE	Asia	NO CASE	27/01/20	9,90	112,44	1,30	1,20	27/01/21	811	0,2375	26/02/21	1198	0,3243	28/03/21	1481	0,3727
14	QATAR	Asia	NO CASE	27/02/20	2,89	227,32	1,70	1,20	27/02/21	257	0,2821	29/03/21	286	0,2902	28/04/21	445	0,4197
15	NORWAY	Europe	NO CASE	26/02/20	5,42	14,46	17,50	3,60	26/02/21	622	0,4256	28/03/21	656	0,4149	27/04/21	736	0,4327
16	FINLAND	Europe	NO CASE	29/01/20	5,54	18,14	22,60	3,28	29/01/21	671	0,4765	28/02/21	742	0,4870	30/03/21	826	0,5040
17	CYPRUS	Asia	NO CASE	09/03/20	1,21	127,66	14,40	3,40	10/03/21	235	0,6661	09/04/21	268	0,7021	09/05/21	317	0,7719
18	DENMARK	Europe	NO CASE	27/02/20	5,79	136,52	20,20	2,50	27/02/21	2358	1,5727	29/03/21	2415	1,4887	28/04/21	2481	1,4217
19	ISRAEL	Asia	NO CASE	21/02/20	8,67	402,61	12,40	2,99	21/02/21	5577	2,1203	23/03/21	6122	2,1512	22/04/21	6346	2,0729
20	CANADA	North America	43 / 251 = 17,13%	27/01/20	37,74	4,04	18,10	2,50	27/01/21	19533	3,0159	26/02/21	21900	3,1252	28/03/21	22880	3,0351
21	GERMANY	Europe	0 / 9 = 0%	27/01/20	83,80	237,01	21,70	8,00	27/01/21	55358	2,8599	26/02/21	70421	3,3625	28/03/21	76468	3,3941
22	ESTONIA	Europe	NO CASE	27/02/20	1,33	31,03	20,40	4,69	27/02/21	584	2,2780	29/03/21	879	3,1689	28/04/21	1148	3,8472

Source: Author (2021)

b) On the other hand (Table 4), Spain (FTI426=34.5799), Hungary (28.1022), UK (17.1636), Italy (16.9561), Slovenia (12.6253), Czech (9.5023), Belgium (9.0280), Poland (8.5398), Lithuania (7.8307) and USA (7.8142) were the ten most critical countries with the highest number of FTI426. In this group, most (90%) is from Europe and only the USA (10%) is from North America. Besides, among these countries, 60% (Lithuania, Poland, Belgium, Czech, Slovenia, and Hungary) did not report any case of SARS2003, and all did not report any fatal case of that pandemic, indicating that they do not have experience in dealing with a high number of SARS2003 disease cases. As a result, the delay in taking appropriate measures to prepare, prevent and control the Covid-19 have contributed to the high number of fatal cases per million population over time;

c) The 44 countries' FTI426 average is 5.30656 (S=7.24; CV=136.49%), and the median equals 3.92903, with twenty–nine countries FTI426 average lower than the 5.30656. The 10 best countries´ FTI426 average is **0.0501** (S=0.0544; CV=108.45%), and the median equals 0.01743, with the five best performers countries FTI426 average equal to 0.0061.

It is worth to note that Taiwan (until Feb/15/20=no fatal cases; Jan/21/20 to March/22/21 = 0 to 10 fatal cases), Vietnam (until July/20 = no fatal cases; Jan/23/20 until Mar/24/21 = 0 to 35 fatal cases), Thailand (until Feb/29/20 = no fatal cases; Jan/13/20 until Mar/14/21 = 0 to 86 fatal cases), Singapore (until Mar/20 = 0 fatal case; Jan/23/20 until Mar/24/21 = 0 to 30 fatal cases) and New Zealand (until Mar/27/20 = 0 fatal case; Feb/02/20 until April/29/21= 0 to 26 fatal cases) can be considered the best to keep the number of total fatal cases very low during 426 days.

Table 4: 22 countries profile & performance in ascending order of FTI426 (Continuation of Table 3)

R	COUNTRIES	CONTINENT	SARS2003 TD/TC	START	P2020 (Mil)	PD20	AGE>65(20)	HBED/100K	DTFC366	TFC366	FTI366	DTFC396	TFC396	FTI396	DTFC426	TFC426	FTI426
23	AUSTRIA	Europe	NO CASE	25/02/20	9,00	106,75	19,20	7,37	25/02/21	8493	3,9264	27/03/21	9231	3,9443	26/04/21	10098	4,0109
24	NETHERLANDS	Europe	NO CASE	27/02/20	17,13	508,54	20,00	3,32	27/02/21	15543	4,3973	29/03/21	16473	4,3074	28/04/21	17104	4,1574
25	LUXEMBOURG	Europe	NO CASE	29/02/20	0,62	231,45	14,40	4,51	01/03/21	639	4,0162	31/03/21	746	4,3335	30/04/21	793	4,2821
26	MALTA	Europe	NO CASE	07/03/20	0,44	1454,04	21,30	4,49	08/03/21	334	4,1386	07/04/21	400	4,5810	07/05/21	421	4,4819
27	CHILE	South America	NO CASE	03/03/20	19,11	24,28	12,20	2,11	04/03/21	20838	4,1766	03/04/21	23524	4,3578	03/05/21	26588	4,5785
28	SWITZERLAND	Europe	0 / 1 = 0%	25/02/20	8,68	214,24	19,10	4,53	25/02/21	9954	5,3509	27/03/21	10299	5,1170	26/04/21	10584	4,8882
29	GREECE	Europe	NO CASE	26/02/20	10,43	83,48	22,30	4,21	26/02/21	6439	3,7670	28/03/21	7880	4,2607	27/04/21	10179	5,1162
30	LATVIA	Europe	NO CASE	02/03/20	1,89	31,21	20,70	5,57	03/03/21	1654	4,8468	02/04/21	1893	5,1269	02/05/21	2133	5,3701
31	PORTUGAL	Europe	NO CASE	02/03/20	10,20	112,37	22,80	3,39	03/03/21	16430	6,7941	02/04/21	16870	6,4475	02/05/21	16985	6,0343
32	SWEDEN	Europe	0 / 5 = 0%	31/01/20	10,10	24,72	20,30	2,22	31/01/21	12228	7,1514	02/03/21	13062	7,0604	01/04/21	13547	6,8069
33	IRELAND	Europe	0 / 1 = 0%	29/02/20	4,94	69,87	14,60	2,96	01/03/21	4319	7,0744	31/03/21	4687	7,0955	30/04/21	4908	6,9068
34	FRANCE	Europe	1 / 7 = 14,29%	24/01/20	65,30	122,58	20,80	5,98	24/01/21	73179	6,7360	23/02/21	85044	7,2352	25/03/21	93912	7,4270
35	USA	North America	0 / 27 = 0%	21/01/20	331,03	35,61	16,60	2,77	21/01/21	429952	7,0040	20/02/21	513602	7,7329	22/03/21	558321	7,8142
36	LITHUANIA	Europe	NO CASE	28/02/20	2,73	45,13	20,60	6,56	28/02/21	3246	7,5550	30/03/21	3567	7,6732	29/04/21	3916	7,8307
37	POLAND	Europe	NO CASE	04/03/20	37,85	124,03	18,70	6,62	05/03/21	44914	6,4556	04/04/21	54941	7,2986	04/05/21	69154	8,5398
38	BELGIUM	Europe	NO CASE	04/02/20	11,60	315,56	19,30	5,64	04/02/21	21216	9,6223	06/03/21	22215	9,3121	05/04/21	23169	9,0280
39	CZECH REP	Europe	NO CASE	01/03/20	10,71	137,18	20,10	6,63	02/03/21	21018	7,9240	01/04/21	26719	9,3102	01/05/21	29336	9,5023
40	SLOVENIA	Europe	NO CASE	04/03/20	2,09	102,62	20,70	4,50	05/03/21	3882	13,3161	04/04/21	4075	12,9192	04/05/21	4284	12,6253
41	ITALY	Europe	0 / 4 = 0%	31/01/20	60,48	205,86	23,30	3,18	31/01/21	88516	15,9033	02/03/21	98288	16,3212	01/04/21	109847	16,9561
42	UK	Europe	0 / 4 = 0%	31/01/20	67,90	272,90	18,70	2,54	31/01/21	106307	16,7534	02/03/21	123468	17,9838	01/04/21	126764	17,1636
43	HUNGARY	Europe	NO CASE	04/03/20	9,70	108,04	20,20	7,02	05/03/21	15619	18,0142	04/04/21	21775	23,2117	04/05/21	28360	28,1022
44	SPAIN	Europe	0 / 1 = 0%	31/01/20	46,76	93,10	20,00	2,97	31/01/21	58827	31,3434	02/03/21	69801	34,3730	01/04/21	75541	34,5799

Source: Author (2021)

d) The ten countries with the highest population density are: 1) Singapore (7915.73 people/Km^2), 2) HK (7039.71), 3) Malta (1454.04), 4) Taiwan (673), 5) SK (527.97), 6) Netherlands (508.54), 7) Israel (402.61), 8) Japan (347.78), 9) Belgium (315.56), and 10) Vietnam (308.13). When compared with the 10 best countries' FTI426 average (**0.0501),** special attention should be made to Taiwan (0.0020), Vietnam (0.0025), and Singapore (0.0129) because their FTI426 are lower than 0.0501, indicating that they are the best in facing the pandemic in areas with a high level of people living close to each other, confirming the findings of Silva (2021 p. 451).

6.3 At least 340 Management Practices adopted in Vietnam to save lives against the Covid–19

Between 21st June and 9th November 2020, three Boost Posts run for a total of 70 days with the invitation and link of the questionnaire. The Posts reached 109734 people living in Vietnam, from which 107 (0.097%) respondents accepted voluntarily to participate in the survey.

6.3.1 Basic profile of the respondent

a) 5min18s was the average time to answer the questions.

b) most (105=98.1%) informed the age, 57 years old is the average, the median age is 60 years old, the youngest respondent has 18 years old, and the oldest has 83 years old. This indicates that adult and old people are more motivated to participate in the survey.

c) most (59=55%) is foreigner, while 48 (45%) are native. Most foreigners (58=98.3%) accepted to inform the time living in Vietnam, with the average time being 6.21 years. Around 11 foreigners are living there for less than one year, with the lowest time living there being four months.

6.3.2 Cultural practices from the perception of 107 respondents

Only six respondents (5.6%) don´t believe that cultural practices were decisive to the low rate of Covid–19 in Vietnam, while most (101=94.4%) believe in that.

From the group that believe (Figure 5), the most decisive cultural practices were: first) wear a mask (84.2%), 2nd) wash hands (64.4%), 3rd) not shake hands (51.5), 4th) not hug in public (48.5%), and 5th) few religious assemblies (41.6%).

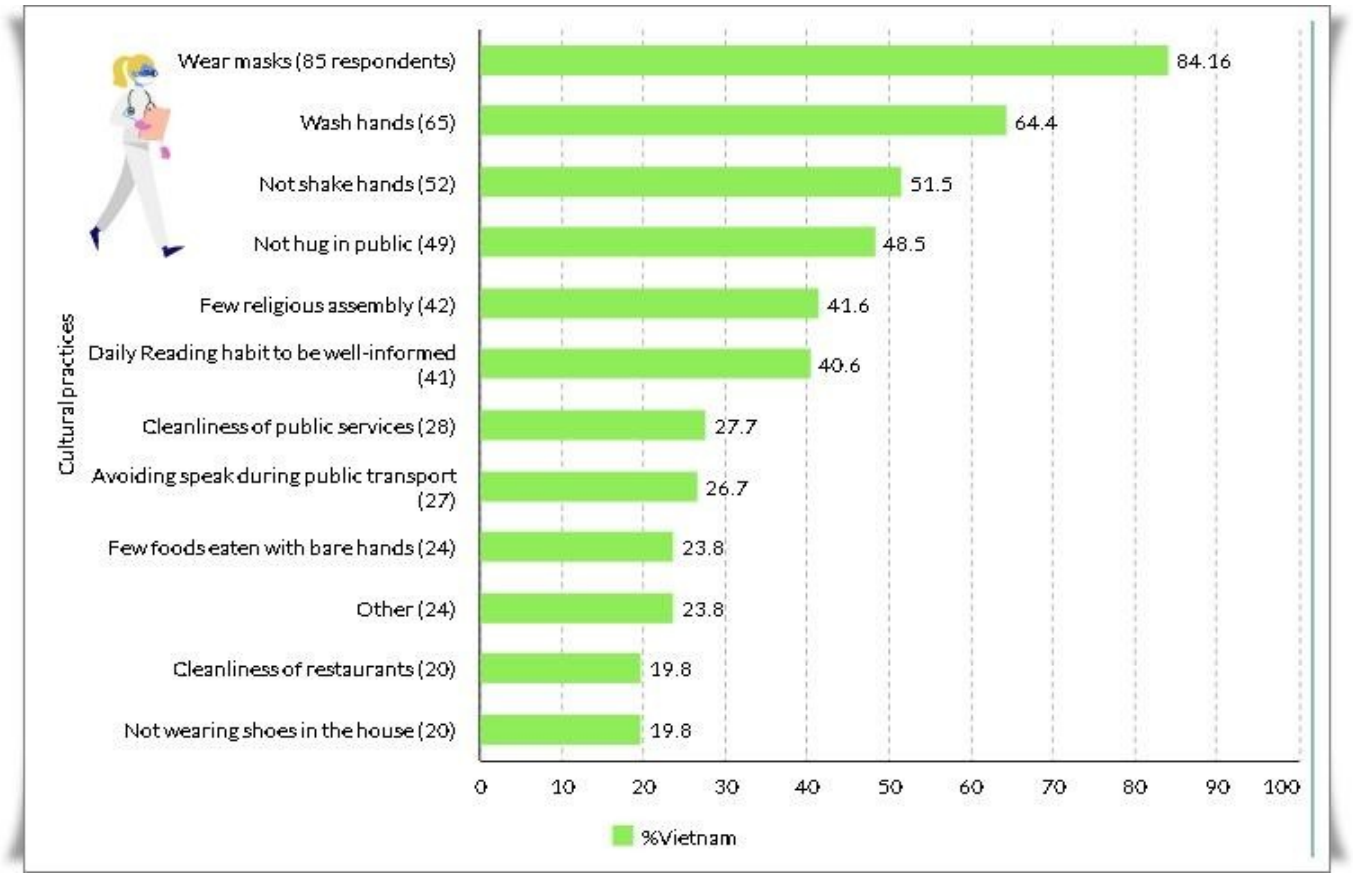

Figure 5: Perception of the 101 respondents that believes that cultural practices were decisive to reduce the rate of Covid–19 deaths in Vietnam

Source: Author (2021)

It is important to note that wear a mask, wash hands, not shake hands and not hug in public also appears among the five main cultural practices that saved lives against Covid–19 in Thailand and Taiwan, as shown respectively by Gomes da Silva (2020 p. 135) and Silva (2021 p. 453).

On the other hand, the less decisive were: 12th) not wearing shoes in the house (19.8%), 11th) cleanliness of restaurants (19.8%), 10th) Other (23.8%), 9th) few foods eaten with bare hands (23.8%), 8th) avoiding speak during public transport (26.7%), 7th) cleanliness of public services (27.7%). Here, not wearing shoes in the house, few foods eaten with bare hands, cleanliness of restaurants, and others also appear among the five less decisive cultural practices that saved lives against Covid–19, according to respondents living in Thailand and Taiwan, as shown respectively by Gomes da Silva (2020 p. 135) and Silva (2021 p. 453).

These results reveal to policy decision-makers the importance of developing programs that incorporate cultural practices during the development of an effective strategic plan to prepare, prevent and control pandemics.

For example, cultural practices of greeting such as shaking hands, hugging in public, or a kiss on the face are widely adopted greetings internationally, especially in western (USA, Brazil, Mexico, Italy, Spain) countries, which contributed to the spread of viruses and bacteria. Several countries have recommended against handshaking and other traditional forms of greeting such as kissing on the cheek and the "nose to nose" greeting. Encouraging the population to alter or adjust customary cultural practices as a form of primary prevention can be difficult, but a necessary tool to slow or alter the transmission of disease (adapted from BRUNS et al, 2020).

Finally, a good example to be followed comes from the Taiwan Ministry of Health and Welfare, where Good Etiquette of Citizen is part of the key success factor against the Covid-19 (SILVA, 2021 p. 446).

6.3.3 Trust in the National Government of Vietnam

All respondents rated from 0 to 10 the level of trust in official statistics released by the National Government of Vietnam about the number of death cases by Covid–19.

The average of trust is high (X=8.65; S=1.97; CV=22.73%) and the median is 9, with most (97=90.65%) giving a rate equal or over 7 points, while 9.35% rated lower than 7.

When the answers are compared by the foreigners and natives, only 8.5% of foreigners rated lower than 7, while 10.42% of natives did so, and the suspicion is slightly higher among old Vietnamese people.

6.3.4 The perception of the respondents on the main policy measures adopted that saved lives

Concerning the respondents' perception, most (106=99.06%) selected at least one (multiple choice) of 18 measures provided.

As a result, Figure 6 shows that for the 106 respondents, the ten main policy measures adopted by the National Government of Vietnam that saved lives against the Covid–19 are:

First) international travel control (87.7%), 2nd) public information campaigns (71.7%), 3rd) schools closures (68.8%), 4th) public event cancellations (66%), 5th) integration with mass media (54.7), 6th) restriction on internal movement (51.9%), 7th) effective public-private collaboration (50.9%), 8th) increase the medical and personal equipment capacity (45.28%), 9th) public transport reduction (44.3%), and 10th) combat fake news (46.79%).

Concerning the best policy, **international travel control**, it is possible to mention several early responses related with, shown in Chart 8 (Appendix A), such as suspend flight to Wuhan (Jan/23/20), isolation of suspected passengers (Jan/23/20), screening on passengers at airports, seaport and crossings

(Jan/23/20), compulsory health declaration at all international ports (Jan/25/20), suspend flight from Vietnam to infected areas of China (Jan/28/20), refuse entrance of foreigners coming from China (Jan/30/20), suspend visa issuance to Chinese tourists (Jan/30/20), etc.

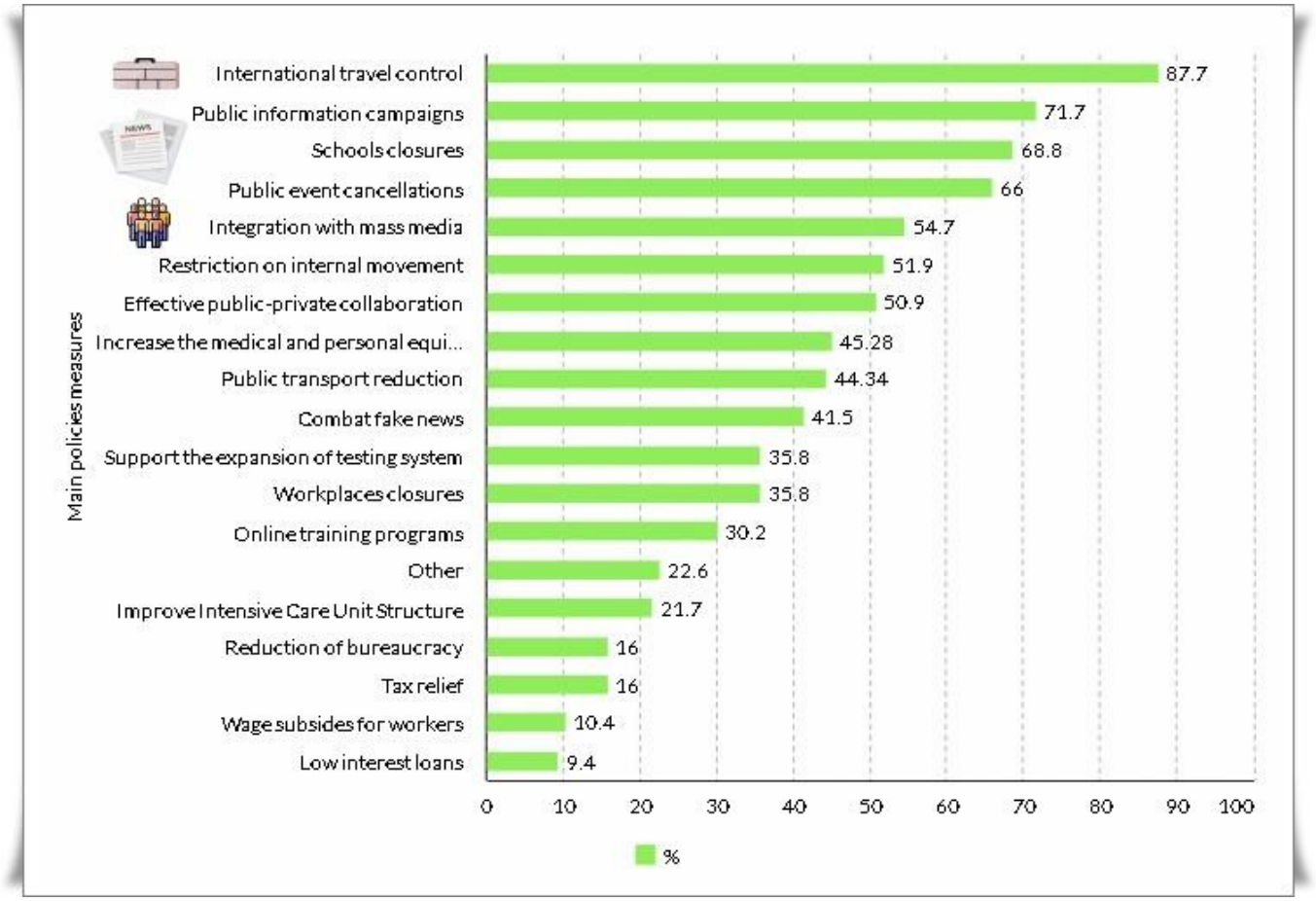

Figure 6: Perceptions of the 106 respondents on the main National Government policies that saved lives in Vietnam against Covid–19
Source: Author (2021)

Concerning **public information campaigns**, Kong Nguyen and Ho (2020) argues that a proactive communication strategy was in place in Vietnam since the beginning, using a) online media; b) social media; c) community loudspeakers, and d) pandemic awareness campaigns. For example, between March 10th to June 2020, these popular campaigns were deployed (example of sponsors: MoH or MIC) to raise public awareness and support to combat the virus: a) Joining hands to push back Covid-19 (contest); b) Every citizen, lets support fight against Covid-19 (SMS donation); c) Lets sing, Vietnam! (music challenge); d) Stay strong Vietnam in fighting Covid-19 (Community support program); e) Vietnam will win (Music collaboration); f) Farewell Covid (music collaboration); g) Proud of Vietnam (Music collaboration); h) Thank you, my Vietnam (Campaign on Facebook); i) Drawing Kindness, Covid-19 (Drawing contest).

Concerning temporary **school closures**, they were reported in Vietnam on the first day of February 2020. As of February 6th, around 63 provinces and cities reported to the Ministry of Education and Training the decision to leave school for students to prevent acute respiratory infections caused by a new strain of coronavirus (nCoV).

Concerning measures related to **public event cancellations**, they started from the beginning of February 2020, with dispatch No. 156/CD–Ttg (restrictions of large gatherings and festivals; February 3,

2020), official telegraph No. 396/CD–BVHTTDL (suspension of festivals and activities at historical monuments and sites; February 3, 2020), stopping religious activities in HCM province with more than 20 people (February 21, 2020), cancel religious festivals, entertainment activities and conferences that attract large people (March 27, 2020), the ban on the gathering of more than 10 people in outside (March 27, 2020), ban gathering of more than 20 people for 2 weeks (March 28, 2020), etc.

Concerning **integration with mass media**, Kong Nguyen and Ho (2020) informed that days before the first two Covid-19 cases were officially reported in Vietnam (January 23th 2020), local news outlets published around 295 articles about a "strange pneumonia" in China, with the earliest article dated from December 25, 2020, on the official website of Hanoi Department of Health.

To Ha et al (2020) that was a close media communication with the Ministry of Health (MoH) to disseminate information on the prevention and control of COVID–19 from the beginning. Official newspapers, the government's website, MOH's website, and open TV channels provided daily updates on positive cases globally and in Vietnam, and conveyed MoH health messages to prevent and control COVID–19, to large audiences. The broadcasting of specific new cases on national TV, and their related epidemiological information, allowed high-risk groups to be traced all over the country, especially between 7 to 20 March/20, when many citizens returned to Vietnam from Europe and the USA.

In addition, according to the Ministry of Health (2020), since February 9, 2020, the Prime Ministry signed Resolution 16/NQCP where reporters who come directly to the treatment site of COVID–19 are supported with VND 130,000 / day.

Other examples used to keep people informed are public information warning about strange pneumonia (Jan/09/20), use of old Loudspeaker system together with cars, motorbikes, TV, Radio and social media (Facebook, youtube, Zalo, Lotus, platform), daily press conferences (since Jan/01/20), directives to strengthen the prevention and control actions against the new strain of coronavirus (Jan/22/20; Jan/28/20; Jan/31/20), the installation of 22 hospitals hotlines free of charge to share information on Covid-19 (Jan/29/20), clarification of responsibilities of ministries, agencies, localities (Jan/28/30), orientation to not travel to China (Jan/31/20), development of information systems with leaders of 63 departments of education and training (Feb/01/20), development of Website <https://ncov.moh.gov.vn/> and App named 'Vietnam Health' to provide information on nCoV infection, etc.

On the other hand, the policy measures that respondents considered less decisive to save people lives are: 18th) low–interest loans (9.43%), 17th) wage subsidies for workers (10.4%), 16th) Tax relief (16%), and 15th) reduction of bureaucracy (16%).

Chart 8 (Appendix A) lists the policy measures adopted in Vietnam over time.

6.3.5 MPs identified in Vietnam against Covid–19 until April 25th, 2021

For question 5 of the questionnaire, the respondent was asked, if know, to write the name of the most innovative products or services that are protecting people in Vietnam against the Covid–19.

As a result, it was noted that most (65=60.8%) respondent tried to inform what they believed as innovative products or services, while 36 (33.6%) respondents did not answer the question, 4 (3.7%) respondents informed that they did not know, and only 2 (1.9%) informed that there was no innovative products or services.

Of 65 respondents that tried to explain the innovative solutions, fourteen (21.5%) informed the name of the products or services. It is worth noting that the main aim of the question was not to evaluate their ability in innovation issues but to find tips to search on the internet for details of the product/service name, organization, goal, period of implementation, and technologies adopted.

For the 65 respondents, the perceptions about the most innovative products or services are related to: Test Kit (19=29.2%), Public or Media information (14=21.5%), Apps (13=20%), Facemask (12=18.5%), Trace and Track (10=15.4%), Government immediate actions (10=15.4%), Webpages (7=11%), Quarantine (5=7.7%), Ventilators (3=4.6%), Telehealth (3=4.6%), Ingredients availability for vaccines (2=3%), Lockdown (2=3%), Temperature measures (2=3%), Facial recognition tech for contact tracing (2=3%), Isolation of positive cases (1=1.5%), Product for wash hand (1=1.5%), Ventilated houses (1=1.5%), Disinfection water (1=1.5%), and Sanitizer gel (1=1.5%).

With these tips, a spreadsheet was built to insert new data from the complementary research on the internet to identify the management practices, with the following fields: 1) organization and solution, which describes the name of the organization and the response developed; 2) type, divided into Corporation, Public Sector, Start-Up, University, and Other; 3) contact, informing the email or link for contact; 4) site; 5) city where it was developed/applied; 6) stage, divided into In Preparation, Pilot/Demo/ Trial, or Ready; 7) category, as described in section 4; 8) technology used; 9) resume, which describes the main information of the solution.

As a result, from June 2020 until April 24th, 2021, it was found 340 responses in Vietnam, with the majority led by Public Sector (242=71.2%), followed by Corporation (30=8.8%), Others (30=8.8%), Start-Up (21=6.2%), and University (17=5%). Regarding the stage of the responses, during the period of data collection, most (331=97.3%) are Ready, while nine (2.7%) are in Pilot/Demo/Trial.

Concerning to Category, most responses is located in Health (Prevention, Diagnostic and Treatment) category (107=31.5%), followed by Social Distance/Quarantine (62=18.2%), Information and Communication (44=12.9%), Life Adaptation (38=11.2%), Economic/Fiscal/Support (37=10.9%), Infrastructure/Operational (22=6.5%), Movement Restriction (21=6.2%), and Lockdown (9=2.6%).

Examples of Health (Prevention, Diagnostic and Treatment) responses are: a) Assess the epidemic situation, review response activities and propose appropriate disease prevention measures; b) Isolation of suspected passengers; c) Screening on passengers at airports, seaports, and land crossings; d) Disinfect villages (sprayed within a radius of 300m from people infected); e) Mobile disinfection chamber system; f) Temperature control and quick test at wholesale markets in Hanoi; g) RT-PCR COVID-19 Thai Duong (kit test); h) Ministry of Health 5K advisory message; i) Sample and Test people; j) Training on disease prevention & control to Private hospitals.

Examples of Social Distance/Quarantine responses are: a) Temporary school closure; b) Mandatory 14d quarantine to travelers from China; c) Suspend festivals and activities at historical monuments and sites; d) Decision No. 344/QD-BYT - Guidance on the health quarantine at quarantine establishments; e) Decision No. 345/QD-BYT - Guidance on medical isolation at home and places of residence; f) Mandatory 14d quarantine to travelers from SK; f) Isolation of 400 people coming from Thailand and Laos; g) Close of restaurants, barbershops; h) Directive No.16/CT-TTG (Strict social distancing rules); i) National wide 15-day social distance imposed; j) Quarantine for the whole city (Hi Duong).

Examples of Information and Communication responses are: a) Public information warning about strange pneumonia; b) 22 Hospital Hotlines free of charge to share information on Covid-19; c) Orientation to not travel to China; d) NCOVI site and app for Vietnamese; e) Public Campaign Awareness “Joining hands to pus back Covid-19”; f) Public Campaign Awareness “Every Citizen, let´s support the fight against Covid-19”; g) Travel Viet Nam Safety App; h) Circular No. 28/2019/TT-BYT - Guidelines for notification and reporting of medical quarantine activities at the border; i) thong tin Chinh Phu Facebook; j) LoudSpeaker System, Minicar and Motobike.

Examples of Life Adaptation measures are: a) Decision No: 137 / QD-BYT – Issuing the plan for

the prevention and control of the infectious epidemic in 2020; b) Decree No.15/20/ND-CP0Ttg (Fake news penalties); c) Directive to boost face mask production; d) Suspend and Fine pharmacies that increased prices; e) Broadcast classes on TV for students in grades 9 and 12; f) Stop rice export; g) Custom clearance in the Lang Son Province; h) Award certificate to officials, teachers, and staff; I) Decree No. 107/2018/ND-CP to simplify the rice export business; j) National mandatory use of masks in public places.

Examples of Economic/Fiscal/Support measures are: a) Exemption of Tax for medical suppliers; b) Representatives of supermarkets/distributors signed commitments to buy agricultural products that are piling up; c) Resolution 42/NQ-CP – Financial Assistance for People affected by covid-19; d) Donations of medical equipment to Laos and Camboja; e) Reduction of land and house rent; f) $2.6 billion fiscal packages; g) Reduce power bills for businesses and households in April, May and June 2020.

Examples of Infrastructure/Operational measures are: a) Clarifies responsibilities of ministries, agencies, and localities; b) Decision No: 225 / QD-BYT - Set up 45 Mobile teams to respond quickly to the epidemic; c) Decision No. 170 / QD-Ttg - Establishment of a National Steering Committee for the prevention and control of acute respiratory infections caused by a new strain of Coronavirus; d) Building two field hospitals with 500 beds; e) Mobile Covid-19 test stations; f) two Mobile lung X-ray vehicles; g) 169 laboratories capable of conducting RT-PCR tests nationwide; h) CDC Vietnam's Global Health Security Program.

Some example of innovative products or services are: a) Mobile disinfection chamber system developed by NIOEH, HCMC University of Technology and CSTDY; b) Isolation room sterilization robot developed by Eastern Military Medical Hospital; c) Robot BK-anti-Covid developed by Da Nang University of Science and Technology; d) Vibot Version 1a robot developed by Military Medical University; e) CD 1.0 disinfection robot (Covid Defender 1.0) developed by Ton Duc Thang University (TDTU); f) Rice ATM developed by the entrepreuner Hoang Tuan Anh, a 24/7 automatic dispensing machine providing free rice for people out of work following an ongoing nationwide lockdown to curb the spread of the novel coronavirus; g) Non-contact hand sanitizer sprayer developed by HCMC University of Technology; h) IoT devices from AIRIOT Start Up; I) Facial recognition system from VinAi Research; j) Testo 830-T2 (Infrared thermometer) and Thermal imager testo 890 Fever Detection Kit developed by Testo Company; l) Bluezone App developed by Bkav; m) Covid19 Check developed by GOT IT Start Up; n) COVID-19 Safe Living Map system (AntoanCovid.vn) developed by VNPT (Vietnam Post); o) RT-PCR COVID-19 Thai Duong a test Kit developed by NICVB; p) Corona RT-Lamp Rapid Test Kit developed by HUST & Innogenex Int. Tech. Science Co; q) LightPower iVA SARS-CoV-2 1st RT-rPCR test kit developed by Military Medical University; r) Ventilators VFS-410 and VFS-510 developed by Vingroup; s) DTU-Vent version 1.0 and 2.0 developed by Duy Tân University; t) Low-cost ventilator system from HCMC University of Technology & UTS; u) BK-Vent Supportive Respirator from HUST; v) Ventilator BAC385 1.0 and 2.0 from Bkav & National Hospital for Tropical Diseases; x) e-commerce solutions from On Point Start-Up; z) Doctor booking platform from Finizz Start-Up, etc

. Concerning to the technologies and methods used in Vietnam, it is important to notice that on line solutions are playing important role, together with Hotlines (toll-free line), Apps, Digital Guidelines or Handbooks, Temperature equipment and systems, Disinfection products, Donations, Campaigns, Youtube, E-learning, E-commerce, Database, Ventilator, Sample and Testing, Robots, Artificial Intelligence, Posters, Test Kit, QR Code, Music, Zalo Platform, Facebook, 3D Print, TV (including Broadcast classes), Radio, IoT, Digital Map, Contests, Camera Sensors, Award Certificates/Prizes, 5K Message, Tiktok, Telehealth, SMS, Smart Phones, Pharmacy Delivery, Face recognition, Custom

Clearance, Cloud Tech, Chat Bot, Big Data, Waste Management, Vehicles (with loud speakers, X ray, etc), UV Rays tech, Ultrasound, Turbine Technology, Traditional embryo egg tech, Telehealth, Storage System, Speech Recognition Technology, single PCRs, serological testing, targeted testing, ramdomic test, Silver nano, Reverse transcription loop-mediated isothermal amplification (RT-LAMP) technique, Remote system, Remote body temperature measurement, Real-time clinical data transmission software, Real time temperature measure, Real time pricing, Protein subunit, Photos, Training, PACs software, Open Source, One sprays electrolyzed water, On line conferences, On line community, News Paper, Management of antibiotic, Magnetic strip navigation technology, National Loudspeaker System, Lotus Platform, Inventory Management, Intelligent image processing system, Helm, GPS, Filters, ERP Software, Electronic Card, Documentary, Deep Learning Model, Computerized tomograpy, Chamber to disinfect, BlueTooth, Biodegradable polymers, B2B sourcing platform, Automatic Rice Dividing System, 4-5-1 nutritional formula, 360-degree ultrasonic spray system, Mini communication car, Motorbike communication..

Finally, all the 340 responses are shown in Chart 8 (Appendix A)

7. Conclusions and recommendations (Golden lessons)

To answer the main question "How Vietnam is saving people against Covid-19?", it was investigated the performance and the best practices adopted in Vietnam to save lives, during the first 426 days facing the pandemic.

From the data collection and analysis, it is possible to conclude and recommend:

1) **Partnership is crucial**. Throughout our history, infectious diseases, epidemics, and pandemics have been a constant challenge, a reason by which every nation should allocate resources, develop international and national partnerships to better prevent and respond to these threats. In this sense, it was found signs of several partnerships among Vietnam National Government and WHO, UNICEF, US CDC, and Defense Threat Reduction Agency, Media, Supermarket and Distributors representatives, Universities, Companies, Start-Ups, and Entrepreneurs. Future research should be done to identify key partnerships, the effectiveness, and the impact of their responses during the Covid-19 pandemic;

2) **Pandemic preparedness is not effective only adopting short-term measures**. Lessons from Taiwan (SILVA, 2021), Thailand (GOMES DA SILVA, 2020), and Vietnam against Covid-19 reveal that they were prepared with investments made before 2020. In the case of Vietnam Public National Sector, it was found 13 measures, most (6=46.15%) related to Life Adaptation, followed by Infrastructure/Operational (3=23.1%), Information/Communication (3=23.1%), and one (7.7%) Economic, Fiscal and Support categories. Further research should be done in Vietnam to investigate more deeply the nature and effectiveness of each preparedness investments developed over time;

3) **Virus is like a fire! Provide Fast Responses is very important.** Before WHO announce Covid-19 as a pandemic (March 11, 2020), at least 86 measures/solutions against the Covid-19 were adopted by Vietnam National Government and main partners. In general, among them, most (18=20.9%) is related to Life Adaptation category strongly related to legal issues, followed by Health (16=18.7%), Information and Communication (16=18.7%), Infrastructure/Operation (10=11.6%), Social Distance/Quarantine (10=11.6%), Movement Restrictions (10.5%), Economic/Fiscal/Support (4=4.6%) and Lockdown (3.5%) categories;

4) **Exemplar Leadership, Communication, and Transparency of Public Leaders generate trust and support.** Around 340 responses were identified in Vietnam, most led by Public Sector (242=71.2%), followed by Corporations (30=8.8%), Others (30=8.8%), Start-Up (21=6.2%), and

University (17=5%). Regarding the stage of the responses, during the period of data collection, most (331=97.3%) is Ready, while nine (2.7%) are in Pilot/Demo/Trial. In addition, for 107 respondents living in Vietnam, the average level of trust is considered high concerning the number of death cases by Covid–19 informed by the National Government. The main lesson is that National and Local Public Government leaders play an important role to inspire, educate, prepare and save lives against a pandemic. Further studies could be done to investigate the leadership style adopted by the Prime Minister and Ministries, as well as the directives, measures, and technologies used to provide transparency to citizens over time;

5) **The proposed new method to classify the measures can be helpful but needs to be improved.** Eight categories were proposed to classify Management Practices (including NPIs) adopted to prepare and combat the Covid-19 pandemic. Far from perfect, the new method helps policy and decision-makers to have a broad perspective of responses that could be taken before and during a pandemic. Further research can be done to criticize and improve the proposed method, and also to create indicators to measure the effectiveness of each category;

6) **Only public health interventions are not enough.** Among the 340 responses identified in Vietnam, most is located in Health (Prevention, Diagnostic and Treatment) category (107=31.5%), followed by Social Distance/Quarantine (62=18.2%), Information and Communication (44=12.9%), Life Adaptation (38=11.2%), Economic/Fiscal/Support (37=10.9%), Infrastructure/Operational (22=6.5%), Movement Restriction (21=6.2%), and Lockdown (9=2.6%) categories. There are many opportunities for further research in each category. One interesting focus for future research could be about how Vietnam was able to increase its laboratory capacity to test people (Infrastructures/Operation), growing from 51 laboratories (May 4th, 2020) to 169 laboratories nationwide (WHO, 2021) able of detecting Covid-19 by Realtime RT-PCR technique with 114 designated as confirmatory laboratories (April 24th, 2021);

7) **Cultural practices must be considered in any plan against a pandemic.** For 101 (94.4%) respondents living in Vietnam, the most decisive cultural practices were wearing a mask (84.2%), wash hands (64.4%), not shake hands (51.5), not hug in public (48.5%), and few religious assemblies (41.6%). Some good examples found in Vietnam to get public support with the adoption of correct behaviors are: at least eleven Public Awareness Campaign deployed over time with the support of UNICEF, WHO, UNDP, Gamuda Land Vietnam, Singers, Composers, Artists, etc. O the other hand, combat fake news, application of fines and detention to those that not follow the laws/rules are the most strict ways used in Vietnam to make people and companies adjust their behavior over time. These results reveal to policy decision-makers, the importance to develop programs that incorporate cultural practices and laws/regulations during the development of an effective strategic plan to prepare, prevent and control the pandemic. Another good example to be followed comes from the Taiwan Ministry of Health and Welfare, where Good Etiquette of Citizen is part of the key success factor against the Covid-19 (SILVA, 2021 p. 446);

8) **Public support is relevant.** For the 106 respondents living in Vietnam, the ten main policy measures adopted by the National Government that saved lives against the Covid–19 are international travel control, public information campaigns, schools closures, public event cancellations, integration with mass media, restriction on internal movement, effective public-private collaboration, increase the medical and personal equipment capacity, public transport reduction, and combat fake news. Additional research should be done to evaluate the most effective management practices (for example: Public Awareness Campaigns, Partnerships with Media or Technology Companies, Start Ups) adopted by the Government to keep the public well informed and get their support over time;

9) **Online solutions are in evidence. However, not only innovative products and services are playing an important role, but also well-known products or services**. It was found more than 100

technological solutions applied in Vietnam to prepare and combat the Covid-19. Some of them are quite new in Vietnam such as test kits, apps, 3D products, digital thermometers, disinfection robots, ventilators, rice ATMs, digital maps, intelligent helm, mobile disinfection machine, Tiktok platform, digital payment or transactions, etc. However, others are not, such as Telehealth services, Facebook, SMS, Youtube, TV, Radio, Delivery, LoudSpeaker used in cars, motors, posts, buildings and by hand (Example police´s borders), Soaps, Gel, Alcohol, Masks, Gloves, etc. In special, Public Loudspeaker System, integrated into Social Media is an example of cheap ways to fight the pandemic.

10) **Vietnam is the second-best performer, but still needs improvements.** Among the 44 semifinalist countries identified by Silva (2020b), when the concept of Fatality Total Index (FTI426) is used to estimate the real number of total fatal cases by the one million population during 426 (14 months) days facing the pandemic, Vietnam was the second-best performer behind Taiwan. However, there are areas for improvements, such as combat corruption (TRANSPARENCY INTERNATIONAL, 2020), economic support for quarantined citizens, quarantine timeline, criminal penalties for violating quarantine, economic sustainability, government surveillance technology for monitoring, level of technological advance, Covid-19 equipment availability and improve the sanitization methods (DEEP KNOWLEDGE GROUP, 2020 p. 155), reason by which new research should focus on these areas.

The research has limitations, it identified the responses considered as management practices, however, it did not evaluate their costs and effectiveness over time, which can open several opportunities for new research. Also, other research can be done with a higher number of participants to get more representative data. Further research should be done to investigate New Zealand and Singapore since these countries were also considered benchmark nations against the Covid-19 pandemic.

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9. Appendix A – Chart 8: 340 Management Practices adopted in Vietnam against Covid-19

Due to space limitation, the Chart 8 can be viewed as a spreadsheet by accessing the link <https://bit.ly/3gSJHUP>

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MOTOR DEVELOPMENT HAS A POSITIVE CORRELATION TO ACADEMIC PERFORMANCE IN SCHOOLCHILDREN

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Abstract

Some studies have investigated the association between motor development and cognitive skills. The present study aims to correlate motor development and academic performance in 79 students between 7 to 9 years old from a private school in São Paulo-Brazil. We used the Movement Assessment Battery for Children - Second Edition (MABC-2) to assess the motor development and the results of school report in

Portuguese and Mathematics as a measure of academic performance. Pearson's correlation analysis showed a positive association between motor development and cognitive skills, evidencing that students who had better academic performance, also obtained better scores in motor performance. The association between MABC-2 total score and Portuguese grade, for example, obtained a significant correlation of p <0.014. Further studies should be carried out to understand if motor development improve can modulate cognitive skills.

Keywords: Motor development; Academic performance; cognitive skills

1. Introduction

Motor development occurs progressively during infancy, the environment can promote motor experiences and influences the biological and cognitive improve. There are milestones in the child's motor development that are references for the evolutionary stages, in which each motor improve becomes the child able to exhibit a more elaborate movement (Amorim, 2018). Changes in motor behavior revels improves in motor development, so that in all age groups, there is a continuous process of learning to move with control and competence (Gallahue & Ozmun, 2005). Thus, the movement can be considered the tool of the motor development process.

Some studies have demonstrated a relationship between motor development and academic performance. Currently, the scientific literature points out that the domains of motor and cognitive development are interrelated (Papalia, 2006). Tavares and Cardoso (2016) carried out a literature review on the interrelationship of learning processes and the development of motor skills. They analyzed 7 articles and 6 of then pointed out evidence of a relationship between learning difficulties and prejudices in motor development. Children with learning difficulties had deficits in motor skills compared to their typically developing peers, which indicates a positive association between these aspects. The authors also present that difficulties in writing and reading are more often associated with problems in motor coordination and balance. Learning disabilities in mathematics are more related to perceptual-motor difficulties (temporal space organization and laterality).

Rosa Neto et al. (2007) studied the motor development of children with learning difficulties at school evaluating the following motor skills: Fine motor skills, global motor skills, balance, body scheme, spatial organization, temporal organization, and laterality. The results showed that 87.1% of the participants had an average of 16 months of motor delay in relation to their chronological age, with the main deficits in the areas of body scheme, spatial and temporal organization. So, the aim of present study is to correlate motor development and academic performance in children between 7 to 9 years old.

2. Methods

The sample consisted of 79 students (41 boys and 38 girls) from 7 to 9 years old from a private school in São Paulo-Brazil, enrolled from the 2nd to the 4th grade of Elementary School. As an exclusion criterion, reports of neurodevelopmental disorders or deficiencies in students' school records were verified. The ethical procedures were approved by the Ethics Committee in research involving human beings from

Mackenzie Presbyterian University (number 3.094.831 and CAAE number 01575018.5.0000.0084)

Movement Assessment Battery for Children - Second Edition (MABC-2), that is the gold standard for diagnosing Developmental Coordination Disorder (DCD), analyzed the performance of students' motor skills. Developed in England by Henderson and Sugden (1992), its second edition was published in 2007 (Henderson, Sugden and Barnett). MABC-2 is divided into 3 bands by age group: section 1 from 3 to 6 years old, section 2 from 7 to 10 years old, section 3 from 11 to 16 years old. Each of the sections contains 8 tasks divided into manual dexterity, ball skills and static and dynamic balance. Depending on the task, performance is assessed by time and / or number of correct answers and errors and their values are converted into standardized scores. The Brazilian version of MABC-2, band 2, used in this research, was translated, and cross-culturally adapted by Quedas (2019). Only the quantitative assessment of MABC-2 was used in the present study, due to our option of using correlation tests. Results of school report of Portuguese and Mathematics was used as indicator of academic performance. The results of these reports were composed of several assessments, such as tasks, assignments, and tests over 3 months.

Pearson's correlation analysis tested possible correlations of our variables (motor development and academic performance) and verify the possible significance. For this study, a significance level of 0.05 (5%) was defined, therefore, all intervals were constructed with 95% statistical confidence. However, the values $0.05 < p < 0.1$ for being close to the acceptance limit, were considered to tend to be significant (up to 5 percentage points above the value of the adopted alpha), so they were also described in the results as potentially significant effect.

3. Results and discussion

Table 1 describes the correlation analysis between motor development and academic performance in Portuguese. It is possible to observe significant difference in the MABC-2 total score and Portuguese grades ($p < 0.014$). It is also noted that when analyzing separately the motor skills abilities, there is a significant correlation between this discipline grade and fine motor coordination ($p < 0.002$), represented by the tasks of manual dexterity. Table 2 describes the correlation analysis between the motor development and the results of Mathematics. It is possible to observe a tendency to be significant in the MABC-2 total score with the mathematics score ($p < 0.052$).

Table 1 – Correlation analysis between the MABC-2 (total and score) Portuguese grades

MABC-2	***Pearson's r***	***p***	***n***
MANUAL DEXTERITY	0,343	0,002	79
AIMING AND CATCHING	0,158	0,164	79
BALANCE	0,026	0,820	79
TOTAL	0,275	0,014	79

Table 2 – Correlation analysis between the MABC-2 (total and score) Mathematical grades.

MABC-2	***Pearson's r***	***p***	***n***
MANUAL DEXTERITY	0,163	0,150	79
AIMING AND CATCHING	0,184	0,105	79
BALANCE	0,072	0,529	79
TOTAL	0,219	0,052	79

These results corroborate the findings of a recent study by Costa et al. (2020), whose objective was to analyze the associations between gross motor skills and academic performance of schoolchildren in in a city of São Paulo-Brazil. They assess 929 children of both sexes (5 to 11 years old) in the study. Anthropometric measurements (weight, height, waist circumference) were evaluated and motor skills were measured using the Körperkoordinationstest für Kinder - KTK test. The usual level of physical activity was assessed by means of a questionnaire and the academic performance by school reports. The results showed that students with good or very good motor coordination are 7.9 times more likely to obtain a good or excellent academic grade in Portuguese and mathematics when compared to students with motor impairment. The authors evidenced a positive relationship between gross motor skills and academic performance of schoolchildren, that is, the higher the values achieved in motor skills, the higher the values of academic grades for both Portuguese and mathematics.

Maurer and Roebers (2014) correlated motor and cognitive performance of children of 5 and 6 years. In their research, they assessed the fine motor coordination skills, using the manual dexterity scale of MABC-2, band 1. For cognitive performance, they used reading, writing and mathematics tests. Like our study, the results showed a significant correlation between motor development and academic tests. Rodrigues (2011) also found a significant and positive correlation between motor and school performance in Brazilian children of 6 to 10 years. They used the School Performance Test – TDE (Stein, 1994) to assess academic performance, which includes tasks for reading, writing and arithmetic skills. They conclude emphasizing the importance of qualified and integrated motor programs to school age children to their integral development.

Therefore, the results of this article corroborate some findings in the literature and reinforce the hypothesis that the better the student's motor development, the better his academic performance, represented here by the Portuguese and Mathematics grades. An Australian study Macdonald et al. (2020), evaluated the association between motor proficiency and academic performance in mathematics and reading, in 55 children of both sexes, from Year 1 (referring to the 1st year of Education). They observed that only fine motor coordination scores were significantly associated with both disciplines, unlike the present study, which found a correlation only with the Portuguese discipline. It also points out that the general motor proficiency obtained a significant relationship only with the discipline of mathematics, differently from the finding in this research in which there was a correlation with both disciplines.

Moreover, even the data from this research have been collected before the beginning of the covid-

19 pandemic, our results lead us to reflect about importance of motor performance and cognitive development. Many current studies have shown that, due to restrictions on circulation and social distance in function of covid-19 pandemic, there has been a significant reduction in physical activities and an increase in sedentary behavior, including school and work activities carried out by Internet. Using multinational survey performed in 14 countries, Wilke et al. (2021) examined the effect of pandemic confinements on physical activity levels. Their observed that physical activity levels have substantially decreased globally during the COVID-19 pandemic. Mitra et al. (2020) analyzed a survey data collected one month in the beginning of Covid-19 pandemic, in order to explore changes in healthy movement behaviors among Canadian children and youth. They verified a decrease in physical activity-related movements during the pandemic, including walking/biking, outdoor or indoor physical exercise and outdoor play. Similar results were observed by Schmidt et al. (2020) for German children and adolescents aged 4 to 17 years. Further results should also analyze the impact of this reduction on academic performance.

4. Conclusion

For the specific group evaluated, there was a significant correlation between motor development and academic performance, that is, students who had better grades, also obtained better scores in the motor skills of MABC-2. It is also considered that, when analyzing specific motor skills separately, manual dexterity, that is associated with fine motor coordination, was possibly responsible for the correlation with the Portuguese score. New studies should be carried out to better understand the association between motor development, and its specific skills, and academic performance in its different segments of learning. Further studies should also be carried out to understand if motor development improve can modulate cognitive skills.

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Influence of irrigation and nitrogen fertilization on the characteristics of seeds of Jatropha

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Abstract

Agronomic information on the cultivation of Jatropha plants (Jatropha curcas L.) in the field is still uncommon in the literature, especially under conditions of water and nutritional stress. Thus, this field study aimed to evaluate the effects of irrigation depths (735; 963; 1,191; 1,418 and 1,646 mm) and nitrogen fertilization (0; 25; 50 and 75 kg ha^{-1}) on the characteristics of seeds of Jatropha. Nitrogen fertilization did not influence the production components of Jatropha. The seeds have an elongated aspect, where the length is always greater than the width and thickness. The highest values of seed thickness obtained in plants under the lowest irrigation depth. Plants under the highest irrigation depth showed the highest values of seed length, total number of seeds per plant and productivity of seeds.

Keywords: *Jatropha curcas* L., biodiesel, productivity.

1. Introduction

The species Jatropha curcas belongs to the family Euphorbiaceae, which is widely distributed in tropical and subtropical areas with potential for the production of biodiesel. This species has several attributes, such as: fast growth, easy propagation, perennial plant, cultivated in areas of low and high precipitation, low cost of seeds and high oil content (Sujatha et al., 2008; Nunes et al., 2009).

According to Santos et al. (2011), the species belonging to the euphorbiae family are excellent examples of the high capacity for obtaining oil, through organic matter, for the production of biodiesel, highlighting the physic nut (Jatropha curcas L.) and the castor bean (Ricinus communis L.). Where Jatropha curcas L. is being considered an agricultural option for the Northeast region of Brazil for being a native species, demanding in insolation and with strong resistance to drought, being a culture that can be developed in family properties, contributing to the income of the owners rural areas.

However, the lack of technical and scientific knowledge about the species, especially in conditions of water and nutritional stress, generates a demand for research that makes the implantation of Jatropha possible as an agricultural crop in the country and in the world (Arruda et al., 2004; Pimenta et al., 2014 and Carvalho et al., 2015b).

Since water is a limiting factor for the expansion of agriculture, especially in arid and semi-arid regions, it is necessary to apply water artificially with the use of irrigation, making it necessary to correctly manage irrigation where are identified the depths water ideal for obtaining a balanced production of the crops to be irrigated (Carvalho et al., 2011b; Carvalho et al., 2015a).

In addition, well-conducted fertilization allows significant productivity gains in most cultivated plants. It is a production factor that can be managed at a low investment cost, but it needs to be conducted technically to avoid unnecessary use of certain nutrients that can cause unnecessary expenses and in certain cases even reduce productivity (Carvalho et al., 2011a).

In view of the scarcity of information on the cultivation of physic nut and the importance of using irrigation and nitrogen fertilization, this work aimed to evaluate the characteristics of irrigated Jartropha seeds cultivated with different doses of nitrogen fertilization.

2. Material and Methods

The experiment was carried out in the experimental area of the Bandeira Farm of the Agroempresa Brasil Ecodiesel, located in the municipality of Crateús-CE, Brazil (05˚23'25'' S; 40˚57'38'' W; 717 m). The climate of the region is BSw`h`, hot semiarid, with rainy season from February to May and mean annual rainfall of 786.7 mm, temperature of 27.1 ºC and relative air humidity of 74% (1971-2000).

The total area of the experiment was 3,750 m2 (75 x 50 m). The experiment was set in a randomized block design, using a split-plot scheme, and the treatments consisted of the combinations of five irrigation depths (plots) and four levels of nitrogen (N) fertilization (subplots), totaling 20 treatments with three replicates (Figure 1).

Figure 1. General view of the jatropha experiment in the field.

The experimental plots 250 m^2 (25 x 10 m) and consisted of 4 subplots of 60 m^2 (6 x 10 m) with two plant rows in a spacing of 3 x 2 m, totaling 10 plants per row. Each block had an area of 1,250 m^2 (25 x 50 m). In the subplot, only one plant row was used for the evaluations and the other one was used as a common border row between subplots. The last plants on each side of the evaluated plant row were also considered as border plants, i.e., out of 10 plants in each subplot, only the 3 central ones were used for evaluations.

Five irrigation depths were applied and defined from the daily evaporation measured using a Class A pan (ECA), with the following treatments: L1 = 50%; L2 = 75%; L3 = 100%; L4 = 125% and L5 = 150% of ECA, which, together with the effective rainfall, resulted in the applied water depths of 735.53, 963.30, 1,191.03, 1,418.82 and 1,646.60 mm, respectively.

N fertilization was performed according to the recommendation of the Laboratory of Soils and Water of the Soil Science Department of the Federal University of Ceará (UFC). The applied doses were 0, 50, 100 and 150% of the total recommended (50 kg ha^{-1} of N), corresponding to 0, 25, 50 and 75 kg ha^{-1} of N, with 40% of each dose applied in the form of urea (45% of N) and 60% as ammonium sulfate (21% of N and 24% of S). Phosphorus (P) and potassium (K) fertilization was the same for all treatments with doses of 50 kg ha^{-1} of P_2O_5, as single superphosphate (18% of P_2O_5; 16% of Ca^{2+} and 8% of S) and 50 kg ha^{-1} of K_2O, as potassium chloride (60% of K_2O).

Physical-hydraulic and chemical characterization of the soil for the layer of 0-0.20 m (Table 1) was performed using samples randomly collected in the experimental area. Basal and topdressing fertilizations, throughout the crop cycle, were based on the results of chemical analysis.

Table 1. Physical-hydraulic and chemical characterization of the soil in the experimental area

Parameter	Unit	Layer (m)
		0-0.20
Physical-hydraulic		
Coarse Sand	g kg^{-1}	615
Fine Sand	g kg^{-1}	307
Silt	g kg^{-1}	49
Clay	g kg^{-1}	29
Natural Clay	g kg^{-1}	17
Soil Bulk Density	kg dm^{-3}	1.54
Soil Particle Density	kg dm^{-3}	2.66
Total Porosity	%	41
Field Capacity*	%	13.24
Permanent Wilting Point*	%	5.27
Available Water Content	%	7.97
Textural Class		Sand
Chemical		
Organic Matter	g kg^{-1}	5.17

Calcium	$cmol_c\ dm^{-3}$	1.40
Magnesium	$cmol_c\ dm^{-3}$	1.40
Calcium + Magnesium	$cmol_c\ dm^{-3}$	2.80
Aluminum	$cmol_c\ dm^{-3}$	1.00
Potassium	$mg\ dm^{-3}$	31.00
Phosphorus	$mg\ dm^{-3}$	5.00
Sodium	$mg\ dm^{-3}$	3.00
pH		4.50

*The water contents at field capacity and permanent wilting point were determined using the volumetric ring method at the potentials of -0.010 MPa and -1.5 MPa, respectively

The soil preparation in the area cultivated with Jatropha consisted of plowing and a mechanical crosswise harrowing. In addition, soil liming with approximately 2 t ha^{-1} of limestone and a basal fertilization with 240 g $plant^{-1}$ of NPK (8-30-20) were performed, according to the soil chemical analysis (Table 1) and the recommendations for the crop adopted by the 'Agroempresa Brasil Ecodiesel' at the Bandeira Farm.
The water used for irrigation came from a deep well located beside the experimental area, which was analysed and classified as C_1S_1 (Table 2), with no restrictions for irrigation purposes.

Table 2. Chemical characterization of water in the experimental area

Parameter	Unit	Quantity
Cations		
Calcium (Ca^{2+})	$mmol_c\ L^{-1}$	0.19
Magnesium (Mg^{2+})	$mmol_c\ L^{-1}$	0.16
Sodium (Na^{+})	$mmol_c\ L^{-1}$	0.17
Potassium (K^{+})	$mmol_c\ L^{-1}$	0.10
Sum	$mmol_c\ L^{-1}$	0.63
Anions		
Chloride (Cl^{-})	$mmol_c\ L^{-13}$	0.42
Sulfate (SO_4^{2-})	$mmol_c\ L^{-1}$	0.01
Bicarbonate (HCO^{3-})	$mmol_c\ L^{-1}$	0.20
Carbonate (CO_3^{2-})	$mmol_c\ L^{-1}$	-
Sum	$mmol_c\ L^{-1}$	0.63
EC (Electric Conductivity)	$dS\ m^{-1}$	0.062
SAR (sodium adsorption ratio)		0.42
pH		6.8
Dissolved solids	$Mg\ L^{-1}$	62
Classification		C_1S_1

After 194 days after transplanting, pruning was performed in order to standardize all the plants at a height of 0.3 m, and

then the treatments with irrigation depths and N fertilization started.

A localized drip irrigation system (PLASTO®) was used, with service pressure of 200 kPa and nominal flow rate of 8 L h^{-1}, with emitters spaced 2 m apart, one for each plant at a distance of 0.10 m from the stem.

The irrigation depths applied in the treatments were controlled through valves according to the daily irrigation time, based on the evaporation measured in the Class A pan, as in Eq. 1.

$$Ti = \frac{(f * ECA * L_R * L_p * Fc)}{(Ei * Q_E)} \quad (1)$$

where:

Ti – irrigation time, h;

f – adjustment factor according to the treatments;

ECA – evaporation measured in the Class A pan, mm d^{-1};

LR – space between plant rows, m;

LP – space between plants, m;

Fc – soil cover factor, dimensionless;

Ei – irrigation efficiency, dimensionless (adopted value of 90%, obtained from field evaluations of the system used); and

QE – emitter flow rate per plant, L h^{-1}.

The analysed variables were:

Mean mass of seeds (MMS), in grams, obtained using a precision scale (0.01 g).

Seed length (SL), in mm, was measured with the aid of a digital caliper, measuring the longitudinal distance of the seed.

Seed width (SW), in mm, was measured with the aid of a digital caliper, measuring the equatorial distance from the seed.

Seed thickness (ST), in mm, was measured with the aid of a digital caliper, measuring the polar distance of the seed.

Mean number of seeds per fruit (MNSF), in seeds fruit-1, was determined by Eq. 2.

$$MNSF = \frac{TNS}{TNF} \quad (2)$$

Where: MNSF is the mean number of seeds per fruit, in seeds fruit-1; TNS is the total number of seeds; TNF is the total number of fruits.

Mean mass of seeds in the fruit (MMSF), in g $fruit^{-1}$, was determined by equation 3.

$$MMSF = MMS.MNSF \quad (3)$$

Where: MMSF is the mean mass of seeds in the fruit, in g $fruit^{-1}$; MMS is the mean mass of seeds, em g; MNSF is the mean nunber of seeds per fruit, in seeds $fruit^{-1}$.

Ratio between mass of seed and mass of fruit (RMSMF), in %, was determined by equation 4.

$$RMSMF = \frac{(MMS.NSF)}{MF}.100 \quad (4)$$

Where: RMSMF is the ratio between mass of seed and mass of fruit, in %; MMS is the mean mass of seeds, em g; NSF is the number of seeds per fruit and MF is the mass of fruit, em g.

Total number of seeds per plant (TNSP), in seeds $plant^{-1}$, was determined by counting the number of seeds in each plant.

Productivity of seeds (PRODS), in kg ha^{-1}, was determined by equation 5.

$$PRODS = \frac{PRODSP.\left(\frac{10000}{AP}\right)}{1000} \quad (5)$$

Were: PRODS is the productivity of seeds, in kg ha^{-1}; PRODSP is the production of seed per plant, in gram; AP is the area of the plant in m^2

The results were subjected to analysis of variance by F test and the data regarding irrigation depths and N fertilization were subjected to regression analysis. In the regression analysis, the equations that best fitted the data were chosen based on the significance of the regression coefficients at 0.01 and 0.05 probability level by F test and on the highest coefficient of determination (R^2). Variance and regression analyses were performed in electronic spreadsheets (Excel), using the software Assistat 7.7 (Silva & Azevedo, 2016).

3. Results and Discussion

The statistical analysis of mean mass of seed, seed length, seed width, seed thickness and mean number of seeds per fruit, is shown in Table 3.

Table 3. Summary of the analysis of variance for mean mass of seeds (MMS), seed length (SL), seed width (SW), seed thickness (ST) and mean number of seeds per fruit (MNSF)

Source of Variation	DF	Mean Square				
		MMS (g)	SL (mm)	SW (mm)	ST (mm)	MNSF (seeds $fruit^{-1}$)
Irrigation depths (L)	4	0.00092^{ns}	0.10903*	0.01449^{ns}	0.02422**	0.00415^{ns}
Linear regression	1	-	0.07656*	-	0.01806*	-
Quadratic regression	1	-	0.03159^{ns}	-	0.00244^{ns}	-
Cubic regression	1	-	0.00306^{ns}	-	0.00056^{ns}	-
Nitrogen levels (N)	3	0.00070^{ns}	0.00588^{ns}	0.00667^{ns}	0.00362^{ns}	0.01126^{ns}
Interaction L x N	12	0.00112^{ns}	0.03168^{ns}	0.00920^{ns}	0.00615^{ns}	0.00708^{ns}
Block	2	0.00331**	0.00573^{ns}	0.00702^{ns}	0.00175^{ns}	0.01472^{ns}
Residue (L)	8	0.00032	0.02614	0.01703	0.00340	0.00593
Residue (N)	30	0.00084	0.02439	0.00643	0.00480	0.01051
CV (L)	(%)	2.44	0.87	1.16	0.65	2.97
CV (N)	(%)	3.95	0.84	0.71	0.78	3.95

(**) Significant at 0.01 and (*) at 0.05 probability level; (^{ns}) not significant at 0.05 probability level by F test

According to the analysis of variance (Table 3), except for seed length and the seed thickness, which responded to the effects of irrigation depths, none of the Jatropha seeds characteristics responded significantly to the effects of the interaction between irrigation depths or the isolated effects of the N doses.

The maximum and minimum values of seed mass observed in this experiment were 0.79 and 0.72 grams per seed. These values are much higher than those observed by Heller (1996), who obtained values of 0.575 and 0.417 grams per seed. The results found in this experiment were very close to the maximum

limit found by Peixoto (1973) and Rocha et al. (2008) which was 0.8 grams per seed. With regard to the general mean value of 0.73 grams per seed, it is slightly higher than that found by Santos et al. (2011) who obtained an mean mass of 0.694 g.

The increase in the irrigation depths stimulated the seed length (Figure 2). The values increased from 18.60 to up to 18.79 mm, which represents an increment of 1.08% between seeds of plants under the lowest (735 mm) and the highest (1,646 mm) irrigation depths, respectively.

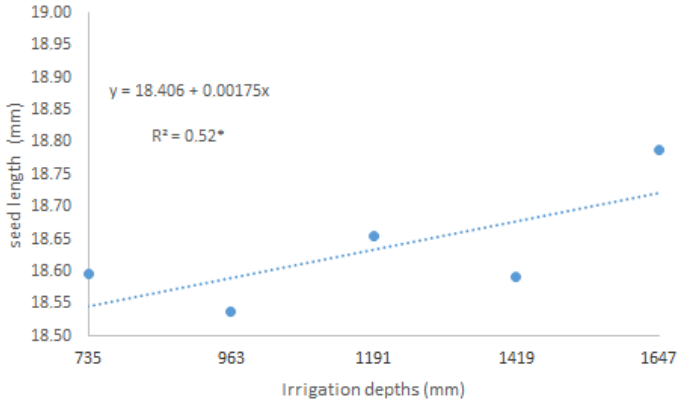

Figure 2. Jatropha seed length, depending on the water depth.

Linear equation (Figure 2) may also be used to express the behavior of seed length a as function of the different irrigation depths for its simplicity, though with value of R2 = 0.52.

The mean value of the seed length for the irrigation depth obtained in this experiment was 18.63 mm. This mean value observed for the jartropha seed length is higher than the mean values of 18.09 mm obtained by Santos et al. (2012), of 17.50 mm obtained by Pimenta et al. (2014), of 16.20 mm obtained by Nunes et al. (2009).

Similar values for seed length were reported by Dantas et al. (2007), in which their values were around 10 mm to 20 mm.

Regarding the seed width, an mean value of 11.24 mm was observed in this experiment, which is higher than the values found by Santos et al. (2012), Pimenta (2014) and Nunes (2009), which were 10.85, 10.90 and 10.7 mm, respectively.

The growing irrigation depths provided an inverse effect on seed thickness when compared to the length seed, i.e., with the addition of the irrigation depths, the thickness values dropped, resulting in a decreasing linear regression (Figure 3).

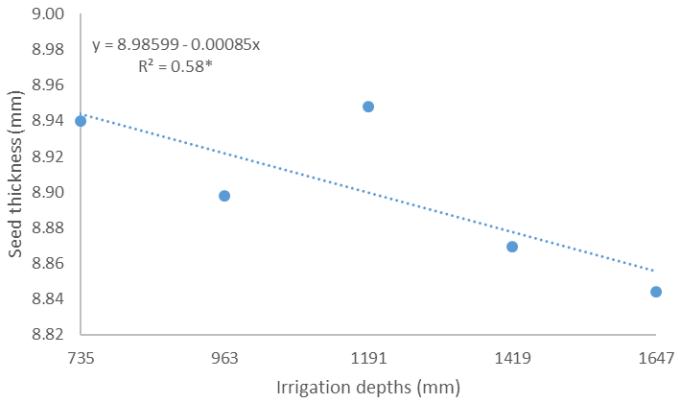

Figure 3. Jatropha seed thickness, depending on the water depth.

The seed thickness values decreased from 8.94 to up to 8.84 mm, which represents a decrease of 1.13% between seeds of plant under the lowest (735 mm) and the highest (1,646 mm) irrigation depths, respectively.

Linear equation (Figure 3) may also be used to express the behavior of seed thickness a as function of the different irrigation depths for its simplicity, though with value of R2 = 0.58.

The mean value of the seed thickness obtained in this experiment was 8.90 mm. This value is higher than that found by Santos et al. (2011) with 8.64 mm, by Pimenta et al. (2014) with 8.70 mm and by Nunes et al. (2009) with 4.70 mm.

It was also observed that due to the fact that the length is always greater than the width and thickness, the seeds presented an elongated aspect, as observed by Dantas et al. (2007), Nunes et al. (2009), Santos et al. (2011) and Pimenta et al. (2014).

With regard to the mean number of seeds per fruit, there was no influence of irrigation depths or nitrogen doses, an mean number of 2.6 seeds per fruit was obtained, where 5.61% of the fruits presented 1 seed, 28.14% of the fruits had 2 seeds, 66.14% of the fruits had 3 seeds and only 0.12% had 4 seeds.

According to the analysis of variance (Table 4), except for the total number of seeds per plant and the productivity of seeds, which responded to the effects of irrigation depths, none of the Jatropha production components responded significantly to the effects of the interaction between irrigation depths or the isolated effects of the N doses.

Table 4. Summary of the analysis of variance for mean mass of seeds in the fruit (MMSF), ratio between mass of seed and mass of fruit (RMSMF), total number of seeds per plant (TNSP), and productivity of seeds (PRODS)

Source of Variation	DF	Mean Square			
		MMSF (g fruit^{-1})	RMSMF (%)	TNSP (seeds plant^{-1})	PRODS (kg ha^{-1})
Irrigation depths (L)	4	0.00294^{ns}	0.16370^{ns}	17,308.44956**	23,805.20461**
Linear regression	1	-	-	12,930.85640**	18,728.98729**
Quadratic regression	1	-	-	7,244.73754**	9,820.37315**
Cubic regression	1	-	-	2,531.59921*	2,830.30152*
Nitrogen levels (N)	3	0.00449^{ns}	0.27214^{ns}	1,709.18585^{ns}	2,269.45446^{ns}
Interaction L x N	12	0.00567^{ns}	0.56969^{ns}	899.14007^{ns}	1,340.62244^{ns}
Block	2	0.00172^{ns}	0.16370^{ns}	76.95032^{ns}	464.63013^{ns}
Residue (L)	8	0.00430	0.36627	1,245.54107	2,040.26713
Residue (N)	30	0.00468	0.47745	881.60948	1,431.19018
CV (L)	(%)	3.45	0.94	22.55	23.62
CV (N)	(%)	3.59	1.07	18.97	19.79

(**) Significant at 0.01 and (*) at 0.05 probability level; (^{ns}) not significant at 0.05 probability level by F test

With respect to fertilization, similar results were obtained by Carvalho et al. (2013), Fernandes et al. (2013) and Carvalho et al. (2015), working with different sources of fertilization, who observed no significant effect in any of the studied growth and production components in the first crop cycle.

The increase in the irrigation depths stimulated the total number seeds per plant (Figure 4). The values increased from 136.49 to up to 224.31 seeds, which represents an increment of 64.3% between plants under the lowest (735 mm) and the highest (1,646 mm) irrigation depths, respectively.

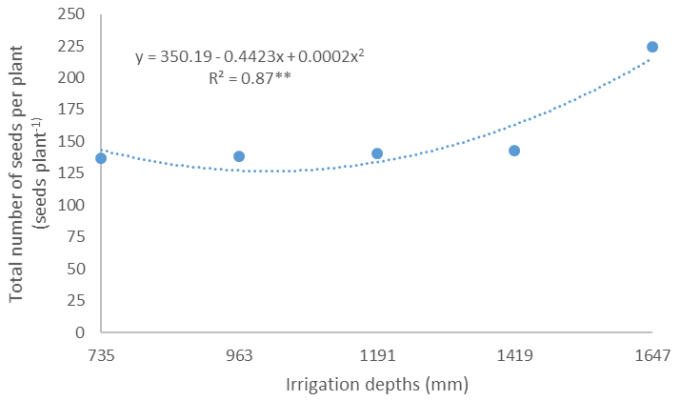

Figura 4. Total number of seeds per plant as a function of irrigation depths.

The production of seeds of Jatropha increased from 167.13 to 270.51 kg ha^{-1}, an increment of 61.86% between plants subjected to the lowest and the highest irrigation depths (Figure 5). Similarly, Silva et al. (2011) and Carvalho et al. (2015b) observed that plants showed a continuous production, especially those

under conditions of adequate water availability.

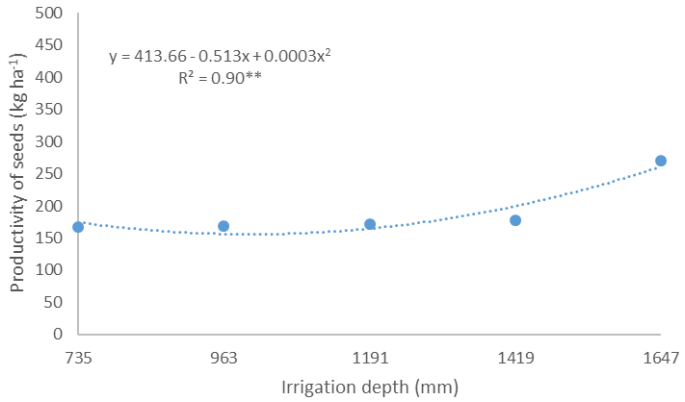

Figura 5. Productivity of seeds of Jatropha plants per hectare as a function of irrigation depths.

Oliveira et al. (2012) observed that the productivity of Jatropha plants under irrigation depth corresponding to 120% of ECA was 69% higher compared with non-irrigated plants, reaching maximum seed productivity of 192 kg ha^{-1}.

The importance of irrigation in the production of seeds of Jatropha is shown in the data of Evangelista et al. (2011), who concluded that the irrigated treatment was superior to the non-irrigated one, with seed productivity of 236.2 and 83.87 kg ha^{-1}, respectively.

In the treatments with the lowest irrigation depth, there was a reduction in the values of the production variables, which was also observed by Evangelista et al. (2009) and Carvalho et al (2015b).

According to Larcher (2000), the first and most sensitive response to water deficit is the decrease in turgor and, associated with this event, the decrease in the growth process (particularly growth in length). Water deficit compromises cell elongation, because the turgor pressure is not sufficient for cell growth, which becomes slower due to the high concentration of abscisic acid and, consequently, there is a reduction in crop growth (Carvalho et al., 2013) and production (Carvalho et al., 2015b).

4. Conclusions

Nitrogen had no effects on the characteristics of seeds of Jatropha.

The seeds have an elongated aspect, where the length is always greater than the width and thickness.

The highest values of seed thickness obtained in plants under the lowest irrigation depth.

Plants under the highest irrigation depth showed the highest values of seed length, total number of seeds per plant and productivity of seeds.

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Effects of Various Training Techniques on Bat Velocity of High School Baseball Players

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Abstract

Faster bat speed allows a baseball or softball player more time to decide how to hit the ball and provides more transfer of momentum to the ball (Nathan, 2003; Syzmanski, DeRenne, Spaniol, 2009). ***Purpose:*** *This paper examines the effectiveness of three training strategies for improving bat speed among high school baseball players.* ***Methods:*** *Nine high school students were recruited and separated into 3 groups using different training implements. A standard bat (29 oz.), a weighted bat (45 oz.), and Therabands attached to a standard bat were used over a 3-week training program. Data were analyzed using a Kruskal-Wallis ANOVA.* ***Results:*** *The standard bat group experienced no change in bat speed (± 0.89), while the weighted bat group increased by 1.9 ± 0.46 mph and the Theraband group improved by 3.1 ± 0.38 mph. The only significant difference was in the change in bat speed between the Theraband group and the standard bat group (p = .022). All other data were non-significant.* ***Conclusions:*** *Attaching Therabands to a standard bat may be an effective training tool to improve bat speed.*

Keywords: bat speed, standard bat, theraband, weighted bat, training implements

1. Introduction

Bat swing velocity is one of the most important components of a baseball or softball swing. A high swing velocity is vital for hitting success because it allows the hitter to decrease their total swing time, increase their decision-making time, and increase ball exit velocity (Nathan, 2003; Szymanski, DeRenne, & Spaniol, 2009). All of these factors can improve a baseball or softball players' offensive game performance.

Many studies have tried to identify both short-term and long-term training tools to improve bat velocity (DeRenne & Szymanski, 2009; Higuchi, Nagami, Mizuguchi, and Anderson, 2013; Kim, 2013; Kobak, Rebold, Buser, Kappler, & Otterstetter, 2018) Liu, Kiu, Kao, and Shiang, 2011; Montoya, Brown, Coburn, & Zinder, 2009; Pillmeier, Litzenberger, & Sabo, 2012; Szymanski et al., 2009; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). The studies included in this literature review looked at various warm-up implements for athletes to use in the on-deck circle as well as training implements that were used for multiple weeks to increase bat swing velocity.

1.1 On-Deck / Short-Term Strategies

DeRenne and Szymanski (2009) conducted a general review of weighted baseball implement training which described general guidelines for utilizing weighted bat implements for baseball. This review reported that on-deck, warm-up implements weighing ± 12% of the standard bat weight (30 ± 3.6 oz) showed an increase in bat velocity for high school, college, and ex-college baseball players. Studies using implements that were over or under this 12% limit showed either no significant improvement or a reduction in bat velocity (DeRenne & Szymanski, 2009).

This information was intriguing because warming up with a heavier bat or weighted implement has been a common on-deck routine for baseball and softball players for many years. It was originally thought that swinging a heavier bat would make the standard bat seem lighter and, therefore, allow the athlete to swing their bat faster (Southard & Groomer, 2003). In order to test this theory, multiple studies have tested the effect of warm-up devices on bat velocity. Surprisingly, the majority of the studies showed that there was no difference in bat velocity or that warming up with heavier weighted implements (>12% standard bat weight) showed a reduction of bat velocity (Kim, 2013; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). In spite of no beneficial change in bat speed, coaches and athletes may gravitate toward heavier implements because of the sensation of greater “normal” bat speed, identified as “kinesthetic aftereffect” (Southard & Groomer, 2003).

Additionally, some studies have identified that swinging lightweight implements as a warm-up device showed an increase in bat velocity (Montoya et al., 2009; Pillmeier et al., 2012). Montoya, Brown, Coburn, and Zinder (2009) performed a study on 19 male recreational baseball players that compared the effect of three warm-up weights; light (9.6 oz), normal (31.5 oz), and heavy (55.2 oz). This study showed a significant improvement of bat velocity with the group that was assigned the light bat warm-up implement (Montoya et al., 2009).

Similar findings were found by Pillmeier, Litzenberger, and Sabo (2012) when they analyzed four male amateur baseball players. This study also compared the effect of light (.68 kg), normal (.88 kg), and heavy (1.73 kg) weighted bats on bat velocity. Again, the highest bat velocity that was found in this study belonged to the participants that swung the lighter bat. These findings suggest that, in terms of on-deck warm-up, light weight swinging implements can be an effective tool for increasing bat velocity (Pillmeier et al., 2012).

1.2 Training / Long-Term Strategies

Other popular means of increasing bat velocity include weighted training implements and/or sport-specific training programs. Most studies so far have analyzed the effect of swinging a weighted implement over a long period of time (> 8 weeks) or performing a workout program consisting of sport-specific movements for improving rotational velocity (Higuchi et al., 2013; Kobak et al., 2018; Liu et al., 2011; Szymanski et al., 2009).

In order to swing a heavy bat, an athlete may rely on poor mechanics to execute the movement because the bat is longer and heavier than normal (Liu et al., 2011). A study performed by Liu et al. (2011) showed improved bat velocity with a weighted device. This study was unique in that it analyzed a training tool that is relatively new to baseball and softball. The dynamic moment of inertia bat was designed to have the weight start near the handle of the bat and slide down as the hitter progresses through their swing. This device allows the athlete to use a weighted bat while reducing the chance of compromising their swing mechanics. Liu et al. (2011) found that bat velocity, hitting distance, and muscle power of each arm was increased after 8 weeks of training with the dynamic moment of inertia bat.

Bat velocity also increased with a periodized, sport-specific training program. Higuchi, Nagami, Mizuguchi, and Anderson (2013) studied the long-term effects of isometric contraction conditioning on bat velocity in 24 collegiate baseball players. The study required the participants to perform an isometric contraction at the point of ball contact 3 days per week for a total of 8 weeks. The results showed a significant increase in bat velocity after the 8-week training protocol (Higuchi et al., 2013).

Kobak, Rebold, Buser, Kappler, & Otterstetter (2018) analyzed the effect of medicine ball training on bat velocity in 27 prepubescent softball players. The participants performed 8 weeks of medicine ball exercises aimed at improving rotational velocity (Kobak et al., 2018). No significant differences in bat velocity were discovered; however, it should be noted that the authors did not periodize the training program. The participants used the same weight and training volume throughout the entire study, meaning that there was little opportunity for continued adaptation to the training (Kobak et al., 2018). These findings are contradictory to those by Szymanski et al. (2009), who found improvements in bat velocity with a training program that incorporated rotational medicine ball exercises. In light of the adaptations found by Liu et al. (2011) and Higuchi et al. (2013), the findings from Kobak et al. (2018) reveal the importance of periodization for generating meaningful adaptation to training.

Szymanski et al. (2009) performed 3 different 12-week studies on high school baseball players utilizing a combination of resistance training and supplemental swing exercises. All 3 studies used the same full body resistance training protocol (7 exercises, stepwise model, 65-85% 1RM) while the supplemental swing exercises varied for each study. These supplemental exercises consisted of dry swings with a game bat in the first study, dry swings and 4 rotational medicine ball exercises in the second study, and handgrip and forearm exercises in the third (Szymanski et al., 2009).

The results of these 3 studies showed an increase in bat velocity regardless of the supplemental exercise that was used. This indicates that a general resistance training program with supplemental exercises that are specific to baseball can improve bat velocity (Szymanski et al., 2009). Furthermore, these results suggest that specificity of exercise may be another vital key to long-term bat velocity training.

1.3 Conclusion

In conclusion, research has shown multiple techniques to increase bat velocity using both short-term implements and long-term training programs. When using on-deck or warm-up implements for increasing bat velocity, coaches should encourage players to utilize implements that are within ± 12% of the standard bat weight. Warm-up implements that were over or under the suggested 12% weight significantly reduced or failed to improve of bat velocity.

Increasing bat velocity through a training program seems to follow the general guidelines for creating a strength and conditioning program. The studies that showed an improvement of bat velocity included sport-specific movements with a periodized training program. The only program that did not show an improvement in bat velocity included sport-specific movements but no periodization throughout the 8-week program. This may suggest that there is a heavier reliance on the increase in training volume compared to exercise selection; however, more research is warranted before this assumption can be clarified.

The purpose of the current study is to evaluate the impact of a short duration (3 week) training program using a weighted implement or bands on bat velocity among high school baseball players.

Method

The Institutional Review Board at the lead investigator's institution approved this study.

2.1 Participants

The participants consisted of 9 high school baseball players who volunteered for this study (ages= 16-18 years old, height = 71.3 ± 4 inches, weight= 177.2 ± 53 lbs). All of the participants in this study had previous baseball experiences at the high school or the statewide youth baseball program (ages 15-19) level. Prior to participating in this study, parental consent was obtained along with a health history questionnaire, Physical Activity Readiness Questionnaire (PAR-Q), and informed consent. In August prior to the study, all volunteers were required to pass an athletic physical to be eligible to participate in any sport affiliated with a public high school. Based on the physical exam and questionnaires, all participants were deemed healthy enough to take part in the study.

2.2 Design

This study was a randomized, control study. The participants were randomly assigned to the three groups: a standard bat group, a weighted bat group, and a Theraband group. The standard bat group served as the control group.

2.3 Instrumentation

JUGS Professional Sports radar gun, which recorded speeds in miles per hour (MPH), was used to measure bat velocity. This radar gun measures speeds that range from 5-140 MPH with an accuracy of ± 0.5 MPH (The JUGS Gun™, 2018). The radar gun was calibrated with a tuning fork prior to each testing session to clarify that it was reading the correct MPH (JUGS Sports™, 2011). The radar gun was positioned approximately 10 feet in front of the batter to measure the bat velocity of each swing. The official high school baseball, Wilson A1010, was utilized throughout the study. All participants used a 2016 Rawlings 5150 BBCOR baseball bat that measured 32 inches long and weighed 29 ounces. The baseballs were placed on a Champro Rubber Batting Tee so that height could be adjusted to align with the participant's iliac crest, which simulated a pitch that was thrown to the middle of the strike zone.

For the training sessions, there were 2 tools used for this study: a 16-ounce Easton bat weight and a variety of Theraband Latex Exercise Tubing. The 16-ounce bat weight was added to the standard bat creating a total bat weight of 45 ounces. This was the "weighted bat" used for the duration of the study. The second training tool used comprised of an assortment of Theraband Latex Exercise Tubing to add resistance during the swing. Each participant chose their own Theraband by using the color that provided a moderate amount of resistance during their swing.

2.3 Procedures

2.3.1 Pre-test

All participants took a pre-test to measure their bat velocity prior to the training sessions. Participants completed a generalized dynamic warm up and practice swings off of the tee before the testing initiated. During the pre-test, participants were instructed to conduct 3 game-like swings with the standard bat while generating as much bat velocity as they could. The tee was adjusted so that the baseball was even with the top of the iliac crest. As stated earlier, this position was selected because it replicated a ball that was thrown to the middle of the strike zone.

Once the tee height was properly adjusted, the participant was told to swing whenever they were ready. Bat velocity was measured using the JUGS Professional Sport Radar Gun, which was placed behind a screen positioned directly in front of the baseball in line with the pitcher's mound. This radar gun position was selected because, according to the owner's manual, this provided the most accurate reading. The participant completed three swings; the average velocity of the 3 swings was used as the participant's pre-test bat velocity.

2.3.2 Training sessions.

After the pre-testing was completed, participants were randomly assigned to one of three groups: a standard bat group, a weighted bat group, and a Theraband group. Participants met 5 days per week for 3 weeks for a total of 15 sessions. During these training sessions, participants were given their specified training tool to increase bat velocity. The standard bat group used the predesignated standard, non-weighted, bat. The weighted bat group added the 16-ounce bat weight to the standard bat, making it weigh a total of 45 ounces. The final group used various Therabands to create a moderate amount of resistance throughout the swing. This was not predetermined like the standard bat or weighted bat, which made it more individualized for each participant.

The participants in the Theraband group determined which colored band to use after they completed the warm up. Participants were instructed to choose the band that provided a moderate resistance from the beginning of their swing to their contact point. Because the bands created more resistance as the swing was further executed, the participants were able to reach contact, but were not able to complete the follow through portion of their swing. The Therabands were connected to a pole that was directly behind the hitter. The bands were connected to the bat 2 inches above the grip of the bat. This positioning allowed the participants to maintain as much of a normal swing as possible.

Prior to each training session, the participants were led through a generalized dynamic warm-up routine that consisted of upper and lower body stretches. The participants then warmed up their swings by hitting baseballs off of a tee at their own pace. After the participants were ready, they separated into their designated training groups and began the training protocol.

All groups had the same training protocol. Each participant was instructed to take 25 game like swings, with each swing being on a cue. A 30-second rest period began after each swing was completed to ensure the participant received adequate rest. After completion of 15 training sessions, a post-test was conducted.

2.3.3 Post-test

The post-test was conducted in the same manner as the pre-test. The average velocity of the 3 swings was used as the post-test bat velocity.

2.4 Statistical Analysis

All statistical analyses were completed using IBM SPSS Statistics 23. A Chi Square test was run to ensure there were no significant differences among the pre-test groups. After this was determined, a Kruskal-Wallis ANOVA was conducted to determine differences between pre- and post-test bat velocities within groups. Significance was set at an α of ≤ 0.05.

Results

The results showed minimal change in bat velocities between groups. Table 1 shows the average bat speeds at pre-test and post-test for all groups. All groups were similar at baseline based on the Chi Square analysis

of the pre-test bat velocities. The Kruskal-Wallis ANOVA revealed no significant differences in the post-test scores among the three groups ($p > .05$). However, when the difference between pre- and post-test velocities was accounted for, the model recommended rejecting the null hypothesis ($p = 0.027$). The only significant difference was found to be between the Theraband and the standard bat group ($p = .022$) when evaluating the change in bat speed.

	Pre-test (mph)	Post-test (mph)	Change (mph)
Weighted Bat (n = 3)	71.0 ± 4.7	72.9 ± 4.9	1.9 ± 0.5
Theraband (n = 3)	73.9 ± 11.7	77.0 ± 11.5	3.1 ± 0.4*
Standard Bat (n = 3)	73.9 ± 4.5	73.9 ± 5.4	0.0 ± 0.9

*Statistically significant ($p < 0.05$).

Table 1 Average Bat Speed Velocity for Each Group, Mean ± SD

The results of the study showed minimal significant differences, but it should be noted that there were some positive improvements seen in the averages of the weighted bat group as well. The average bat velocity for the weighted bat group before the training program was 71.0 ± 4.7 mph and the average bat velocity post training improved to 72.9 ± 4.9 mph. This shows that there were improvements seen with the weighted bat technique, but not at a statistically significant level. On the other hand, the change in bat speed for the Theraband group was statistically significant.

Discussion

Having optimal bat velocity during game-like swings is important to be a successful hitter in baseball. Individuals who have a faster bat velocity will have a longer time to track the ball, decide if it is a ball or a strike, and then begin the swing (Syzmanski, DeRenne, Spaniol, 2009). Additionally, a faster bat swing leads to an increased ball exit velocity (Nathan, 2003). The purpose of this study was to examine which training technique (standard bat group, weighted bat group, and Theraband group) improved the bat velocity of high school baseball players the most. The findings of this study showed that resistance bands had the greatest impact on bat velocity.

Although there were no statistically significant differences found in the weighted bat group, the average speed did improve by 1.9 mph. The lack of significance may be attributable to the fact that the total weight chosen for the weighted bat group was outside of the ± 12% standard (DeRenne & Szymanski, 2009). This may be because the weight chosen for this study was simply too heavy for high school players even though there was a trend toward faster bat speed.

The lack of improvements may have been due to the failure to periodize either with the bat weight or with an increase of overall number swings each week. A study conducted by Higuchi et al. (2013) showed that a periodized, sport-specific training program showed an improvement in bat swing velocity over an 8-week period. The current training program used a set number of swings in every session, which may have contributed to the lack of significant findings.

This may also help explain why the Theraband group was more successful at improving bat velocity. Not only was the Theraband group within the ± 12% range, but the resistance was also able to be increased according to the participant throughout the duration of the study. At the beginning of each session, participants were asked to select a resistance band that provided a moderate amount of resistance. As the participants progressed through the training program, the Theraband resistance increased as well. This may have provided the participant with a mild amount of periodization throughout the program, which is the most likely explanation for the Theraband group producing a significant improvement in bat velocity.

Practical Applications

Coaches who are hoping to improve the bat speed of their high school athletes may find that bands are the best choice. If coaches have longer than 3 weeks to train their athletes for these improvements, they may find that a heavy weighted bat is also beneficial. There was an improvement in bat speed among the weighted bat group, which allows this recommendation. However, other research shows that a lighter bat and a periodized training plan would be more likely to have a positive impact on bat speed (DeRenne & Szymanski, 2009; Higuchi et al., 2013; Kobak et al., 2013).

Future research needs to focus on techniques to improve bat velocity that are within $\pm$12% of an individual's game bat weight and follow a periodized format. Specifically, research should examine how much periodization is needed to see improvements when it comes to baseball or softball swing progressions. There are currently no guidelines in place for a periodized swing program both with and without training implements.

Conclusions

In conclusion, research has shown multiple techniques may be used to increase bat velocity using both on-deck/short-term and training/long-term strategies. When using on-deck warm-up implements for increasing bat velocity, sport coaches as well as strength and conditioning coaches should encourage players to utilize implements that are within ± 12% of the standard bat weight, according to previous research (Kim, 2013; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). Training, or long-term, strategies should emphasize similar weights to the on-deck strategies and rely heavily on periodization to increase the likelihood of success.

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Chemical investigation, antifungal activity and anatomical aspects of *Protium puncticulatum* J.F Macbr. and Protium tenuifolium (Engl.) Engl

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Abstract

*Protium Burm. f. (Burseraceae) is well known in the Brazilian Amazon for its diversity of species, though some of them are difficult to identify based on only morphological characteristics. We investigated the species Protium puncticulatum J.F. Macbr. and Protium tenuifolium (Engl.) Engl. in relation to their chemical constituents and some biological aspects. The phytochemical study of the hexane extract from the trunk of P. puncticulatum led to the identification of a mixture of triterpenes: α, β-amyrin (**1** and **2**), and lupeol (**3**); the methanolic extract gave the lignans 7-oxo-parabenzolactone (**4**) and 7'-hydroxy-9α-methylcubebin (**5**); this last lignan showed a MIC of 320 µg/mL for Candida albicans and 160 µg/mL for Cryptococcus neoformans and C. gattii. The hexane extract from the branches of P. tenuifolium also provided a mixture of α and β-amyrin (**1**, **2**); the methanolic extract gave dimeric alkylresorcinols named integracin B (**6**) and integracin A (**7**). Analyses of anatomical characteristics confirmed the identity of the species Protium tenuifolium (Engl.) Engl. Essential oils obtained via hydrodistillation from the fresh bark of the trunk of P. tenuifolium showed a predominance of the monoterpenes limonene (56.17%), α-phellandrene (16.22%) and ρ-cymene (10.52%). This study is important since it increases knowledge on the volatile and non-volatile chemical constituents of the woody parts of two species of Protium from the Amazon.*

Keywords: *triterpenes; lignans; alkylresorcinols derivatives; essential oil; monoterpenes.*

1. Introduction

Protium Burm. f. (Burseraceae), commonly known as "breu" in the Brazilian Amazon, is well known for its diversity of regional species. There are approximately 73 species, 42 of which are endemic to the region (Daly, 1992). However, the genus has species that are difficult to identify based on only morphological characteristics (Daly, 1989). Studies related to the non-volatile chemical constituents of Amazonian species demonstrate the predominance of pentacyclic triterpenes with ursane and oleanane skeletons in leaves (Guimarães and Siani, 2007), stem bark (Zoghbi et al., 1993; Costa et al., 2012) and resins (Almeida et al., 2015; Susunaga et al., 2001); and lignans of dibenzylbutitolactone and arylnaphthalene types have been found in the trunk wood (Siqueira et al., 1995; Siani et al., 1998). As these are resinous species, there is considerable interest in studies of their essential oils, since these have high yields and their volatile constituents are predominantly monoterpenes (Lima et al., 2014; 2016; Zoghbi et al., 2005; Pinto et al., 2013) and sesquiterpenes (Oliveira et al., 2018; Carvalho et al., 2010).

The species *Protium puncticulatum* J.F. Macbr. [syn. *Protium juruense* Swart] has confirmed occurrence in northern Brazil (Acre, Amazonas, Rondônia), *Protium tenuifolium* (Engl.) Engl. [syn. *Protium neglectum* Swart; *Icicopsis tenuifolia* Engl.] is distributed in the Amazon (Flora do Brasil, 2021). Both species, known as "breu" and breu-vermelho", lack studies related to their volatile and non-volatile chemical constituents.

2. Materials and Methods

2.1 General experimental procedures

NMR spectra of compounds **1-5** were measured using a Bruker Fourier-300 apparatus. Analyses of compounds **6** and **7** by LC-DAD SPE/NMR were performed on a chromatograph (1200 series; Agilent GmbH) equipped with a quaternary pump (G1311A) and a degasser (G1322A), a variable wavelength diode array detector (G1315D), and an autosampler (Bruker Biospin GmbH). The LC system was controlled by HyStar 2.3 software (Bruker). A Knauer (K120 Knauer Smartline Pump Control 100, Bruker Daltonics GmbH©, V01.11) make-up pump diluted the post-column flow with water before the peaks were trapped using a Prospekt 2 SPE unit. The 1D and 2D NMR spectra of the isolated compounds were acquired at 299 K with the use of a Bruker Avance III instrument (14.1 Tesla/600 MHz) equipped with an automatic sample changer and a 5 mm inverse triple resonance cryoprobe (1H/13C/15N) and with a z-field gradient. LC-HRMS measurements were obtained using a MicroTOF-QII (Bruker Daltonics) mass spectrometer connected to an LC (Prominence UFLC, Shimadzu). Mass spectra were acquired using an ion trap spectrometer (LCQ Fleet^{TM}, Thermo Scientific) equipped with an electrospray source, operating in positive mode. Analyses of volatile constituents were performed on a Shimadzu QP5000 instrument equipped with a DB-5 fused silica capillary column.

2.2 Obtaining samples and extractions

Samples from *Protium puncticulatum* (trunk) and *Protium tenuifolium* (branches and stem bark) were provided by the Wood Technology Laboratory at the Instituto Nacional de Pesquisas da Amazônia (INPA), and originated from the leftovers of studies of the wood species that were collected in the Estação

Experimental Silvicultura Tropical (53 Km north of the city of Manaus, Amazonas state). The samples from the trunk and branches were submitted to drying and then pulverized in a knife mill. Subsequently, extracts were obtained through successive macerations with hexane and methanol for a period of 7 days for each solvent at room temperature. Samples of fresh trunk bark of *P. tenuifolium* were submitted to hydrodistillation (triplicate) for 4 hours using a Clevenger-type apparatus.

2.3 Chromatographic fractionation of extracts from Protium puncticulatum

The hexane extract from the trunk (215 mg) was fractionated in a silica gel column (70-230 mesh; h X Φ = 39.4 X 2.3 cm) using hex:EtOAc (9:1) as the gradient to provide a mixture (9.2 mg) of triterpenes α,β-amyrin (**1**, **2**) and lupeol (**3**), as well as a mixture (22.1 mg) of the known steroids β-sitosterol and stigmasterol. The methanolic extract (7.35 g) was subjected to a fractionating column with Sephadex LH-20 eluted in methanol that generated 20 fractions, fractionation of fr. 4 (2.3 g) in a silica gel column (70-230 mesh; h X Φ = 54.8 X 3.2 cm) eluted with CH_2Cl_2:MeOH (98:2 → 9:1) generated 14 subfractions, for which the subfr grouped 8-9 by the process of recrystallization with methanol to give compound **4** (124.4 mg); fractionation of the subfr 10-12 in Sephadex LH-20 column eluted with MeOH followed by silica gel column (230-400 mesh) eluted with CH_2Cl_2: EtOAc (98:2 → 9:1) gave compound **5** (10 mg).

2.4 Chromatographic fractionation of extracts from Protium tenuifolium

The hexane extract of samples from the branches was fractionated over a chromatographic column of silica gel (70-230 mesh; h X Φ = 33.0 X 2.8 cm), using hexane, hex: EtOAc (9:1→8:2) as the gradient to give a mixture of α, β-amirina (**1** and **2**; 36 mg), and also a mixture of β-sitosterol and estigmasterol (115 mg). The methanolic extract (10.9 g) was successively partitioned with dichloromethane, ethyl acetate, and methanol. The dichloromethane phase (1.6 g) was fractionated in a sílica gel chromatography column (70-230 mesh; h X Φ = 27.0 X 3.5 cm) eluted with hexane, hex:AcOEt (9:1→7:3). Fractions 14-15 (12 mg) were rechromatographed in a Sephadex LH-20 column eluted with MeOH and then subfractions 11-16 (5 mg) were analyzed using LC-DAD SPE/NMR.

2.4.1 Isolation of compounds 6 and 7 from subfractions 11–16

A 5 mg portion of the subfr 11-16 was dissolved with 1.5 mL of acetone, and the solution was filtered through a PVDF membrane syringe filter (25 mm, 0.45 μm; Tedia, Brazil) prior to the LC analysis. The chromatographic separations were carried out using an analytical Eurobond Prontosil C18 column (125 × 4.0 mm, 5 μm) with a 20 μL injection volume. Gradient elution was performed using a combination of CH_3CN/Milli-Q H_2O with a linear gradient varying from 0-100% of CH_3CN, with a flow rate of 0.8 mL/min for the separation of the two chromatographic peaks of interest. The two compounds were adsorbed on solid-phase extraction cartridges (HySphere Resin GP, 10 mm × 2 mm, 10 μm spherical polydivinylbenzene stationary phase) using an automatic cartridge exchanger (Bruker Biospin GmbH,). After the adsorption process, the cartridges were dried with nitrogen for 30 min to remove residual solvent. CD_3OD (99.8% D) was used to elute compounds **6** and **7** from the SPE cartridges directly into NMR tubes (Bruker, 3 mm o.d.) for analysis.

2.5 Essential oil analysis

Quantitative analysis of the volatile constituents were performed on a GC-MS (QP5000, Shimadzu), operating by electron impact (70 eV), which used a DB-5 (30 m × 0.25 mm × 0.25 μm) capillary column in the GC experiment. The operating conditions were as follows: carrier gas was helium (flow 10 $mL.min^{1}$); temperature program at 60-240 ºC (3 $ºC.min^{-1}$); injection size of 1.0 μL; sample injection temperature at 250 ºC; detector temperature 290 ºC; split 1:20. The compounds were identified by comparing their mass spectrum to those of the database of the GC-MS (NIST 62.lib), literature (McLafferty and Stauffer, 1989) and retention indices (Adams, 2007). Quantitative analysis was performed using a GC 2010 GC-FID (Shimadzu) using the same conditions as the GC-MS method.

2.6 Antifungal assay

Cryptococcus neoformans (ATCC 90112), *Cryptococcus gattii* (ATCC 32269) and *Candida albicans* (ATCC 60193), from the culture collection at the Instituto Nacional de Pesquisas da Amazônia (INPA) in Manaus, Amazonas state, Brazil, were used as references. Minimum inhibitory concentration (MIC) assays were performed using the broth microdilution method, as described by the Clinical and Laboratory Standards Institute in documents M27-A3 (CLSI, 2008). Amphotericin B was used as the antifungal standard.

2.7 Macroscopic analysis of Protium tenuifolium

The woody species was identified via macroscopic analysis and comparison with samples available in the xylotheque of the Instituto Nacional de Pesquisas da Amazônia (INPA).

2.8 Spectroscopic data of compounds

α and β-amyrin(**1** and **2**) and lupeol (**3**). ^{1}H NMR (300 MHz, TMS, $CDCl_3$, δ, ppm, J/Hz): Text. ^{13}C NMR and DEPT (75 MHz, $CDCl_3$, δ, ppm): Text.

7-*oxo*-Parabenzolactone (**4**). HRMS m/z 369.0975 $[M+H]^{+}$. ^{1}H NMR (300 MHz, TMS, $CDCl_3$, δ, ppm, J/Hz): δ 7.28 (1H, dd, J = 8.0 and 1.7, H-6), 7.19 (1H, d, J = 1.6, H-2), 6.81 (1H, d, J = 8.0, H-5), 6.59 (1H, sl, H-2'), 6.62 (1H, d, J = 8.0, H-5'), 6.54 (1H, dd, J = 8.0 and 1.7, H-6'), 6.06 and 5.88 (4H, sl, OCH_2O), 4.42 (1H, t, J = 8.5, H-9a), 4.16 (1H, t, J = 8.4, H-9b), 4.05 (1H, m, H-8), 3.49 (1H, m, H-8'), 3.08 (1H, dd, J = 14.1 and 6.5, H-7a'), 2.94 (1H, dd, J = 14.1 and 6.5, H-7b'). ^{13}C NMR (75 MHz, $CDCl_3$, δ, ppm): 194.5 (C-7), 177.0 (C-9'), 152.6 (C-3), 148.5 (C-4), 147.9 (C-3'), 146.5 (C-4'), 130.6 (C-1'), 130.3 (C-1), 124.8 (C-6), 122.5 (C-6'), 109.6 (C-5'), 108.0 (C-2'), 108.2 (C-2), δ 107,9 (C-5), 102.1 ($O\underline{C}H_2O$), 101.0 ('$O\underline{C}H_2O$'), 68.1 (C-9), 46.6 (C-8), 44.8 (C-8') and 34.6 (C-7'). HSQC (300/75 MHz, $CDCl_3$): Text. HMBC (300/75 MHz, $CDCl_3$): 7.28 → 108.29, 148.52, 194.54; 7.19 → 148.52, 124.84, 152.65, 194.54; 6.81 → 130.30, 152.65, 148.52; 6.62 → 34.63, 122.50, 130.68, 146.58, 6.59 →122.50, 130.68, 194.54; 6.54 → 34.63, 107.92, 109.66, 146,58; 6.06 → 148.52, 152.65; 5.89 and 5.88 → 146.58, 147.90, 4.05 → 34.63, 44.82, 68.18, 177.05, 194.54; 4.42 → 44.82; 4.16 → 44.82; 3.49 → 34.63, 46.69, 130.68, 177.05, 194.54; 3.08 → 44.82, 46.69, 109.66, 122.50, 130.68, 177.05.

7'-Hydroxy-9α-methylcubebin (**5**). HRMS *m/z* 387. 3481[M+H]$^+$. ^{1}H NMR(300 MHz, TMS, $CDCl_3$, δ, ppm, J/Hz,): Table 1. ^{13}C NMR (75 MHz, $CDCl_3$): Table 1. HSQC (300/75 MHz, $CDCl_3$): Text. HMBC (300/75 MHz, $CDCl_3$): Table 1.

Integracin B (**6**). ^{1}H NMR (600 MHz, TMS, MeOD, δ, ppm, J/Hz): Table 2. ^{13}C NMR (150 MHz, MeOD,): Table 2. HSQC and HMBC: Text.

Integracin A. (**7**). ^{1}H NMR (600 MHz, TMS, MeOD, δ, ppm, J/Hz): Table 2. ^{13}C NMR (150 MHz, MeOD,): Table 2. HSQC and HMBC: Text.

3. Results and Discussion

3.1 Protium puncticulatum - Identification of compounds and antifungal activity of lignans 4 and 5

A mixture of the triterpenes α- and β-amyrin (**1** and **2**), and lupeol (**3**) from the hexane extract was identified using NMR. The ^{1}H NMR spectrum showed signals of methyl hydrogens between δ 0.79 – 1.61, olefinic hydrogens at δ 5.13 and δ 5.19 (t, J = 3.6 Hz) from H-12 from the mixture of α- and β-amyrin (**1** and **2**), double-terminal vinyl hydrogens (H-29) at δ 4.57 and 4.69 from the lupeol (**3**). The analysis of spectrum ^{13}C NMR and DEPT-135º confirms the occurrence of the three triterpenes, the typical signals of olefinic carbons were verified at δ 124.40 (C-12) and 139.55 (C-13) from α-amyrin (**1**), δ 121.71 (C-12) and 145.19 (C-13) from β-amyrin (**2**), δ 150.95 (C-20) and 109.32 (C-29) of lupeol (**3**). Carbinolic carbons were found at δ 79.05, 79.04 and 78.84, respectively. Based on the intensities of the ^{1}H and ^{13}C NMR signals, it appears that in the triterpene mixture α-amyrin is the most abundant, followed by β-amyrin and lupeol. The mixture of α-amyrin (ursane skeleton) and β-amyrin (oleanane skeleton) has been widely reported in *Protium* species from the Amazon region, however this is the first report of it appearing in *P. puncticulatum.*

The ^{1}H NMR spectra of compounds **4** and **5** exhibited six hydrogens that are characteristic of the aromatic system between δ 7.28-6.36, with a substitution pattern that indicates trisubstituted aryl groups. The signals at δ 6.06 and 5.88 (**4**), 5.94 and 5.91 (**5**) integrated by two hydrogens each, are indicative of a substitution of the methylenedioxy group of the aromatic rings. The butyrolactone system was verified for compound **4** due to the signals of methine hydrogens at δ 4.05 (H-8) and 3.49 (H-8') and methylene hydrogens at δ 4.42 (H-9a) and 4.16 (H-9b). For compound **5**, there were signals of methine hydrogens at δ 2.40 (H-8) and 2.37 (H-8'), oxymethine at δ 4.70 (H-9) and 4.59 (H-7'), oxymethylene at δ 4.18 and 3.92 (H-9') and oxymethylic at δ 3.36.The correlations observed in the HMBC experiment of compound **5** justify the substitution for the presence of methoxy at C-9 and hydroxyl at C-7' (table 1). The orientation of the α-methoxy group at C-9 was based on the coupling constants and comparison with the literature (Marco et al., 1996). Thus, based on the ^{13}C NMR data analyzed together with DEPT, HSQC and HMBC, lignan **4** was identified asv7-oxo-parabenzolactone, and **5** as 7'-hydroxy-9α-hydroxy-9α-methylcubebin. 7-oxo-parabenzolactone lignan was previously isolated from *Protium tenuifollum* trunk wood (Siqueira et al., 1995), 7'- hydroxy-9α-methylcubebin is unprecedented in the literature.

Antifungal tests showed that 7-oxo-parabenzolactone (**4**) in the concentration of 320 µg/ml did not show any growth reduction in strains of three fungal species. Lignan **5** (7'- hydroxy-9α-methylcubebin) showed a MIC of 320 µg/mL for *Candida albicans* and 160 µg/mL for *Cryptococcus neoformans* and *C. gattii*. The greatest activity of **5** is probably due to the presence of hydroxyl and methoxy that influenced it in some way and produced toxicity to fungi.

Table 1. NMR data for compound **5** ($CDCl_3$)

Position	^{1}H NMR	^{13}C NMR	HMBC
1		132.58	
2	6.36 d (J = 1.5 Hz)	109.01	C-3, 4, 6, 7
3		147.46	
4		145.88	
5	6.62 d (J = 7.8 Hz)	107.75	C-1, 3
6	6.41 dd (J = 7.8, 1.5 Hz)	121.77	C-2, 4, 7
7	2.30 dd (J =12.2, 7.5 Hz; H-7a)	38.89	C-1, 2, 6, 8, 9
	2.67 dd (J =12.2, 7.5 Hz; H-7b)		
8	2.40 m	49.72	C-1, 7, 7', 9
9	4.70 sl	108.12	C-7, 8, 8', 9', O**C**H_3
1'		137.80	
2'	6.62 d (J =1.5 Hz)	106.01	C-3', 4', 6', 7'
3'		146.32	
4'		147.50	
5'	6.64 d (J = 7.8 Hz)	107.84	C-2', 3', 4', 6'
6'	6.62 dd (J = 7.8, 1.5 Hz)	118.59	C-2', 7'
7'	4.59 d (J = 4.4 Hz)	73.60	C-8, 2' 8', 9'
8'	2.37 m	47.80	C-1, 7, 8, 9, 7',
9'	4.18 t (J = 8.9 Hz; H-9a)	69.02	C-8', 8, 9, 7'
	3.92 dd (J = 8.9, 6.2 Hz; H-9b)		C-8, 7'
OCH_3	3.36 sl	54.00	C-9
CH_2O_2 (3, 4)	5.94 d (J =1.5 Hz)	100.94	C-3, 4
CH_2O_2 (3', 4')	5.91 d (J =1.5 Hz)	100.88	C-3', 4'

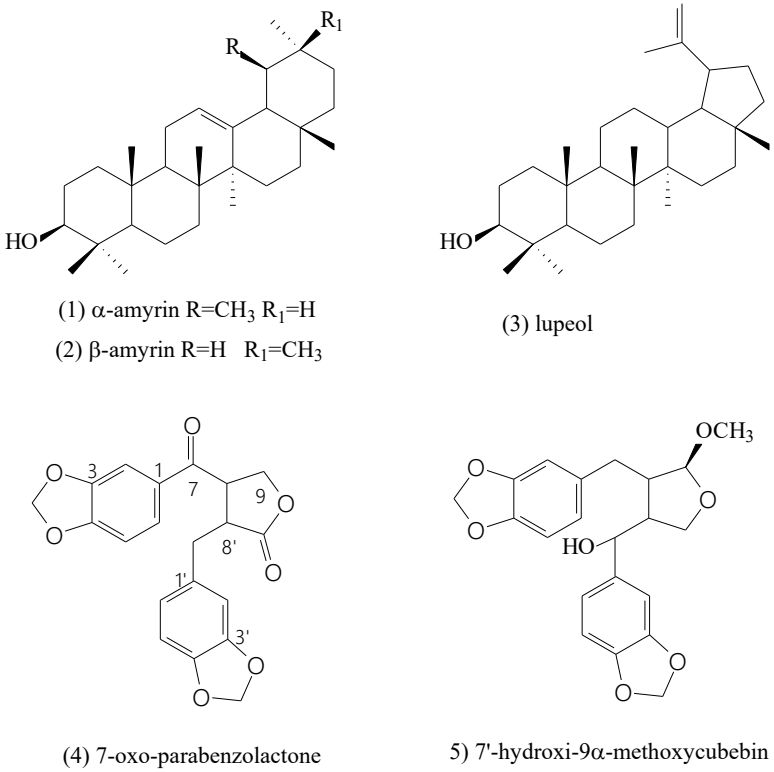


Figure 1. Compounds from *Protium puncticulatum* trunk wood

3.2 Protium tenuifolium - Identification of compounds and wood anatomy

A mixture of the triterpenes α- and β-amyrin (**1**, **2**) was also identified from the hexane extract of *P. tenuifolium* branches. The ^{1}H and ^{13}C NMR spectrum showed the characteristic signals of these triterpenes as methylic, carbinolic and olefinic groups, whose signal intensity indicated that α-amyrin is present with a high concentration in the mixture.

The ^{1}H NMR spectra (Table 2) of compounds **6** and **7** showed methyl triplets at δ 0.94 and 0.90 Hz of compound **6**, δ 0.96 and 0.92 of compound **7**; oxymethine hydrogens as multiple's at δ 5.24 and 3.50 (**6**); δ 5.27 and 4.88 m (**7**). Two meta coupled aromatic hydrogens located on the tetrasubstituted phenyl ring, and three aromatic hydrogens on the 1,3,5-trisubstituted phenyl ring were observed for **6** and **7**. Methylene hydrogens were observed at δ 2.80-1.31. The ^{1}H NMR spectrum of **7** displayed an acetyl methyl singlet at δ 1.99. The ^{13}C NMR (Table 2) and HSQC spectra of **6** exhibited signals of aromatic carbons for two substituted aromatic rings, two oxymethines, one ester carbonyl carbon, two methyl groups and aliphatic methylene groups, which accounted for 18 carbons. Via analysis of these spectral data associated with the correlations established by HMBC experiments and comparison with literature, these two dimeric alkylresorcinols were identified as integracin B (**6**) and integracin A (**7**) (Singh et al., 2002). Phenolic lipids or long-chain phenols called 5-alkylresorcinols have been reported in some families including Anacardiaceae (Dang et al., 2019), which are taxonomically close to Burseraceae (APG, 2021).

Table 2. ^{1}H NMR (600 MHz) and ^{13}C NMR (150 MHz) in MeOD of **6** and **7**

Position	^{1}H NMR		^{13}C NMR	
	6	**7**	**6**	**7**
1			159.3	159.3
2	6.06 d (2.2 Hz)	6.07 d (2.2 Hz)	101.0	101.0
3			159.3	159.3
4	6.10 d (2.2 Hz)	6.11 d (2.2 Hz)	107.9	107.9
5			146.2	146.3
6	6.10 d (2.2 Hz)	6.11 d (2.2 Hz)	107.9	107.9
7	2.41 t (7.9 Hz)	2.43 t (7.5 Hz)	37.0	37.0
8	1.50 m	1.50-1.56 m	32.4	32.4
9	1.31-1.41 m	1.27-1.45 m	31.2	30.3
10	1.31-1.41 m	1.27-1.45 m	30.3	30.4
11	1.31-1.41 m	1.27-1.45 m	30.4	30.7
12	1.31-1.41 m	1.27-1.45 m	26.8	26.7
13	1.65 m	1.65 m	35.5	35.5
14	5.24 m	5.27 m	76.6	76.6
15	1.65 m	1.65 m	37.8	37.7
16	1.31-1.41 m	1.39 m	19.9	19.9
17	0.94 t (7.4 Hz)	0.96 t (7.2 Hz)	14.3	14.3
1’			166.1	166.0
2’	6.15 d (2.5 Hz)	6.16 d (2.5 Hz)	102.0	101.9
3’			163.8	163.7
4’	6.19 d (2.5 Hz)	6.20 d (2.5 Hz)	112.0	111.9
5’			149.0	149.0
6’			105.7	105.7
7’			172.8	172.7
8’	2.80 m	2.83 m	37.8	37.7
9’	1.50 m	1.52-1.54 m	33.6	33.6
10’	1.31-1.41 m	1.27-1.45 m	31.1	31.0
11’	1.31-1.41 m	1.31 m	30.5	30.6
12’	1.31-1.41 m	1.31 m	30.9	30.6
13’	1.31-1.41 m	1.37-1.32 m	26.6	26.4
14’	1.31-1.41 m	1.50 m	38.4	35.5
15’	3.50 m	4.88 m	72.2	75.4
16’	1.31-1.41 m	1,67 m	40.7	37.5
17’	1.31-1.41 m	1.31 m	19.9	19.6
18’	0.90 t (7.2 Hz)	0.92 t (7.2 Hz)	14.5	14.3
1’’				172.9
2’’		1.99 s		21.1

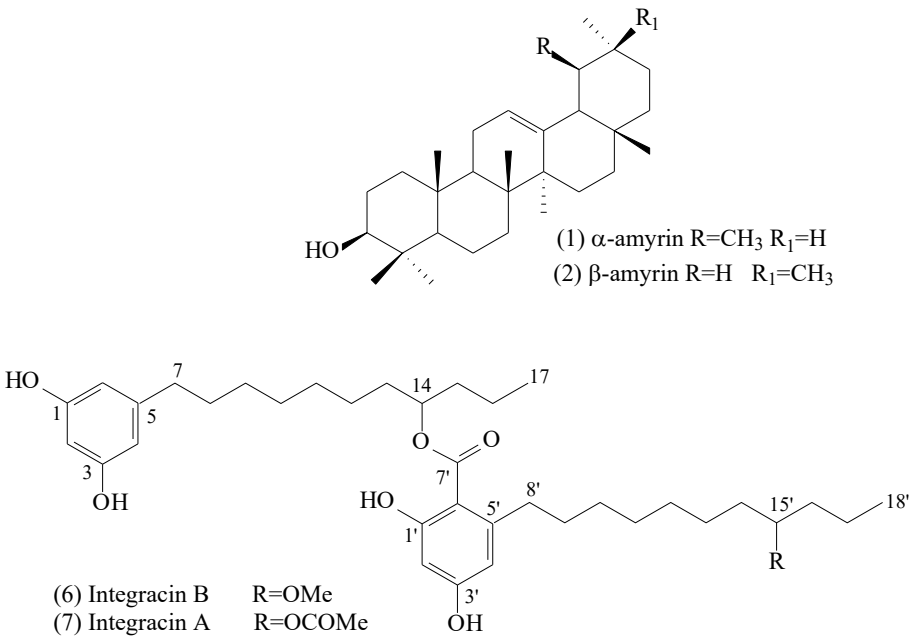
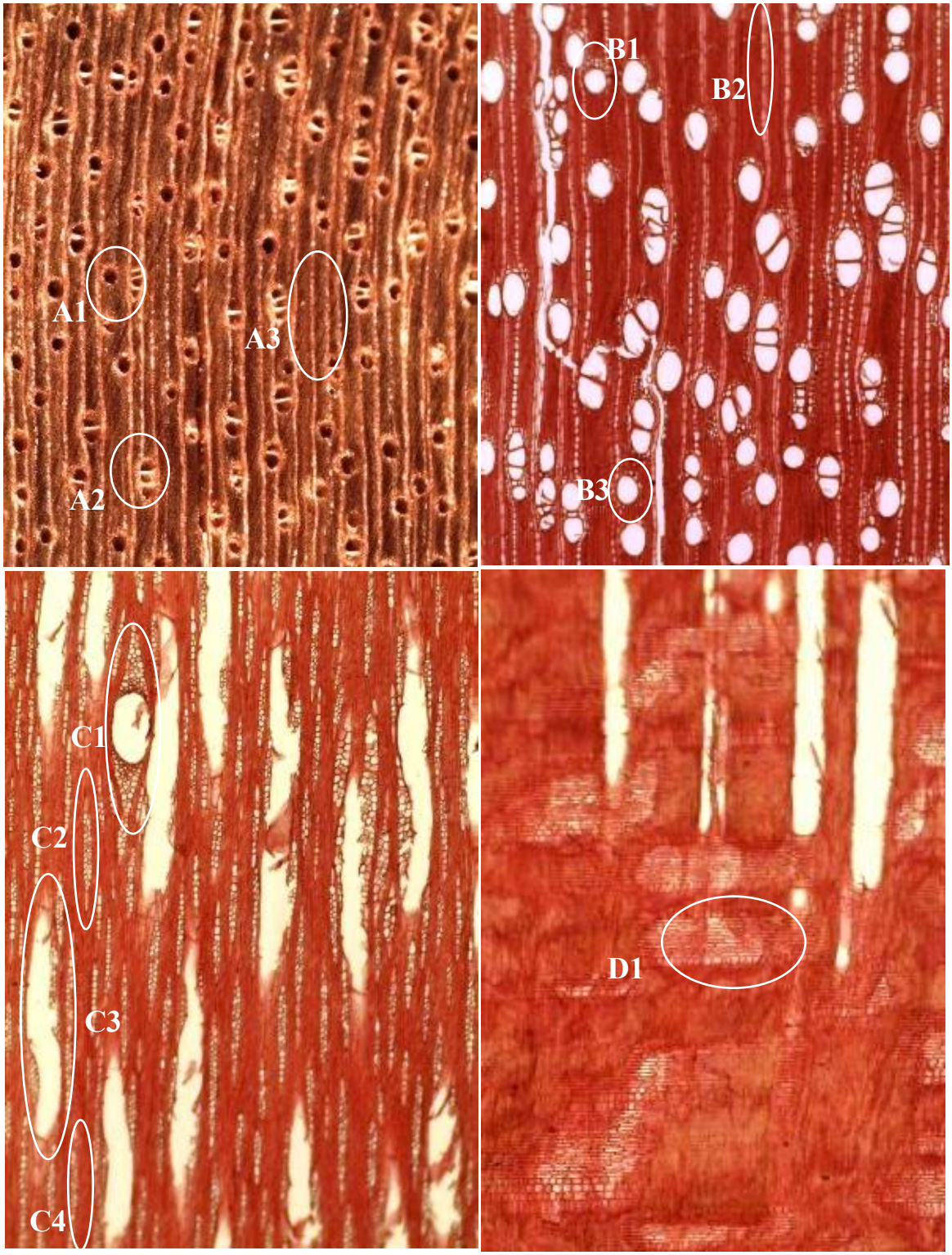


Figure 2. Compounds from *Protium tenuifolium* branches

Since the phenolic lipids identified in this research from *Protium tenuifolium* were not previously reported in Burseraceae species, it was decided to confirm the botanical identification of the wood using macroscopicanatomical analysis. This was performed with the aid of an X lens (Coradin and Muniz, 1992) and then divided into the following two groups: general or sensory characteristics and anatomical characteristics.

General/sensory characteristics: medium density wood; heartwood (light brown-pink) distinct from sapwood (light beige); regular grain; regular grain; medium texture; indistinct smell and taste.

Anatomical characteristics: axial parenchyma practically indistinct, even under the lens; pores seen with the naked eye, numerous, small to medium, predominant solitary, multiples of 2 to 4 (Figure 3A), empty, some clogged; vascular lines long and straight, sometimes interrupted. The rays at the top are thin and numerous, visible only with the aid of a lens; in the tangential side, they are low and irregularly distributed (Figure 3B); on the radial face, they are well contrasted (Figure 3C); growth layers demarcated by dark areas of fibrous tissue. Secretory channels observed in the tangential plane (Figure 3D).



3A:A1.solitary pores; A2.multiple pores; A3.rays (thin and light lines), fibers (wider and darker part). **3B:**B1 solitary pore; B2.rays; B3.axial parenchyma cells. **3C:**C1.secretory channel within the ray; C2.rays; C3.vase; C4.fiber; D1.rays

Figure 3. Microphotographs of transverse (A and B), tangential (C) and radial (D) planes

3.3 Protium tenuifolium - Essential oil composition of trunk bark

The essential oil from the bark of the trunk of *Protium tenuifolium* had a yield of 0.05%. The GC/MS analysis of the volatile components indicated the presence of 33 constituents, of which 24 were identified

(93.93%). The chemical profile (Table 3) revealed a high proportion of monoterpene hydrocarbons (84%). The major constituents were limonene (56.17%), α-phellandrene (16.22%) and ρ-cymene (10.52%). Studies on the essential oils found in the bark of *Protium* species are rare, and this is the first study of the chemical composition of the volatile compounds from *Protium tenuifolium.*

Table 3. Composition of the essential oil from *Protium tenuifolium*

Compounds	IR cal	%	Compounds	IR cal	%
α-pinene	930	0.58	α-zingiberene	1493	0.29
α-phellandrene	1003	**16.22**	α-muurolene	1497	0.26
α-terpinene	1014	0.27	δ-*amorphene*	1511	0.21
p-cymene	1021	**10.52**	7-*epi*-α-selinene	1520	1.21
limonene	1027	**56.17**	ni	1545	0.22
terpinolene	1085	0.24	ni	1573	0.39
linalool	1096	0.66	caryophyllene oxide	1580	0.26
trans-*p*-met-2,8-dien-1-ol	1118	0,23	viridiflorol	1589	0.26
trans-sabinol	1135	0.22	ni	1621	0.22
α-terpineol	1187	1.38	1-*epi*-cubenol	1624	0.87
ni	1192	0.22	ni	1628	0.30
piperitone	1251	1.14	ni	1638	1.89
α-cubebene	1348	0.73	α-muurolol	1642	0.58
α-copaene	1374	0.25	ni	1646	0.18
β-caryophyllene	1417	0.39	ni	1647	0.20
γ-gurjunene	1474	0.31	ni	1650	2.45
γ-muurolene	1478	0.68			
Hydrocarbon monoterpenes 84.0%			Hydrocarbon sesquiterpenes 4.33%		
Oxygenated monoterpenes 3.63%			Oxygenated sesquiterpenes 1.97%		
Not identified (ni) 6.07%			Total identified 93.93%		

4. Conclusion

This study is important since it increases the chemical knowledge of the woody parts of Amazonian species of *Protium*, principally as there are no previous reports of volatile and non-volatile chemical constituents in the vegetative parts of the two species evaluated. The presence of alkylresorcinol in the Burseraceae family is also an unprecedented finding.

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Are recorded lectures suitable for medical students? Impact of attendance on students' outcome.

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Abstract

Background: During the Covid -19 lockdown, the Faculty of Medicine at the University of Balamand adopted the Webex platform to deliver the lectures live for the students. All lectures were also recorded and posted. This study compares the results of students who attended the live online lectures with those who only reviewed the recordings of the lectures, taking the previous year's rank into consideration.

Method: We retrieved attendance data of Med 2 students and their grades for 7 modules. We also had access to the previous year's rank as predictor of outcome. The students had two types of exams, the standardized NBME questions and in-house questions prepared by the lecturers. The students rank from the previous year was used to divide the students into the top 20%of the class, the lower 20% and the rest. Analysis to assess the impact of attendance on outcome was made for the two types of exams, and for the different groups of students.

Results: Our analysis shows a significant correlation between the two types of questions, and a significant correlation between attendance and the previous years' rank. Also for all the groups, attendance had a significant contribution to the outcome, more significant among the top students and the bottom of the class students.

Conclusion: This study shows the importance of attending lectures even if they are online, not only for the poor performing students but also for the top 20%. Recorded lectures may be a beneficial adjunct but not a replacement of live lectures, at least for now.

Keywords: Online medical education**,** Live versus recorded lectures, attendance among medical students, lecture delivery and outcome.

Introduction

The Covid-19 pandemic resulted in significant challenges for medical schools, not in lecture delivery as much as in ensuring adequate knowledge acquisition among students. Schools and universities have adopted different platforms for lecture delivery ranging from live lectures to prerecorded sessions.

Online teaching is not a recent occurrence in education, and in fact, it was introduced in the 1980's in certain universities that offered degrees exclusively taught online. (1). Over the last decades however, online teaching has evolved tremendously with the emergence of many online courses in almost every field of study.

In medical education, and with the increasing number of studies that have shown the usefulness and positive perception of online teaching, hybrid education is becoming a well established teaching approach in some medical curricula. (2,3).

With the Covid-19 pandemic and the resulting lockdowns, medical schools, even those with no previous experience with online teaching, had to shift quickly and completely to online lecture delivery, either live through virtual platforms or through prerecorded lectures.

Between August 2020, the beginning of the academic year, to December 2020, seven Med II course modules were delivered at the University of Balamand -Faculty of Medicine. All module lectures were delivered live using the WebEx platform. Lectures were also recorded and posted on MOODLE at the end of each session. Some students chose not to log in on WebEx and attend the live lectures and elected to review the recordings. In this study we compared the exam results of all Med 2 students in the seven different modules and correlated these results with the students' attendance and their previous year's rank in order to assess any impact the attendance might have on academic outcome.

Methods

We evaluated the performance of Med 2 students in 7 different topics: Pathology, Pharmacology, Virology, Parasitology, Bacteriology and Infectious and Cardiology. All lectures were delivered through live WebEx sessions, respecting the same schedule as for in-house lectures. The slides of the lectures were posted on MOODLE before the lectures and all the sessions were recorded and then posted on MOODLE after they were delivered. The attendance in each lecture was retrieved from the database as the students would login using their names (Table1). Each of the seven courses had one exam, and all exams consisted of both National Board Medical Examination (NBME) questions and in-house questions except for one that was entirely composed of in-house questions due to technical issues related to NBME administration. All the lectures were represented in the exams and the lecturers provided the questions related to the lectures they delivered with the same question / lecture-hour ratio. All exams were computer-based and were done on campus with direct monitoring. All safety measures against Covid-19 transmission were taken; students were divided into small groups and distributed to different classrooms to provide safe physical distancing, masks were obligatory and the exam rooms were disinfected before and after each exam session and the classrooms windows remained opened. Body temperature checks were done for all students before they were allowed on campus. Students who were diagnosed with Covid-19, provided a medical report and had to sit for a makeup exam after they became asymptomatic and after providing a negative PCR test. The percentage of each type of questions varied between courses as shown in (Table-2).

The results for NBME and in-house questions were retrieved separately for each student.

Table 1 Average attendance in each module.

Module	**Attendance**
Pharmacology	75%
Pathology	43%
Parasitology	24%

Virology	61%
Bacteriology	65%
Infectious diseases	14%
Cardiology	40%

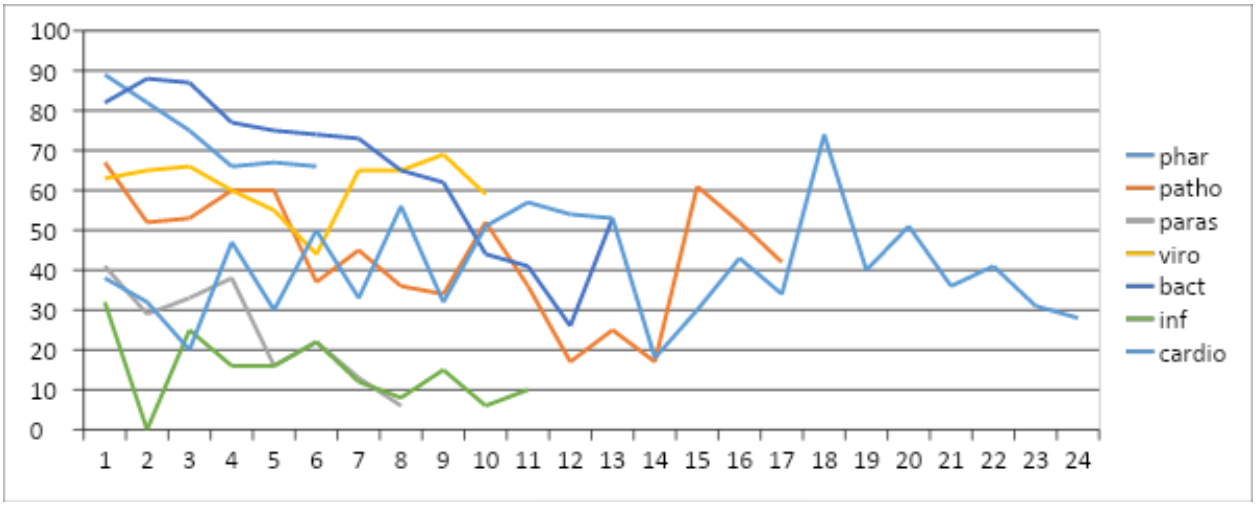
Table 2 Percentage of NBME versus in-house questions

Module	NBME	MOODLE
Pharmacology	69%	31%
Pathology	40%	60%
Parasitology	0%	100%
Virology	67%	33%
Bacteriology	72%	28%
Infectious diseases	55%	45%
Cardiology	65%	35%

Results:

As discussed above, the attendance varied between modules, and it was observed that there is a certain tendency for the attendance to decrease as the module progressed irrespective of the length of the module or the number of lectures (fig 1).

Figure 1 Attendance throughout different modules



Analysis of the grades in both exam modalities, showed a statistically significant positive linear correlation between the NBME grades and the grades obtained for the in-house questions, (Pearson=.518, sig=0.000). Both grades (NBME and MOODLE) have a positive linear association with attendance (Pearson=+0.301, sig=0.000 and Pearson=.518, sig=0.000 for NBME and MOODLE respectively).

While both exams are linearly associated with rank and attendance the bias related to students' rank and attendance was analyzed and there was a statistically significant correlation between the two (Pearson=-.183 and Sig= 0.000).

To assess the influence of attendance on performance irrespective of rank, four models were tested. First, the effect of attendance on NBME (model 1) and MOODLE (model 2) performance. Second, the students were divided according to rank into High (top 20%), medium (21%-79%) and low (bottom20%) and the 2 models (NBME and MOODLE) were tested again. Results revealed that all models were significant and attendance influenced the grade. Adjusted R2 were recorded for all models indicating that for all students, attendance explains 9.1% of the Moodle grade and 8.9% of the NBME grade (F= 53.856, p=0.000 for Moodle and F=46.935, p= 0.000 for NBME). For the subcategories, attendance contributed up to 10% for the top students and (table below).

Table 3 Contribution of attendance to grades.

	Percentage Attendance	Mean	N	Std. Deviation	**Moodle** Regression R^2	**NBME** Regression R^2
Rank Category	Low	51.99	97	31.46	10%	10.2%
	Mid	58.32	321	31.51	4.5%	4%
	High	70.67	123	31.57	7.2 %	10.7%
Rank	Total	59.99	541	32.07	9.1% (F= 53.856, p=.000)	8.9% (46.935, p=.000)

Discussion:

While classroom lectures are still an important component in preclinical medical education, the use of alternative lecture-delivery methods such as prerecorded or video lectures is common in medical schools with a resulting decline in classroom attendance observed among medical students (4,5). While some studies suggested that the availability of recorded lectures adversely affected the attendance of live lectures (6), others showed the contrary (7,8). Some students prefer the recorded lectures because they are readily available so they can repeat them as many times as they want, and at an accelerated speed to save time (9, 10). The type of recording is also important for student engagement as studies have shown that video recorded lectures are more appreciated and engaging than power point recordings (11). In addition, the recorded lectures may help students with language (non-native speakers) or other barriers, who may find it difficult to follow live lectures efficiently (12). Some students however, still prefer live lectures and find them motivating with the direct interaction with instructors and their colleagues (4). The drop in attendance observed among students became a major concern for the educators as it may negatively affect students' knowledge acquisition and performance in exams. In our study, the decrease in attendance and the variation of attendance between different modules may be related to the topic and content of the lectures or negative experiences with the lecturer (13).

Some studies have found that the video recorded lectures are comparable to live lectures advocating the utilization of this methodology for its efficiency and accessibility, and even some have gone to the extreme of abolishing live lectures in favor of the virtual classrooms (10,14, 15). However, other studies warned against the widespread use of this modality and concluded that the recorded lectures are not as beneficial

as the live lectures when it comes to students' retention of information and assimilation of knowledge (16,17,18). A hybrid system of both methodologies, using the recorded lectures and other web-based resources as complementary to classroom lectures has also been advocated as it will enhance students' self-learning abilities (19).

A significant positive correlation between NBME and the in-house exam scores indicates that our students have acquired the competencies needed to sit in for an international standardized exam.

What is appealing and unique about our study is that we included the student rank of the previous year in our analysis. There is significant negative correlation between last year's rank and the attendance (p= -0.183; Sigma= 0.000), which means that highly ranked students attend more the live lectures, however, R2 analysis showed that attendance improved the results for all students irrespective of their rank. This can be attributed to the way students attend the live lectures and the ability to interact and focus more as compared to recorded lectures during which students can accelerate the videos missing some information or even get distracted and pause the video multiple times affecting the flow of information and their assimilation of knowledge. One can add to that, the students' maturity and responsibility in being implicated in the live lectures and the effect live interaction can have on the student's cognitive abilities as social interaction would improve knowledge creation (20).
The contribution of attendance on grades is significant for all students but interestingly, it is more the two extremes, the top students and the bottom of the class, based on the previous year's rank, as shown in table-3. One can assume that the top students are more implicated and responsible and they would also review the recorded sessions. Their participation in the live sessions gives them the possibility of understanding and assimilating the material completely so there would be no gaps in their understanding. For the lower performing students, they would certainly benefit from the discussion that happens during the live sessions and also have the chance to clarify any issue as needed, and they are guided to acquire a deeper understanding that could me missed with just reviewing the recordings at accelerated speed (21,22).
In conclusion, our study revealed the importance of attending the lecture live, even in the absence of physical presence and further studies to explore student's readiness and familiarity with online teaching as additional factors that would affect performance would further explain the differences in outcome.

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