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FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-9: 2021 (September, 2021) of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)",** an international journal which publishes peer-reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Swapnesh Taterh
Editor-in-Chief
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Skills of Nursing Academics in Collecting the Preventive Exam for Uterine Cervical Cancer

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Abstract— Objective: The general objective of this study was to identify the level of competence in the collection of preventive cervical cancer examination among nursing students attending the supervised internship. Method: The study presented a quantitative approach conducted in 2019. Participants were 80 students of the 9th semester of the Nursing Course of the University of the Amazon, during three months of supervised internship in Primary Health Care. Twenty-one competencies were analyzed in the collection of the oncopherotic colpocytology exam. From the application of a checklist during the supervised internship, each student was evaluated five times. Results: The evolution of the minimum competencies of the nursing student during the five collections of the onoptic cytology examination was notorious. From the third collection, it was observed that 41.3% of the students with unsatisfactory performance, there was a reduction to 5% in the fourth collection. In the fifth collection of the exam, 92.5% of the students with the satisfactory exam technique. Conclusion: Therefore, it is suggested the implementation of the checklist during the collection of the onoptic cytology exam in the supervised stage, that each student has the opportunity to make at least five collections.

I. INTRODUCTION

In the Northern region of Brazil, the estimate for the most prevalent types of cancer in males are prostate (30/100 thousand), stomach (11/100 thousand), lung (8/100 thousand), colon and rectum (4/100 thousand). thousand). In females, the most prevalent are the cervix (25/100 thousand), breast (19/100 thousand) and colon/rectum (7/100 thousand). [1]

The high prevalence and the growing morbidity and mortality rate of cervical cancer make it a global public health problem. Thus, Brazil presents a similar panorama of developed and developing countries [2].

The test for early detection of cervical cancer is oncotic colpocytology. The exam receives various terminologies such as oncotic cytology, oncological cytology, exfoliative cytology and Pap Test. It is a test developed by the physician George Papanicolau for the identification, under the microscope, of atypical, malignant or pre-malignant cells of the uterine cervix [3].

The oncotic colpocytology exam can be performed by the professional Nurse. In the curriculum guideline of the Nursing course, it is necessary that the student has the ability to perform the Pap smear exam. During the supervised internship of the ninth semester of the nursing

course, there was a need for an evaluative tool to assess the competence of the nursing student at the time of carrying out the collection of the oncotic cytology exam.

In order to optimize the available resources, the Pap smear test should be offered to women between 25 and 65 years old and to those who started sexual activity before this age group, with emphasis between 45 and 49 years old, period that corresponds to the peak incidence of precursor lesions and precedes the peak of mortality from cancer. After two negative annual collections, the periodicity may be three-yearly, allowing the identification of cases in which a false negative result may have occurred. However, cervical cancer is among the most common cancers in women, occupying, respectively, the second and third places in the world and in Brazil. [4]

Wanda Horta, in 1979, defined nursing as a science and art of assisting human beings in meeting their basic human needs, of making them independent from this assistance through education, of recovering, maintaining and promoting their health, counting with the collaboration of other health professionals. [5]

For nurses to acquire the competence to perform the preventive examination through oncotic colpocytology, they must have, during graduation, through supervised internship, the opportunity to practice such competence. The best way to improve the ability to collect the exam with quality is in patients. An instrument to assess the collection of the exam is the checklist. The use of a structured instrument, such as a checklist, for assessment during the exam helps the teacher to focus his attention on specific skills, increasing the accuracy in detecting failures. In addition to serving as an assessment tool, these lists serve as a learning tool, offering objective elements to give feedback to students, helping them to reinforce their strengths and correct their deficiencies. [6]

The internship comprises the period in which the student has the chance of personal and professional growth, through the development of experienced actions, critically and reflexively, providing greater security to the student at the end of the undergraduate course and beginning of professional practice. [7] In line with this, it is noteworthy that the training of a professional for the labor market should not be restricted to theory only, but also to the student's knowledge of their future space of action. Thus, the supervised internship gives the student the opportunity to expand their knowledge, associating theory with practice. [8]

Nursing students must have theoretical and practical content developed during training, it is mandatory to include supervised internship in hospitals, clinics, basic network of health services and community in the curriculum of Undergraduate Nursing. According to the National Curriculum Guidelines for the Undergraduate Nursing Course, the internship must consist of a minimum workload of 20% of the total workload of the Undergraduate Nursing Course, carried out in the last two semesters of the course with mandatory effective participation of nurses services in which the referred internship is developed. With the CNE/CES opinion nº 213/2008, a minimum duration of 5 years was established, comprising a workload of 4000 hours/class. Considering this minimum total workload and the obligation of 20% of the total workload, a minimum workload of 800 hours is foreseen for the supervised internship. [9]

Thus, this study aims to identify the level of competence in collecting the preventive exam for cervical cancer among nursing students attending the supervised internship.

II.   METHOD

The study was analytical, with a quantitative approach and was developed in Basic Health Units (BHU) located in the District of Icoaraci, municipality of Belém, being the BHU Paracuri 1, BHU Tenoné, BHU Parque Guajará and BHU Eduardo Angelim. In these places, the supervised internships of the higher education institution take place. The location was, specifically, in the collection room for the Pap smear exam at the BHU, located in the city of Belém.

Participants were students from the Nursing Course of a private university, enrolled in the 9th semester in the supervised internship module in Primary Care and of both sexes. Patients who underwent the Pap smear exam in Primary Care and who accepted to be part of the research participated. There were 100 students enrolled in the 9th semester, but only 80 students met the research inclusion criteria. The research was carried out with students from the Nursing Course of a private university, enrolled in the 9th semester in the supervised internship module in Primary Care, of both genders, from 18 years of age and who accepted to be part of the research.

The students were invited to participate in the research at the beginning of the internship that took place in the Basic Health Units and were given an explanation on how to carry out the collection of the Pap smear test in the patient. Data collection was carried out in the second half of 2019, after approval by the Research Ethics Committee of the Centro Universitário do Pará (CESUPA).

During the examination performed by the nursing student, the preceptor used an evaluative instrument, the checklist, to assess the level of competence in collecting the preventive exam for cervical cancer among nursing students attending the supervised internship at the BHU. Data

collection was performed using an evaluative instrument in the form of a checklist, the instrument for evaluating the collection technique of the Pap smear test was based on the validation of the correct technique established by the Brasil's Ministry of Health Manual of 2002. The students were informed who would go through the evaluation process at the beginning of the internship with the presence of the preceptor. The preceptor could at any time intervene in the execution of the exam collection so as not to harm the exam result. Thus, effectively guaranteeing a quality result. To assess the level of competence in the collection of the preventive exam for cervical cancer among nursing students attending the supervised internship, a descriptive analysis of the data was performed.

The organization and tabulation of the results was performed in an Excel spreadsheet and statistical analyzes in the Bioestat 5.3 program. To assess the existence of an association between collections and the variables sex, age, technical level and previous experience, the chi-square test and G test were applied. And the chi-square test was used to assess whether there was a significant change in the global concept of each participant, during the five evaluations. Throughout the work, a significance level of 5% was used. The total population is 100 students; of this total, 80 students participated in the survey, as they met the

inclusion criteria. A descriptive analysis of all items evaluated in the checklist was performed and the Wilcoxon test was used to assess whether there was a significant change in the concept of each participant in the five assessments that each one was submitted.

III. RESULTS

The study population consisted of 80 students regularly enrolled in the Nursing Course of a higher education institution in the year 2019 of the ninth academic semester. The student who achieved a grade between 9 and 10 was considered satisfactory, with a grade of 10 for the student who got the 21 items on the checklist of all skills right; partially satisfactory, the student with a grade from 6 to 8.99 and unsatisfactory the student with a grade below 5.99. Some manual skills of greater relevance in performing the collection were given greater weight, such as item number 14 (Turned 360° to scrape the cellular material from the cervical mucosa); item number 16 (Turned 360° to collect the mucosal material from the neck portion); and item number 18 (The collected material was uniformly spread across the entire slide).

Graph 1 - Evaluation of nursing students during the five collections of the Pap smear exam during the 3 months of supervised internship.
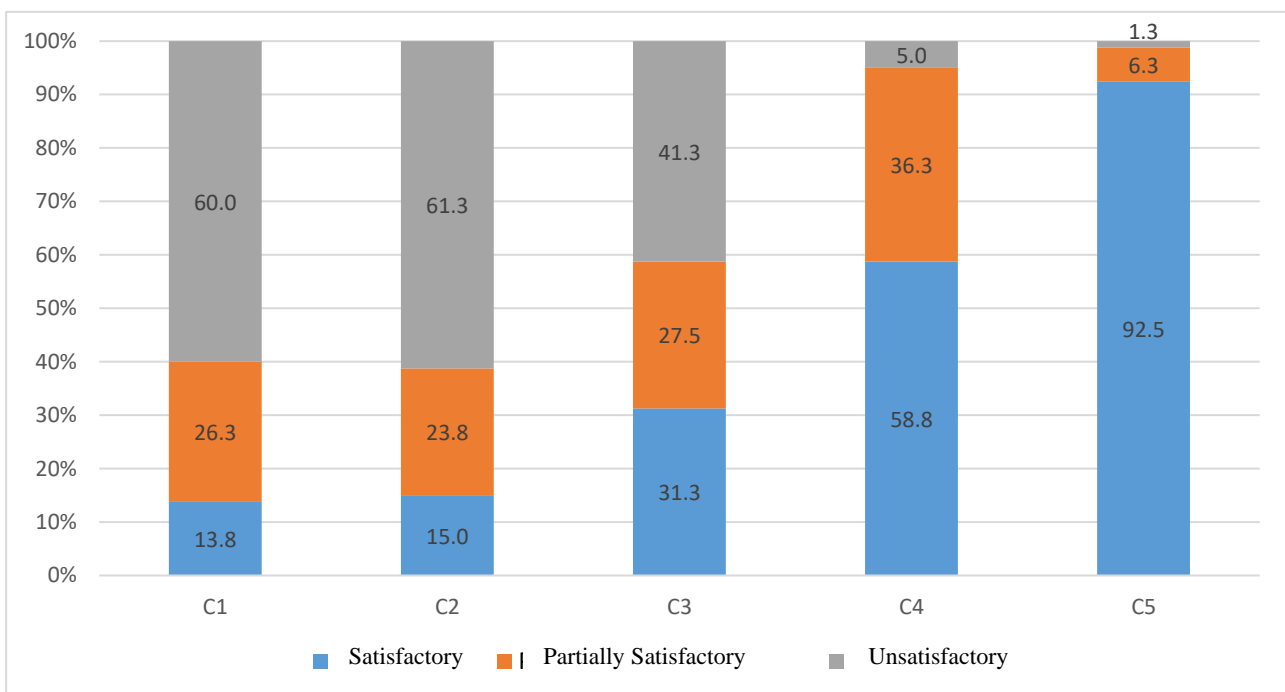
Note: *$p < 0.05$ (Test G – $p < 0.0001$) Source: Research data.

Graph 1 shows the evolution of the minimum competences of the nursing student during the five

collections of the Pap smear exam. After the third collection, it was observed that 41.3% of unsatisfactory

students decreased to 5% in the fourth collection. In the fifth exam collection, 92.5% of the students reached the satisfactory exam technique.

Table 1 - Checklist assessment by abilities during the five collections of the Pap smear exam during the 3 months of supervised internship.

	Collect 1	%	Collect 2	%	Collect 3	%	Collect 4	%	Collect 5	%	P Value
1 – He behaved in a kind way and made himself available to the patient;											
No - 0		16.3		11.3		2.5		3.8		1.3	0.0005[a]
Yes - 0.1		83.8		88.8		97.5		96.3		98.8	
2- Washed hands according to proper technique;											
No - 0		36.3	c	32.5		31.3		5.0		0.0	< 0.0001[a]
Yes - 0.2		63.8		67.5		68.8		95.0		100.0	
3 - Put on a pair of clean gloves;											
Yes - 0.2		100.0		100.0		100.0		100.0		100.0	-
4 - Observed the external genitalia for apparent abnormalities and separated;											
Yes - 0.5		100.0		100.0		100.0		100.0		100.0	-
5 - Gently parted labia minora and continued visual inspection;											
No - 0		43.8		43.8		20.0		1.3		0.0	< 0.0001[a]
Yes - 0.5		56.3		56.3		80.0		98.8		100.0	
6 - Knew how to choose the size of the speculum;											
No - 0		65.0		67.5		50.0		26.3		6.3	< 0.0001[b]
Yes - 0.25		35.0		32.5		50.0		73.8		93.8	
7- Parted the little lips;											
No - 0		6.3		2.5		2.5		3.8		1.3	0.6699[a]
Yes - 0.25		93.8		97.5		97.5		96.3		98.8	
8- Inserted the speculum with pin downwards;											
No - 0		53.8		41.3		32.5		8.8		0.0	< 0.0001[a]
Yes - 0.5		46.3		58.8		67.5		91.3		100.0	
9 - Held the speculum in his left hand and rotated the pin in his right;											

						p-value
No - 0	65.0	62.5	50.0	22.5	5.0	< 0.0001[a]
Yes - 0.5	35.0	37.5	50.0	77.5	95.0	
10 - Opened the speculum to center.						
No - 0	0.0	0.0	0.0	3.8	1.3	0.1485[a]
Yes - 0.5	100.0	100.0	100.0	96.3	98.8	
11 - Had difficulty finding the cervix;						
No - 0	83.8	85.0	66.3	30	37.5	8	10.0	< 0.0001[b]
Yes - 0.5	13	16.3	12	15.0	27	33.8	50	62.5	72	90.0	
12- Verbalized the inspection of the cervix;						
No - 0	0.0	0.0	0.0	3.8	1.3	0.1485[a]
Yes - 0.5	100.0	100.0	100.0	96.3	98.8	
13- Inserted the spatula with concave end;						
Yes - 0.5	100.0	100.0	100.0	100.0	100.0	-
14- Rotated 360° to scrape the cellular material from the cervical mucosa;						
No - 0	82.5	85.0	71.3	33.8	6.3	< 0.0001[b]
Yes - 1	17.5	15.0	28.8	66.3	93.8	
15- Introduced the cytology brush into the cervical canal;						
No - 0	0.0	0.0	0.0	3.8	1.3	0.1485[a]
Yes - 0.5	100.0	100.0	100.0	96.3	98.8	
16- Rotated 360° to collect the mucosal material from the neck portion;						
No - 0	61.3	66.3	55.0	27.5	10.0	< 0.0001[b]
Yes - 1	38.8	33.8	45.0	72.5	90.0	
17- The blade was properly identified at the frosted edge;						
No - 0	6.3	20.0	10.0	3.8	1.3	0.0003[a]
Yes - 0.5	93.8	80.0	90.0	96.3	98.8	
18- The collected material was evenly spread across the entire slide;						
No- 0	0.0	0.0	0.0	3.8	1.3	0.1485[a]
Yes - 1	100.0	100.0	100.0	96.3	98.8	

19- Immediately put in the fixer;

No - 0	63.8	61.3	37.5	1.3	0.0	< 0.0001[a]
Yes - 0.5	36.3	38.8	62.5	98.8	100.0	

20- Removed the closed speculum;

No - 0	55.0	43.8	40.0	26.3	8.8	< 0.0001[b]
Yes - 0.25	45.0	56.3	60.0	73.8	91.3	

21 - Cleaned the perineal area with gauze.

No - 0	17.5	22.5	17.5	17.5	15.0	0.8041[b]
Yes - 0.25	82.5	77.5	82.5	82.5	85.0	

Note: *p < 0, 05 ([a] Test G / [b] chi-square test – p < 0,0001). **Source:** Research data.

Table 1 shows the execution of the technique performed by the oncotic colpocytology exam by the nursing student in the supervising internship, describing the average performance in each of the five times it was performed. It was considered in this analysis as (Yes) when the student performed the technique and (No) when the student did not perform the technique. There was statistical significance in some technical skills during the course of collections, as shown in the table above. Some skills have already started with 100% satisfaction percentage; in this way, it is not possible, the growth of correct answers (skills 3 and 13).

Table 2 - Analysis of the percentage of execution of the correct technique for cervical cancer preventive collection, in relation to the sex of the performer.

	Female		Male		
	n=63	%	n=17	%	P Value
Collect 1					
Unsatisfactory	36	57.1	12	70.6	0.4653[a]
Partially Satisfactory	17	27.0	4	23.5	
Satisfactory	10	15.9	1	5.9	
Collect 2					
Unsatisfactory	36	57.1	13	76.5	0.0464[a]
Partially Satisfactory	15	23.8	4	23.5	
Satisfactory	12	19.0	0	0.0	
Collect 3					
Unsatisfactory	26	41.3	7	41.2	0.0598[a]
Partially Satisfactory	14	22.2	8	47.1	
Satisfactory	23	36.5	2	11.8	
Collect 4					
Unsatisfactory	3	4.8	1	5.9	0.1077[a]

	Partially Satisfactory	19	30.2	10	58.8	
	Satisfactory	41	65.1	6	35.3	
Collect 5						
	Unsatisfactory	1	1.6	0	0.0	0.8495[a]
	Partially Satisfactory	4	6.3	1	5.9	
	Satisfactory	58	92.1	16	94.1	

Note: $*p < 0.05$ ([a] Test G – $p < 0.0001$). **Source:** Research data.

Table 2 shows the reality of gender distribution in the Nursing course, where there is a significant predominance of females (78.75% were women). There were no statistically significant differences between the two groups, with males showing a significant increase in competence, going from 5.9% satisfactory in the first collection to 94.1% in the fifth collection.

IV. DISCUSSION

The nursing education process in contemporary times points to professional training for the exercise of general and specific skills, in addition to skills based on the conceptions of the student as the subject of their training process, the articulation between theory and practice, the diversification of learning scenarios, active methodologies, articulation of research with teaching and extension, curriculum flexibility, interdisciplinarity, incorporation of complementary activities, learning assessment, monitoring process, evaluation and management of the course, as well as completion of the course. [9]

General and specific competences can be more easily achieved through active methodologies, with the student as the subject of their learning, capable of "learning to learn", and the teacher as a facilitator of this learning. [10] Within these competences for the nursing student, we have the collection of oncotic cytology, which is an exam that uses a manual method, performed by nurses and physicians, which allows the identification of cells suggestive of pre-invasion to malignant lesions, through multichromic staining of slides containing exfoliated cervical cells. The exam is part of the Health for Women in Primary Care program promoted by the Unified Health System. [11]

The current study has shown that the competency-based assessment process is dynamic. During the five applications of the checklist in the collection of the oncotic cytology exam, the performance that was initially unsatisfactory in the first collection was evidenced and that in the fifth collection it was considered a satisfactory percentage. This evolution was notorious after the third collection, when it

was observed that 41.3% of unsatisfactory students rose to 5% in the fourth collection. In the fifth exam collection, 92.5% of the students reach the satisfactory level. The supervised curricular internship is a modality of practical teaching that provides the transition from the academic world to the world of work, being a privileged space for contact with the reality of services and work in health. [12]

The supervised internship provides students with greater knowledge based on experiences in different practice scenarios. He further points out that the skills acquired by academics increase as the internship period progresses, their perception changes, and they feel more confident in their communication skills and techniques. [12]

In the present study, the first skill (behaves kindly and puts oneself at the patient's disposal) appeared as a skill that showed growth with the increase in the number of individual collections. As it is an attitudinal skill, it was expected that all students had an adequate behavior, from the beginning, as they were in the final period of the undergraduate course and had already heard a lot about humanization.

The students arrived with a partially satisfactory level and throughout the five collections, they reached the satisfactory level, showing that the humanization capacity can be improved in each service and providing a link of trust between the student and the user. The study shows that the academic does not arrive with 100% of the attitudinal ability ready in the internship field, despite this being worked throughout the academic life. It also shows the importance of humanized contact being worked on in the supervised internship, so that the academic knows how to work and develop this attitudinal skill and become an empathetic professional.

The nurse must always act in a humane way during the service to the user, paying attention to health education and consequently making these women look for the Health Unit more, increasing the demand and coverage of preventive exams. [13] Since the creation of the National Humanization Policy - NHP, humanization has been constantly exercised within the scope of the SUS, seeking

to achieve quality care. In addition, the union between public health and higher education schools increasingly improves the provision of services as partnerships and programs are created between the Ministry of Education and the Ministry of Health. [14]

The Undergraduate Nursing course has curricular guidelines established by the National Council of Education (NCE), which has the function of verifying whether educational legislation is being effectively exercised, ensuring that teaching in institutions is of quality, in addition to ensuring that the population participate in improving education. A 2001 NCE resolution establishes a plan for the curriculum designs of the Nursing course, in order to govern the profile of graduates during their professional training. Therefore, this future nursing professional must have a humanistic education based on the ethical principles of the profession. [15]

The reception, in the daily practice of services, is expressed in the relationship established between the professional and the user through attitudes such as: the professional introducing himself, calling the users by name, informing the conduct and the procedures that will be carried out and adopted, listening and valuing what is said by them, guaranteeing privacy and confidentiality, among others. It does not consist of a step in the process, but an action that must take place in all places and moments of health care. [16]

Other manual skills observed in the study, such as rotating the spatula and cytology brush 360 degrees, which are eminently technical skills, started with a low percentage. The manual ability to rotate the spatula 360º in the first collection was 17.5% satisfactory, but in the fifth collection, this percentage was 93.8%. The manual ability to rotate the cytological brush 360º degrees starts in the first collection with a percentage of 38.8% and ends in the fifth collection, with a rate of 90% correct.

The manual ability to immediately put in the fixative in the first collection was 36.3% and in the fifth collection with all students reached this ability, in a total of 100%. These skills are important, because if poorly performed they can affect the result of oncotic colpocytology, giving a false positive for precursor lesions of cervical cancer. One study shows that the quality of oncotic Pap smears performed by nurses was above the national average. [17]

Data show that cervical cancer is the fourth most common type of cancer in women worldwide, with approximately 528,000 new cases annually, 85% of which in developing countries. In 2012, this cancer was responsible for 266,000 deaths worldwide, of which about 90% occurred in developing countries. In the State of Pará, the cancer that most affects women is cervical cancer. [1]

These data are important to show the relevance of a well-executed exam, that is, the quality of oncotic cytology exam collection directly influences patient survival. To maintain this quality, the academic's theoretical knowledge associated with the experiences acquired with the supervised internship generate skills, that is, a know-how. However, knowledge and know-how are not enough, there is a need to want to do, a preponderant factor in defining the praxis of the professional. [18] A study carried out in Mexico shows that medical professionals are more qualified and knowledgeable in performing the oncotic cytology exam compared to trainees. [19]

Teaching strategies need to make teachers lead the student to achieve skills, understanding and practicing learning to know, learning to do and learning to be in nursing care, which can be used problem-based and student-centered learning, interactive teaching-learning strategies, guided by practice and effective in learning critical thinking, skills and abilities both for clinical decision making and for discussion of clinical cases, [20] situations with simulated patients and the formation of a critical-creative professional, rescuing their sensitivity and allowing the construction of meanings and interpretations that drive this process. [21]

Table 2 shows the reality of the Nursing course, with a predominance of females in the number of students. The hypothesis was raised that the male nursing student could have less ability due to the exposure of the female genital organ, being embarrassed when performing the exam. In this study, there was no difference between females and males at the end of the five collections of the oncotic cytology exam.

The second collection, the unsatisfactory number is for males, with an improvement from the third to the fourth collection and arriving in the fifth collection with 0% of unsatisfactory. The characterization of the majority female sample in the research corresponds to other studies. Studies show nursing workers worldwide and in Brazil the female figure has always been very present. [22]

However, it was not possible to find in scientific articles, discussions about the difference between the female and male gender in the specific competence of collecting the oncotic cytology exam. A study in Taiwan that suggests that male nurses should be counseled about the importance of Pap smear testing for detecting cervical cancer and also about strategies to reduce pain and embarrassment during the exam. And nurses with less negative attitudes and experiences related to oncotic cytology exams serve as an

example to persuade women to take exams, thus increasing the acceptance rate of exams in Taiwan. [23] In another study carried out in Australia, it states that patients prefer a welcoming environment and that the sex of the professional is not a barrier for the patient to be able to undergo the exam. [24]

V. CONCLUSION

In the present study, the competences of nursing students to perform the Pap smear test during the supervised internship period in Primary Care were evaluated. The evolution of the students during the exam collections was notorious. Some manual skills in the first collection were unsatisfactory in the proper execution of the exam, but with the course of other collections, the student can evolve, reaching a satisfactory level in the fifth collection. Thus, one can notice a significant improvement in manual and attitudinal skills. Although the Nursing course has a predominance of females, there was no difference in performance in the skills of performing the exam between males and females. The same was found regarding the student's age, having or not having a technical nursing course and having or not previous experience in cytological collections.

The supervised internship performed during undergraduate nursing is a moment of intense learning, as the academic experiences real situations in the day-to-day work of nurses, at all levels of care.

Given these findings, it can be inferred that the supervised internship of the nursing course to collect the oncotic cytology exam constituted an efficient way of learning.

Periodic curriculum reviews that follow the specific needs of the course are necessary to better train academics. It is important to assess the student's needs in the teaching-learning process, giving them the opportunity to perform at least five oncotic cytology collections, ensuring the development of their skills during the collections, acquiring minimal skills for a satisfactory performance.

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Application of factor analysis to identify entrepreneurial characteristics in students of Management and Information Technology course

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Abstract—The phenomenon of globalization has considerably increased the knowledge, skills and abilities in the vocational training process. Vocational training today, not only depends on the development of classroom subjects, but it also depends on training with a creative, critical focus on global solutions and a vision to improve society and the world. This is the focus of entrepreneurial qualification. This requires a multidisciplinary, systemic and comprehensive training. The objective of this article is to recognize the variables that identify the characteristics of entrepreneurship of the studied group. As for the methodology, to identify these variables, a factor analysis was used as a statistical treatment. For data collection it was used a questionnaire with 45 statements on the theme entrepreneurship, involving the issue of professional situation and intentions to open its own business. The questionnaire was answered by 235 students of Technology courses in the area of Management and Information Technology of the unit under study. The following characteristics were highlighted: self-efficacy, sociability and innovation. Other important traits for entrepreneurship development, such as planning to take calculated risks, leadership, and opportunity detection are characteristics that need to be worked on to develop these in students. The result presented can serve in the definition of strategies and structures to support pedagogical management. It can also serve as an instrument for raising awareness and supporting students in pursuing a career as an entrepreneur. It is important to constantly reflect and rethink what teaching methodologies and pedagogical approaches help to encourage learning.

I. INTRODUCTION

Organizations such as the World Economic Forum, the United Nations (UN), the Organization for Economic Co-operation and Development (OECD), and the Inter-American Development Bank study and are very interested in the characteristics and behavior of young people in relation to entrepreneurship.

Reference [28] state that, since 1985, Drucker, through their studies, identified that entrepreneurship can be taught. Later, authors [20] supported this thesis and academic organizations began working with

entrepreneurship education programs. Recent studies [44, 45, 36, 47, 48, 49, 50, 51, 52, 53, 54] show the importance of entrepreneurial education in schools and universities.

Mapping the characteristics of entrepreneurs and their actions can help to understand more about what has been achieved, as well as help to create new programs or improvements to the existing ones. Identifying the potential entrepreneur aims to make a summary of the skills, motivations and personality traits which can lead to an analysis and identification of characteristics that need to be learned and developed for the "entrepreneurial profile".

The entrepreneur needs to combine three fundamental elements: knowledge, skills and attitudes. The entrepreneur needs to combine three fundamental elements: knowledge, skills and attitudes. To combine these fundamental elements, it is important to provide comprehensive, systemic and interdisciplinary training, considering the needs of companies, with a focus on opening new companies and maintaining and growing existing companies on the market. Reconciling theory with practice [44] is of great relevance.

Activities such as preparation and evaluation of business plans and the search for financing instruments induce entrepreneurial behaviors and are part of the ability to anticipate change and take action and decision, as well as understanding the social, political, economic and cultural environment of an organization.

Another way to encourage student entrepreneurship is through activities related to technological research and development. To work [13, 14] with research is to work with doubt, it is to walk a path of investigation; is to recognize and apply the concepts of multi, inter, trans and pluridisciplinarity. And through these concepts and applications, develop the critical and scientific spirit in the student, stimulating entrepreneurship in the learning environment.

These characteristics and activities are part of the entrepreneur's daily life and need to be worked on in the academic context.

The aim of this paper is to recognize the variables that identify the characteristics of entrepreneurship of the studied group. For this it was used factor analysis.

Seeking to identify the attributes that contribute to the formation of the entrepreneurial profile, knowing that these attributes are increasingly relevant in society and that the entrepreneurial profile requires a precise definition of the characteristics which compose it.Reference [25] tested an instrument of measurement of potential entrepreneur - Carland Entrepreneurship Index (CEI) academically recognized in the US.

Authors such [18, 31, 34] highlight in their works the difficulty of working with subjective concepts which can trace characteristics for an entrepreneurial profile.

In 2005, Reference [27] built and validated an entrepreneurial attitude measurement instrument, as well as the measurement of this attitude, in owner-managers of small retail and/or service companies participating in the "Empreender" Project, in the Federal District, distributed in eleven types of sectoral centers, twelve different administrative regions of the DF, totaling 33 sectoral centers and 687 companies.

Surveying the characteristics to draw a profile which can be worked in students' vocational training, can be revealed as a potential benefit for measuring entrepreneurial intent and guidance, and may also contribute to a more efficient and effective analysis direction of potential entrepreneurs. It is important to stress here that entrepreneurial attitudes and attitudes should be encouraged.

Reference [35] emphasizes that entrepreneurial qualification is based on: learning about understanding the world, analyzing and defining the different facets of its individual and institutional context; and, creative thinking and problem solving, not forgetting competitiveness, personal mastery. It is the process in which the self-knowledge, self-development and competitiveness that is part of the business world is developed.

References [19, 30] emphasize that it is necessary to work with different educational methods, since in entrepreneurial training it is opportune to deal with the imagination, in addition to defining and structuring a space that is not yet occupied in the labor market.The importance of using various educational methods is applied to several areas of knowledge[55, 56, 67, 58, 59, 60, 61] .

This theory is related to Ausubel's cognitive learning theory and the theory of meaningful learning, which Reference [29] states needs two conditions for the process: "1) the learning material must be potentially significant and 2) the learner must present a predisposition to learn".

The difference is in the educational process of entrepreneurial formation in which the central element is the student, with his active participation plus what he already brings from knowledge from the most diverse sources of information.

For Reference [23], the intention to undertake, the knowledge, the experience of learning by practice, the action through the exploration of the opportunities or needs (our emphasis) and the entrepreneurial behavior is the process through which education must pass the entrepreneurial education. This leads to a reflection based

on the studies by References [30, 32] state that the reference of this formation is in the process of theoretical learning, practical learning and what the author calls social learning. It is the learning from examples, both positive and negative. It considers successful entrepreneurs and entrepreneurs who have failed in business, those who persisted and who gave up.

Table 1 presents the characteristics of entrepreneurial capacity, based on the thinking of entrepreneurship schools [16].

Table.1: Characteristics of entrepreneurial capacity

Entrepreneurship School	Thought Base	Features
"Great man"	The entrepreneur has an intuitive and natural ability.	Intuition, persistence and trust,
Personal characteristics	The entrepreneur has values, attitudes and needs that differentiate him.	Need for personal fulfillment, strong personal values, etc.
Classical	The behavior of entrepreneurial approach is based on innovation.	Innovation and creativity.
Management	Entrepreneurs are those who start and run a business. Your skills can be developed.	Planning, budget and investment.
Leadership	Entrepreneurs are leaders who achieve their goals by developing their team.	Motivation, development and direction.
Intrapreneurship	Ability to develop initiatives within the company to develop them.	Identification of opportunities in the corporate environment

Important is to highlight that, the study by [1] demonstrates the Theory of Planned Behavior (TPB). The author states that personal attitudes refer to the attitude or belief towards a behavior and corresponds to the favorable or unfavorable assessment that the individual makes of that behavior, thus the characteristics presented represent the entrepreneurial profile of the studied courses and the predisposition to the entrepreneurial attitude or not.

Reference [25] state that entrepreneurship goes through social, economic and psychological variables, which ends up influencing the act of entrepreneurship. As the authors argue, this is a complex and multifaceted process through social and cultural mobility. The entrepreneur has characteristics such as: need for achievement, risk propensity, creativity, vision, high energy, strategic posture and creativity.

These characteristics are related to the entrepreneurial attitudinal characteristics presented in Table 2, used by Reference [33] to trace the entrepreneurial profile.

Table 2: Attitudinal Characteristics [33]

Attitudinal characteristics	Description
Self effective	"It is a person's cognitive estimate of his/her ability to mobilize the motivation, cognitive resources, and courses of action necessary to exercise control over events in his/her life" [36]. "In almost all definitions of entrepreneurship, there is a consensus that we are talking about a kind of behavior that includes: (1) taking initiative; (2) organize and reorganize social and economic mechanisms in order to transform resources and situations for practical gain; (3) accept risk or failure "[24].
Take calculated risks	"Individuals who need to be sure are all but impossible to be good entrepreneurs" [37]. "The corporate passport for the year 2000 will be entrepreneurial ability, that is, the ability to innovate, to take risks intelligently, to act quickly and efficiently to adapt to the continual changes in the economic environment" (Kaufman, 191, p. 3).)
Planner	"Entrepreneurs not only define situations, but also imagine visions of what they want to achieve. Their main task seems to be to imagine and define what they want to do and almost always how they will do it"[19]. "The entrepreneur is the one who

	makes things happen, anticipates the facts and has a future vision of the organization" [38].
Detect Opportunities	"It is the ability to capture, recognize, and make effective use of abstract, implicit, and ever-changing information" [39]. "That has the ability to identify, exploit and capture the value of business opportunities" [40]. "The willingness to identify opportunities is fundamental for those who want to be entrepreneurs and consists in taking every opportunity to observe business" [41].
Persistent	"Ability to work intensively, subjecting even to social deprivation, in projects of uncertain return" [42]. "Developing the entrepreneurial profile is enabling the student to create, lead and implement the process of developing new life plans... Entrepreneurial training is based on the development of self-knowledge, with emphasis on perseverance, imagination, creativity, associated innovation "[35].
Sociable	"Entrepreneurs… provide jobs, introduce innovations and stimulate economic growth. We no longer see him as uninteresting suppliers of goods and auto parts. Instead, they are seen as energizers who take necessary risks in a growing, productive economy "[43].
Groundbreaking	Reference [12] conclude that entrepreneurship is mainly a function of four elements: personality traits (need for achievement and creativity), propensity for innovation, risk and energy stance.

Innovation [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 57, 63, 64, 65] occurs when there is a successful commercial exploitation of a creation. The development of entrepreneurial attitudes has an impact on the creation or development of innovative products and services for society. The development of an entrepreneurial education can be carried out through specific disciplines of entrepreneurship and through projects and other activities that encourage innovation, the establishment of strategies, leadership and other skills, in various disciplines during a course [61, 62].

II. MATERIAL AND METHOD

For data collection, a questionnaire with 45 statements about the theme of entrepreneurship was used, involving the issue of professional situation and intentions to open his/her own business.

This questionnaire was answered by students of Technology courses in the area of Management and Information Technology of the unit under study. The answers were given by the Linkert scale (-3 to 3), from totally disagree to totally agree. The number of respondents in each class was around 40 students per accidental sample.

The applied questionnaire was divided into four categories: professional situation, obstacles, intention and motivation.

Based on the conceptual basis on the entrepreneurial profile [33], considering the various definitions found in the literature, the entrepreneurial attitudinal characteristics and developed a questionnaire were defined, with the aim to deepen and clarify the theme, without intending to exhaust it. It was also defined that the research lacked a methodological standard, which eventually imposed restrictions on the analysis of the results. Even with these difficulties, it was possible to raise characteristics and describe an entrepreneurial profile that can be worked in vocational training.

In this research, it was chosen to use this questionnaire, as it is already tested and validated. The questionnaire is entitled "entrepreneurial profile" and "entrepreneurial intention". To use other questionnaires raised in the survey, it would be necessary to test and validate each one. Due to the reduction of time, this was the one that best fit the proposal. The questionnaire underwent a minor adaptation to suit the reality of the unit, object of study.

The questionnaire aims to identify the entrepreneurial motivation of the students, with special attention to the university context, also identifying the family business past. The observation is also related to the evaluation of the university's activities and the offers related to its students 'entrepreneurial education, also evaluating the students' perceptions about the basic conditions offered by the unit for entrepreneurship.

After collecting the data, statistical analyzes were performed using the software SPSS 19 (Statistical Package for the Social Sciences).

In order to obtain the factors or constructs, from the 45 statements (variables) that were submitted to Factor Analysis (FA), which aims to identify dimensions of common variability, called factors, among a set of variables. That is, "this technique seeks to identify factors that may explain the relationship between a set of variables" [15].

According Reference [22], the objective of FA is to summarize the information contained in several original variables, in a smaller set of factors with minimal information loss.

The presented constructs came from a cross-sectional survey, ie, in a given period of time, all students answered through the online questionnaire.

Pearson's correlation coefficient (r), or product-moment correlation coefficient, which measures the degree of linear correlation between two quantitative variables was calculated. It is a dimensionless index with values between -1.0 and 1.0 inclusive, which reflects the intensity of a linear relationship between two data sets. As stated in Equation 1 below:

$$r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{\left[n(\sum x^2) - (\sum x)^2\right]\left[n(\sum y^2) - (\sum y)^2\right]}} \tag{1}$$

At where:

n = number of data pairs;

$\sum xy$ = sum of the product of the variables "x" and y ";

$\sum x$ = sum of variable "x";

$\sum y$ = sum of variable "y";

$2 x^2$ = sum of square of variable "x";

$\sum = y^2$ sum of square of variable "y".

When r = 1, there is a perfect positive correlation between the two variables and r = -1 the perfect negative correlation between the two variables; that is, if one increases, the other decreases, and when r = 0, the two variables do not depend linearly on each other. However, there may be another dependency that is "nonlinear". Thus, the result r = 0 should be investigated by other means.

The correlation coefficient was used to verify which variables had no significant correlations (p> 0.05), thus such variables were removed from the analysis.

The Kaiser-Meyer-Olkin Test (KMO) [26] was performed, represented by an index that evaluates the suitability of the factor analysis, being calculated by Equation 2:

$$KMO = \frac{\sum_{j \neq k} \sum r_{jk}^2}{\sum_{j \neq k} \sum r_{jk}^2 + \sum_{j \neq k} \sum q_{jk}^2} \tag{2}$$

At where:

r^2 jk is the square of the elements of the original off-diagonal correlation matrix;

q^2 jk is the square of the partial correlation between the variables.

KMO index values that indicate that Factor Analysis is appropriate varies from author to author. For Reference [21] are acceptable values between 0.5 to 1.0, so below 0.5 indicates that factor analysis is unacceptable. The data from this research were appropriate for a factor analysis, so the next step was factor extraction. Then, the commonality (which is the portion of the variance that a variable shares with all other variables considered, ie, the proportion of variance explained by the common factors) of each variable, was evaluated and one by one excluded. variables with commonality lower than 0.5 in ascending order [22].

In this process, the variable with the lowest commonality was excluded and then the total variance explained and the new commonality of the other variables verified, the process continued until all the remaining variables reached commonality greater than or equal to 0.5 and thus, The cumulative variance of each model was verified (looking for the variance> 60% [22]. Finally, for each variable, the factor loadings were observed, identifying the highest load in one of the factors.

To maximize the effect of the variable on one of the factors, the orthogonal rotation method called Varimax was applied. This method emphasizes that for each major component there are only some significant weights and all others are close to zero, ie the goal is to maximize the variation between the weights of each major component. Hence the name Varimax.

Varimax rotation [17] tries to maximize the dispersion of loads within the factors, that is, it tries to aggregate fewer variables on each factor resulting in more clusters of interpretable factors.

III. RESULTS AND DISCUSSION

The total sample was 235 students. Pearson correlation coefficients between the variables were calculated. Some of them were removed from the analysis when they correlated with less than 18 variables.

The KMO test was performed comparing the best index.

1st Stage: 45-variable KMO test = 0.733 - 14 factors (Explained variance = 69.89%)

2nd Stage: KMO test with 39 variables = 0.773 - 12 factors (69.09%)

3rd Stage: 36-variable KMO test = 0.805 - 11 factors (69.31%)

4th Stage: 29-variable KMO test = 0.832 - 7 factors (66.75%)

At this moment, the explained variance of the models was verified and the largest variance was sought. For this, 7 more variables were eliminated, leaving 29 variables in the model, thus, the variables that correlated with less than 25 variables were extracted.

The analyzes were performed with and without Varimax rotation, reaching the same result. Therefore, it was decided to rotate Varimax, obtaining 7 factors and an explained variance of 66.75%.

With the results found, by using SPSS software, a comparison of the KMO test was made, eliminating some variables until it became with a high KMO index. The cumulative variance of each model was verified, looking for variance greater than 60%.

Pearson's correlation coefficients showed the variables that were most positively and negatively related. The highest positive correlation coefficient is r = 0.662 between the variables "respect for opinion" and "influence".

Other variables that stand out in terms of correlation are "instinct" and "opportunity detection" (r = 0.642).

Some variables have negative correlation coefficients, ie the more one variable increases, the more the other decreases.

The most negative coefficient is r = -0.464 between the variables "opportunity detection" and "fear of taking risks", that is, the more detection, the lower the fear.

The correlation coefficient between the variables "non-detection of opportunity" and "idea of entrepreneurship" is -0.357; that is, to open the business, the student visualizes the importance of opportunity detection.

The best matrix with the factor loadings was searched through the Varimax rotation, that is, when the factor loadings above 0.40 occurred in both components, the variable was removed.

Seven factors were found - 66.75% of cumulative variance and for each variable were observed the factor loadings, identifying the highest load in one of the factors.

The variables were grouped by factor and thus, it was possible to identify the characteristic of that group of variables. Such features are shown in Table 3.

Table 3: Factors found in the search

Factor 1	Entrepreneurship lacks maturity
Factor 2	Indecision and lack of proactivity
Factor 3	Innovation
Factor 4	Intuition
Factor 5	Accommodation, lack creativity
Factor 6	Ability to establish self-effective relationship network
Factor 7	Perspective

It is verified that the variables "instinct" and "opportunity detection", as they are positively correlated, show us that the student still uses his instinct to detect opportunities, which should be further worked, while the student should use his technical knowledge to detect opportunities..

Some characteristics should be highlighted, such as persistence and idea of entrepreneurship, which are positively correlated (r = 0.570) and show that students have a perspective, being the construct or factor 7.

A striking construct found was the lack of maturity for entrepreneurship (Factor 1), a feature that should be taken into account in the preparation of the teaching and lesson plan, as Reference [30] state that it is important to learn from social learning. That is, having the successful entrepreneurs and the failing entrepreneurs as a model. Because from the cases presented, it is possible to identify how they acted during the development and growth of the business. Showing the strategies and difficulties faced during the process.

The variables that were grouped in Factor 3 showed that these students have innovation as a differential for the market, thus, according to the authors [12], who group four elements: personality traits (need achievement and creativity), propensity for innovation, risk and energetic posture for propensity to entrepreneurship.

Although the characteristic of calculated risk and creativity (Factor 5) was not found, the profile of innovative students can be verified. It is clear from these

results that while they realize how important innovation is to the market, creativity is still lacking to put this product or service into circulation.

Another factor found was intuition (Factor 4), which is not in the picture as attitudinal characteristics at the present time, but intuition was once synonymous with entrepreneurship when the entrepreneurship school saw it as a "Great Man", because this is a natural characteristic of the entrepreneur.

Reference [24] state that there is a consensus on a kind of behavior that includes: (1) taking initiative; (2) organize and reorganize social and economic mechanisms in order to transform resources and situations for practical gain; (3) accept the risk or failure ". A construct found was this characteristic self-efficacy and trust in their social network, which agrees with the profile of these authors, as these students reorganize their social mechanisms to achieve their goal, as shown in Factor 6.

Factors 2 and 7 show students have an objective, but they are afraid ofinvesting and for this reason, they retreat in the action of undertaking. Situation presented by the economic uncertainty that presents the country.

The result presented can serve in the definition of strategies and structures to support pedagogical management, as well as the definition of policies for unit management. It can also serve as an instrument for raising awareness and supporting students in pursuing a career as an entrepreneur.

As it is a cross-sectional study, it is possible to change the student's opinion due to their training and / or experiences about entrepreneurship after a while of applying the questionnaire. This limitation does not invalidate the analysis that remains relevant and significant.

It is necessary to outline and identify the real objectives that entrepreneurship education must fulfill, such as developing basic skills, creativity and innovation, helping students develop ideas and plan their own businesses; introducing them in the world of scientific research, in the production of knowledge on entrepreneurship and innovation through studies and research that contribute to the understanding of the concept, diagnosis, education and stimulation of the area should be the objective of entrepreneurial qualification. And so, leaving students without such an education and with exchanging experiences can lead to a high failure rate.

IV.   CONCLUSION

Considering that the studied undergraduate courses aim to train professionals who contribute to the generation of

innovation in products/services and in the processes of companies and that these professionals are able to anticipate problems and solve them, minimize costs and maximize benefits of the economic activity of the business , and all this with an ethical and sustainable perspective from the business point of view, it can be considered that this research met the need to understand the student's profile.

From the characteristics mentioned for an entrepreneur, some were highlighted in this research, such as self-efficacy, sociability and innovation. Other important traits for entrepreneurship development, such as planning to take calculated risks, leadership, and opportunity detection are characteristics that need to be worked on to develop these in students.

The construct presented was through a cross-sectional research, characterized by data collection in a single temporal moment, not allowing generalization of the results. This suggests further research of a longitudinal or even cross-sectional nature with students who already have their own business.

Although the instrument has offered a result that fits the studied theoretical framework, a new study is suggested, ie, the second round of the same material in another period, thus expanding its application and reliability.

It is proposed to analyze the entrepreneurial intention beyond the profile through other materials also tested and validated, so that different comparisons can be made.

It is important to constantly reflect and rethink which teaching methodologies and pedagogical approaches help to encourage learning and the achievement of entrepreneurial training activities.

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Brazilian Tax Law: From the Science of Finance to interdisciplinary approach

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Abstract— This article aims to do a retrospective analysis of Brazilian Tax Law. We started from the process of Law's consolidation as an independent science, under the foundation of Legal Positivism, moving away from Sociology and Moral and then; afterwards, we discuss the autonomy of the Brazilian Tax Law from the finance sciences and its consolidation through the Federal Constitution, understanding that the positivist paradigm was overcome with a broader perspective in the sense of the protection of Fundamental Rights and Justice as unshakable values. Finally, at the end of the article, we reach the new perspectives and challenges of the Brazilian Tax Law: the interdisciplinary approach.

As a bibliographical methodology, we confronted classical books, specific statutes, as well as new academic works.

I.   INTRODUCTION[1]

1.1. Law as a Science: From Hans Kelsen to Konrad Hesse

Nowadays study and application of Law have been aimed at a paradigm shifted to bring to light, as an inescapable element, the plural and multifaceted reality of human society, the broad fulfillment of fundamental rights and the full realization of human well-being.

Moral and social values hitherto set aside, in favor of a scientific pursuit with pure pretensions, return to academic and jurisprudential discussions, especially after the advent of Brazilian 1988's Constitution, through which democratic institutions have been strengthened.

During the course of the late nineteenth to mid-twentieth centuries, numerous jurists, based on the legal positivism of Hans Kelsen, turned their eyes into the study of the law as a science, based on elements through which it could be empirically applied, leading to extreme ideas such as the separation of Moral concepts, considered as a foreign element of law's, arguing the lack objectivity and the supposed purity of the Law.

According to Kelsen, in the second edition of his Pure Theory of Law, the object of legal science would be human's conduct insofar, as it is determined by cogent norms, established through presuppositions and consequences, so that, such conduct could only be understood through legal rules. Thus, only inter-human

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[1]A Portuguese version of itens 1 to 3 from this work, as well as parts of the conclusions, was published in Brazil as a chapter of the book "Direito constitucional tributário e tributação municipal: estudos em homenagem à professora Elizabeth Nazar Carrazza", by Quartier Latin (publisher), in Sao Paulo, 2021, p. 519-535.

relations present in legal norms would be the object of theLegal Science.[2]

Under this idea, legal propositions produced by science would then be statements (objective descriptions unrelated to meta-juridical values), under which, it could describe its relationsand an hypothetical judgment stating that, in accordance to a given legal order, under certain conditions and assumptions set by it, certain predetermined consequences must intervene. Law scientist's answers, according to Hans Kelsen[3], could only be statements about a conduct prescribed, prohibited, or permitted, and about competences.

On the other hand, legal norms, in Kelsen's view, are not enunciations about objects, but rather commandments, that is, imperative commands (permissions and attributions of power or competence) produced by legal bodies.[4]

Thus, with the function of juridical authority, its mission would be to produce the Law, known and described by Legal Science, not being true or untrue, but valid or invalid.

Then, by suggesting the Pure Theory of Law, Kelsen turns to positive law whereby, having the State's norm as its object and the segregation of foreign elements as a methodology, seeking to develop a science of law free from external influences, as Politics, Ethicsand otherSocial Sciences.

It can be said that the Legal System, as viewed by Kelsen, would have the following characteristics: a closed positive normative system, validity structuredand supported by the hierarchy of State norms, regulating the human conductpositivelyor negatively.

The classification of a closed legal system hastwo main characteristics: unity and self-production. Normsare produced within a single system, that is, operates within and with the Law, so that, it is produced with self-centered validity, maintaining cohesion and coherence.[5]

Therefore, Kelsen'sLegal System is closed, dynamic, hierarchical and pyramidal, given by the supra-below order, under which the lower norm seeks its foundation of validity in the higher norm, leading to the fundamental hypothetical norm, as an assumption and logical-legal proposition that validates the whole system.

Thus, in its logic, there is no norm outside the system, as no norm would be valid outside it.

The legal norm for Kelsen is in the field of prescription (*Sollen*), which is the proper field of the Science of Law.

Under the Pure Theory of Law, Kelsen seeks to delimit what is proper to The Law and to the Science of Law, as an autonomous science. The idea of purity, therefore, removes everything that concerns the Natural, Social Sciences, the world of being and facts, and political or moral issues.

In this sense, there is a necessary distinction between what is and what must-be (*Sollen*). The concept of what is, is just realized in space and time in a sensibly perceptible way, an outward manifestation of human conduct, all that endowed with facticity. On the other hand, the concept of duty is an intentional act directed at the conduct of another, the way of conducting oneself in a certain way which does not imply that the other will, therefore, conduct himself in such a way, but so only as a duty.[6]

Positivists, in general, conceives the conduct as prescribed, prohibited, or permitted, so that conduct, prescribed by norms, can be positively or negatively regulated, or just an attribution of competence or permission (confer rights), which are the deontic modalities of the Legal Order.[7]

Thus, in the closed Legal System there would not be loopholes, as either conduct would be positively regulated through deontic modes, or negatively regulated by negative permission. Such a systematic enclosure gives us the idea that any conflict would be resolved within the Legal System itself, without any necessity of the recourse to any instrument outside the Law.

The Fundamental Hypothetical Norm as a logical-transcendental presupposition would mean a non-positivized but rather thoughtful legal norm that is accepted as valid and effective, regardless any empirical verification (since its logic is given just from the reason).

Therefore, the Fundamental Hypothetical Norm standard would function as a primordial condition of all the system's existence, since only through its presupposition (we must conduct ourselves as the Constitution prescribes, in harmony with the subjective sense of the act of constituent's will), any Law can be established.

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[2] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 79.
[3] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 80 – 81.
[4] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 81- 84.
[5] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 217.

[6] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 86 – 91.
[7] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 5 -10.

So, the Fundamental Hypothetical Norm could be understood not as a product of a free discovery, because its presuppositions do not operate arbitrarily, in the sense that we have a choice between different Fundamental Norms when we interpret the subjective meaning of constituent's acts and other acts put in accordance with the Constitution prescriptions. Only when we presuppose this Fundamental Norm, in reference to a fully determined Constitution, we can interpret the subjective meaning of constituent's acts and constitutionally posed acts as their objective sense, as objectively valid legal norms, and the relations constituted through these norms as legal relations. Concluding that,under the presupposition of the Fundamental Norm, no transcendent value could be affirmed as a positive Law.[8]

Notwithstanding such beliefs, which in some ways were important for the development of the study and affirmation of the Law, the study of law departed from these extreme position. According to Norberto Bobbio, other scientists realized that the human reality is wider and changeable than the whole system of norms, since the existence of the man has an infinite number of possibilities; so that there is no way to foresee all possibilities beforehand.They turn to the values hitherto set aside and theLaw begins to be understand as undissociated to the cultural and social aspects of human society, under the effect of a constant process of improvement and nobility of humanity, appreciated not according to cause and effect relations, but means and ends; not in a structural, but in a functionalist way.[9]

Therefore, new studies, under the movement conventionally called post-positivism or neo constitutionalism,[10] flourishes, and the Lawturns tobe a social discipline endowed with a function, in which society imposes on itself, in the person of its members, certain means, in order to achieve just and moral ends chosen by them, assuming, then, a new configuration.[11]

Law, then, becomes humanized as part of society's idiosyncrasies, projecting values of justice, equity and morality, as a way to perpetuates a minimal dignified existence for the full realization of men.

In such a way, the whole of society is called upon to interpret the Law and this interpretation, then, assumes a fundamental role, so that the Law goes from the hands of the scientist to the hands of the hermeneutic, who now has a creative function, not as a mere declarer of the Standards set.[12]

Thus, in the present day, the Science of Law rests on a pressing need to interrelate with the Social Sciences, and Law turns not only on a *structuralist* theory, important and still in force, but on a functionalist theory, which gives a new character to the jurist: no longer conservative and mere transmitter of a body of rules already given, he is now also a creator of rules that transform in order to integrate and innovate the given system, of which he is no longer mere receiver, but an active collaborator.

In the same sense, is absolutely clear to observe how the Theory of Positivism is in crisis nowadays, showing that the jurist is held no more to a unitary, coherent and complete system of rules, from which it is possible (and also obligatory) to extract the solution of any controversy (thesis of the so-called self-sufficiency of the normative system); but on the contrary, the spread, even in countries of codified law as in Brazil, of a realistic theory of the Law that focus its attention on the effectiveness rather than the formal validity and emphasizes all the interrelationships between the legal system and the economic, political and social systems.

What distinguishes the present situation are precisely those conditions which we find particularly favorable to the formation of a science of anti-traditionalist Law, which ultimately seeks the object itself, not so much in the rules of the given system, but in the analysis of social relations and values; from which the rules of the system are extracted, far from considering, as it was for a long time, that the Law is autonomous and a pure science, but seeking the alliance with the social sciences, to the point of considering itself as a branch of the general science of society.

The creative interpretive act takes a new form and importance from human reality and latent legal devices to create a new reality.

Thus, the normative statements, their purposes and all the axiological contents that support them are analyzed, the facts are interpreted, in order to apply the fairer and egalitarian rule to the concrete case, so that all the law has a logical link with certain social values that come to be constitutionalized, and the constitution thereafter has greater importance in the legal scenario.

According to Konrad Hesse, the constitutional norm has no autonomous existence in the face of reality. Its essence lies in its validity, that is, the situation it

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[8] KELSEN, Hans. Teoria Pura do Direito. 2ª ed. São Paulo: Martins Fontes, 2012, p. 224 - 228.

[9] BOBBIO, Norberto. Da Estrutura à Função. São Paulo: Manole. 1ª ed. 2006, p. 33-34.

[10] BECHO, Renato Lopes. Filosofia do Direito Tributário. São Paulo: Saraiva, 2009, p. 242.

[11] BOBBIO, Norberto. Da Estrutura à Função. São Paulo: Manole. 1ª ed. 2006, p. 33-34.

[12] BOBBIO, Norberto. Da Estrutura à Função. São Paulo: Manole. 1ª ed. 2006,p. 37.

regulates is intended to be realized in reality. This claim to effectiveness (*Geltungsanspruch*) cannot be separated from the historical conditions of its realization, which are in different ways in a relationship of interdependence, creating their own rules that cannot be disregarded.

Natural, technical, economic and social conditions must be considered here. The claim of the effectiveness of the legal rule will only be realized if these conditions are taken into account. Equally, the spiritual substratum that is embodied in a given society must be contemplated, that is, the concrete social conceptions and the axiological basisthat decisively influence the conformation, understanding, and authority of normative propositions.[13]

Thus, the legal system becomes open, since its norms can no longer be interpreted outside the political, economic and social context in which they are inserted. In fact, normative forecasting is open to the inflows of reality, both to substantiate its content and to motivate its eventual resignification.

II.   AUTONOMY OF THE BRAZILIAN TAX LAW

As Law could, gradually, be established as an independence science, the Brazilian Tax Law, as an autonomous discipline, has also suffered major difficulties until its current consolidation, with its on principles, rules, legal relations and institutes and its own codification. Thus, today, we can say that the Brazilian Tax Law has autonomy.

First of all, we should highlight the differentiation between independence and autonomy. This is very important because the idea of independence turns the eyes into the of the whole, so that Law, even though an open system, can be considered independent of other branches of science and can create its own rules according to its dictates.

On the other hand, autonomy takes into account a didactic division, in the sense that the tax matter, by having its own elements, can be studied separately.

However, as a matter, it has no independence, since the creation and application of Tax Law depends on other branches, such as Constitutional Law - in the creation of its norms - Administrative Law and Procedural Law - in the collection of taxes - so the Science of the Law is independent, but Tax Law is just autonomous.

The autonomous status of the Tax Law discipline resulted from a long process of awareness and historical improvement in Europe and Brazil, which initially started from its insertion as an object of the Financial Science, then to be recognized as part of Financial Law - under the auspices, relations, institutes, and principles of Administrative Law.

One of the major jurists of the Brazilian Tax Lax, Geraldo Ataliba, states that didactically and practically, it was agreed to discern the part (the Tax Law) of the whole (Administrative Law), by the isolation of the fundamental institutions of that (the tax).[14]

Then, the Tax Law subsystem was recognized within the positive system of Administrative Law.

Around this notion, the Science of Tax Law was built, with didactic autonomy, under the study of objective Tax Law which is composed of the norms that create and regulate taxation (tax action, privately state), tax and legal relationships between the State and the people.

Only then, by the efforts of several Brazilian and international jurists, it comes to acquire autonomy, with the creation of chairs in the Faculties of Law, through which its structure and dogmatic was established, that is, the factors and behaviors of human society that could generate the tax obligations, developing its interpretation, the types of taxes and the principles, rules and institutes of Tax Law, endowed with broad emancipation.

It is possible to denote that initially the study of the Tax Law did not even have juridical character, since it was the Financial and Economic Sciences - therefore extra-juridical - that took all the pertinent discussions to the matter - the amount that the taxpayers should take to the State and the subsequent application of the amount collected.

Thus, Tax Law was a matter for financiers and accountants, not jurists, turning to the economic, actuarial and accounting aspects of the taxation phenomena.

The first attempts to organize the Tax Law as a *jurisprudence* topic took place in Germany and Austria, through Otto Mayer and Myrbach–Rheinfeld - in the late 19th and early 20th centuries -, which sought to move away from the Finance Sciences to create the Financial Law, through the systematization of the institutes and the establishment of sources of the former, with laws, regulations, administrative as well as judicial decisions and legal methodology that distanced it from the latter.[15]

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[13] HESSE, Konrad. A Força Normativa da Constituição. Porto Alegre: Sergio Antônio Fabris Editor. 1ª ed. 1991, p. 14-15.

[14] ATALIBA, Geraldo. Hipótese de Incidência Tributária. 6ª ed. São Paulo: Malheiros, 2011, p. 41.

[15] COSTA, Alcides Jorge. Notas sobre a Relação Jurídica Tributária. In: Luís Eduardo Schoueri; Fernando Aurélio Zilveti. (Org.). Direito Tributário - Estudos em Homenagem a Brandão Machado.1ª ed. São Paulo: Dialética, 1998, p. 21-35.

For the German authors, the central core of the Financial Law centered on the idea of financial power, whereby the constitutional state, through a public budget, impose taxes, and both budget and taxes should be provided for by law.

Without the tax under the law, which in Mayer's view would be the cash payment imposed on the subject by permanent rule,an independent study would lose its essential characteristic, which can be denoted as an outline of what would then become the principle of legality.[16]

As a jurisprudence topic, taxation could be now ruled under the aegis of Administrative Law, as an appendix to the latter, so that, its relations, institutes, principles, and rules, would be regulate by it.

However, itis also important to remember that Administrative Law, in a way, has just gained disciplinary autonomy - compared to Private Law - the product of ancient Roman Law - only after the advent of the French Revolution, in the context of the Economic Liberalism, in which the "prince" becomes the State and would ever be restrained before the diverse prerogatives of the citizens. Under this conception, the Administrative Law gains prominence, separating the public patrimony - obtained through the collection - from the private patrimony.

Thus, the idea of duty and power, public interest, and public function is born as an activity exercised in the fulfillment of thewill to achieve the public interest, through the use of the instrumentally necessary powers conferred by the legal order.[17]

Under the aegis of positivism, the gradual improvement of Financial Law spread throughout Europe, and gradually it became more prominent than the Administrative Law. Nevertheless, it was used support on a catastrophic event. The first step in separating these branches of law would occur only because of the advent of the First World War.

World War I drove countless European States into a total political, social and financial chaos. Germany - then called German Empire - the main representative of the Central Empires - together with the Austro-Hungarian Empire - was utterly destroyed, with a loss of 15.1% of its economically active male population[18], the Hohenzollern dynasty, food shortages, and astronomical external debt. A

reform of the German Administrative System was then required.

In this context, by the hands of Enno Becker, the German Tax Code was created, which came into force from the year 1919, as a suitable measure to organize the German finances and tax collection.

The German Tax Code can be considered as a landmark of the scientific autonomy of the Tax Law in Europe, since them, a number of institutes, legal relations, principles, and tax rules have been organized systematically, separating it from Administrative Law.[19]

From then on, European Tax Law undergoes relevant theoretical deepening, extending studies on the chargeable events, tax obligations, interpretation of tax legislations according to its institutes, the prerogative of legality before the State, among many other topics that begin to thrive in Tax Law disciplines - recently established in Europe. With Brazil, it was no difference.

Despite the relative backwardness of the Brazilian Doctrine, in view of a broad and solid *civil law* tradition, as well as little contact with the German language, in the 1940s and 1950s began the - still shy - studies of Tax Law as an autonomous subject.[20]

The publications, debates, comments and important works started by Rubens Gomes de Sousa, Aliomar Baleeiro, Gilberto de Ulhôa Canto, Amílcar Falcão, Tullio Ascarelli and, later, Ruy Barbosa Nogueira, Alfredo Augusto Becker, Alcides Jorge Costa, Geraldo Ataliba, José Souto Maior Borges, among many others,enriching the nascent tax literature, strongly influenced by Hans Kelsen's Legal Positivism.

Those factors led, in 1953, to the first attempt to create a tax code in Brazil, by Rubens Gomes de Sousa, with the National Tax Code draft sent to the National Congress in 1954. Nevertheless, despite heated debates, revisions and concerning to Gomes de Sousa's initial proposal - heavily influenced by the 1919 German Code - the Project remained suspended for 12 years, and only in 1966 a statute based on Sousa's project wasapproved, what we now know as the National Tax Code (CTN).[21]

Regarding to the Chair of Tax Law in the law schools of the country, it is considered as a historical

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[16] TEODOROVICZ, Jeferson. História Disciplinar do Direito Tributário Brasileiro – Série Doutrina Tributária Vol. XXI. São Paulo: Quartier Latin, 2017, p. 94-102.

[17]MELLO, Celso Antônio Bandeira de. Curso de direito administrativo. 26ª ed. São Paulo: Malheiros, 2009, p. 29.

[18] KITCHEN, Martin. Europe Between the Wars. New York: Longman. 2000.

[19] TEODOROVICZ, Jeferson. História Disciplinar do Direito Tributário Brasileiro – Série Doutrina Tributária Vol. XXI. São Paulo: Quartier Latin, 2017, p. 125.

[20]TEODOROVICZ, Jeferson. História Disciplinar do Direito Tributário Brasileiro – Série Doutrina Tributária Vol. XXI. São Paulo: Quartier Latin, 2017, p. 131

[21]Trabalhos da Comissão Especial do Código Tributário Nacional: Disponível em http://www2.senado.leg.br/bdsf/handle/id/511517

landmark that occurred at the Pontifical Catholic University of São Paulo (PUC-SP), where, through the lectures of Professor Carlos Alberto Alves de Carvalho Pinto[22], the Science of Finance was taught.

With the entrance of Professor Ruy Barbosa Nogueira, the name of the Chair was changed to "Financial Law" - although his study was absolutely focused on Tax Law - and in the 1970s, just under the mastery of Professor Geraldo Ataliba at PUC- SP, continued the birth of the first regular course of Tax Law in Brazil, which later occurred in several colleges of the country.

In the words of Ruy Barbosa Nogueira, as for university education, with the approval of the Faculty of Law of the Pontifical Catholic University of São Paulo – PUC- SP, was inaugurated the first course of Tax Law, which has been taught for many years, whose course continues today. So PUC -SP created in 1963, the first Chair of Tax Law.[23]

From the 1950s until the advent of the Brazilian Constitution of 1988, the study of the Tax Law had grown exponentially, with numerous works towards the autonomous study of the subject. Still under a clear positivist bias, the academic productions about the tax institutes, principles and rules, the interpretation and application of the Tax Law, the taxes and their types, the tax obligation, the credit constitution, the launching and collection, the separation between Private Law and Tax Law, among other topics.

One of the doctrinal milestones of Brazilian Tax Law - which dates back into 1973- was the launching of the book "Hypothesis of Tax Incidence" by Geraldo Ataliba, which nowadays extends over time.

Geraldo Ataliba's work marked the definitive consolidation of the country's tax knowledge and from it, a school of great jurists was formed, which, as we will treatbelow, from the work of the Professor and the new times brought after the State of Exception that prevailed in the country until the advent of the Charter of 1988, gave a new face to the Brazilian Tax Law, thus starting the studies of Constitutional Tax Law.

In the words of Professor Ataliba, the concept of tribute is constitutional. No law can widen, reduce, or modify it. It is a key concept for the demarcation of legislative powers and underpins the "tax regime", a set of constitutional principles and rules for the protection of the taxpayer against the so-called "tax power", exercised,

within their respective limits of competence, by the Union, the states, and municipalities. Hence the disproportion of this legal definition, the admission of which is dangerous as potentially harmful to the constitutional rights of taxpayers.Constitutionally presupposed or defined rights cannot be "redefined" by law. To admit it is to allow constitutional demarcations to risk their effectiveness is compromised.[24]

III. TAX LAW AS A CONSTITUTIONAL SUBJECT AND NEO CONSTITUTIONALISM

The promulgation of the Federal Constitution - on October 5, 1988 - is the milestone by which the Social and Democratic State of Law will permeate the study of all branches of law, especially tax law.

The Citizen Charter, in its Chapter I, Title VI, affirmed the whole skeleton of the National Tax System, establishing the General Principles of Taxation, Limitations on the Power to Tax and a whole division of competences among the Federation Entities. Interestingly, in the 1970s and 1980s, important studies were emerging in the sense of the Tax Law as a constitutional subject, such as those of Elizabeth Nazar Carrazza[25] and Roque Antonio Carrazza.[26]

According to the author, the tax legislator, at the moment of exercise of its competence, is restricted to the normative parameters established by the Major Law:

> Whenever the constituent legislator elects a fact as a presumptive sign-fact of wealth, granting competence to the political persons to create taxes, the ordinary legislator, in exercising his enforceable competence, must remain within the parameters of reasonableness, so that the constitutional principle of

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[22] Dicionário Histórico Biográfico Brasileiro pós 1930. 2ª ed. Rio de Janeiro: Ed. FGV, 2001.

[23] NOGUEIRA, Ruy Barbosa. O Surgimento e Evolução do Ensino Científico do Direito Tributário no Brasil. São Paulo, 2002, p, 726.

[24] ATALIBA, Geraldo. Hipótese de Incidência Tributária. 6ª ed. São Paulo: Malheiros, 2011. Pg. 32 – 33.

[25] CARRAZZA, Elizabeth Nazar. Sistema Constitucional Tributário Brasileiro. Revista de Direito Público, São Paulo, v. 25, p. 197, 1971.

[26] CARRAZZA, Roque Antonio. Princípio Federativo e Tributação. Justitia, São Paulo, v. 130, p. 162-180, 1985.
CARRAZZA, Roque Antonio. Princípios Constitucionais Tributários e Competência Tributária. 1. ed. São Paulo / SP: Malheiros Editores, 1986.
CARRAZZA, Roque Antonio. Curso de Direito Constitucional Tributário. São Paulo: Editora Revista dos Tribunais, 1989.

contributory capacity will not be retracted.[27]

The advent of the Constitution as the Law's higher document, which is now matured (constitutionalization process), is the process by which the interpretative paradigms of all legal branches turn to the Magna Carta - more democratic and social, bringing in its core an exhaustive list of Fundamental Rights, Political and Social - getting from their devices the guidance needed to achieve their greater end: building a free, just and supportive society, ensuring national development, eradicating poverty and marginalization and reducing social and regional inequalities and promoting good of all, without prejudice of origin, race, gender, color, age and any other forms of discrimination.

As we look at European law, we can list some of the legal documents through which constitutionalization has paved its way in Europe: the German Constitution, called the Bonn Fundamental Law, in 1949 and the creation of the Federal Constitutional Court in Germany in 1951, the 1947 Constitution of Italy and the creation of the Constitutional Court of Italy in 1956, and the constitutions of Portugal - in 1976 - and Spain in 1978.

This process of constitutionalization of the Law, which in the 21st Century comes to be called neo constitutionalism, brought to light the division between principles and rules, with their predominance, the supremacy of Fundamental Rights and the dignity of the human person, the axiological and creative interpretation of the law, the predominance of judicial activity and the approximation of the Morality, bringing a huge opportunity to an interdisciplinary approach.

For Luís Roberto Barroso, neo constitutionalism has three major theoretical pillars: a) the recognition of the normative force of the Constitution; b) the expansion of constitutional jurisdiction; and c) the development of a new dogmatic of constitutional interpretation.[28]

In this context, it is of great importance to recognize the normative force of the constitutions, which must address the social reality and the plan of effectiveness.

In the words of Konrad Hesse, if it does not want to remain 'eternally sterile', the Constitution - understood here as ''legal constitution'' - should not seek to construct the state in an abstract and theoretical way. It does not

succeed in producing anything that is no longer grounded in the singular nature of the present (*individuelle Beschaffenheit der Gegenwart*). If these assumptions are lacking, the Constitution cannot lend "form and modification" to reality; where there is no force to be awakened - force that derives from the nature of things - the Constitution cannot lend it direction; if cultural, social, political and economic laws impose are ignored by the Constitution, it would lack the indispensable germ of its life force. Normative discipline runs counter to these laws, it fails to materialize.[29]

In this way, the meaning of the Constitution, previously seen as a mere formal document by which the Powers of the States were divided and organized, and a few rights were granted, were altered in order to achieve the greatest possible effectiveness of its text - which becomes extensive, establishing a whole set of FundamentalRights - which will govern all the facts of life, a role that had previously occupied by the Civil Law.

We see, then, that the constitutionalization process was based on two important assumptions. Initially, on the one hand, its principles, rules, and institutes are raised to a constitutional level so that the taxpayer - through respect for his fundamental rights –could be protected from an undue invasion of the State through the collection of taxes.

In this context, that vertical relationship, whereby the individual is compelled to bring money to the State, either by the existence of presumptive signs of wealth or by the regulatory exercise of police power, or the use of the public service, must now occur clearly, in accordance with the Constitution and through a series of principles, such as legality, equality, contributory capacity, among others.

On the other hand, the collection, management, and application of the amount brought to the State by way of taxes should take place democratically, fairly and with the ultimate goal of eradicating social and regional inequalities and ending poverty in the construction of a society aligned with social welfare.Thus, there is a resignification of administrative practices in order to transform the Law, including Tax Law.

According to Roque Antonio Carrazza, we note, furthermore, that our Constitution, in the laudable purpose of transforming the Brazilian Republic into a Democratic Rule of Law, has subjected the tax action of the State to an extensive list of principles (federative, legality, equality, precedence, security), which protects taxpayers, as much

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[27]CARRAZZA. Elizabeth Nazar. Progressividade e IPTU - igualdade e capacidade contributiva. 1ª.ed. Curitiba: Juruá, 2001, p. 51.

[28]BARROSO, Luís Roberto. Neoconstitucionalismo e constitucionalização do Direito. O triunfo tardio do Direito Constitucional no Brasil.

[29] HESSE, Konrad. A Força Normativa da Constituição. Porto Alegre: Sergio Antônio Fabris Editor. 1ª ed. 1991, p. 18.

as possible, against possible abuses.Moreover, it is the constitutional principles thatdrive the content of tax laws and their modes of application.[30]

Thus, the collection of exactions and the lawful invasion of private property by the State must necessarily take into account the protection of Fundamental Rights, that is, respect for strict legality, proportionality, and reasonableness, contributory capacity, material equality, confiscation, priority and non-retroactivity.

Therefore, in this constitutional turn, a logical-semantic interpretation of Tax Law, aligned with the Legal Positivism and an already outdated reality, besides representing an innocuous formalism, is not in line with the social needs of the country and the maximum purposes of the Federal Constitution.

The plan of reality and the effective construction of a fraternal society, based on material equality, with the full guarantee of rights for all and liberation from poverty and injustice, demand, in fact, a logical-syntactic shift, with focus on interrelationship between individuals and institutions, a look at the reality of the subjects and not the dead letter of words, and there is, undoubtedly, a need for openness to an interdisciplinary approach.[31]

The interdisciplinary openness in tax law represents a new paradigm whereby the whole phase of separation of the science of law and the autonomy of tax law has already been consolidated in such a way that there is no need for separation, but on the contrary, in a postmodern society, in which reality is advancing at a rapid step, the search for answers to the effectiveness of law and rights can often be found in other sciences, such as accounting, economics, psychology, medicine, computing, Sociology, and Morality.

In this sense is Law No. 13655/18 - which includes in Decree-Law No. 4,657 of September 4, 1942 (Law of Introduction to the Rules of Brazilian Law), provisions on legal certainty and efficiency in the creation and application of public law - through which an epistemological opening can be glimpsed towards effectiveness and practicality, which are in line with the idea of functionalism in law.

Therefore, beyond the phase of birth, separation, consolidation, and constitutionalization of Tax Law, its new perspectives tend precisely to a contrary movement, towards epistemological openness and the possibility of interpenetration of other sciences through an interdisciplinary approach, as an aggregating and enriching value that, in fact, will enable the fulfillment of fundamental tax constitutional values in line with a rapidly evolving multifaceted reality, as we will explain on the next item.

IV. LEGAL ACTIVISM IN TAX LAW AND THE NECESSITY OF AN INTERDISCIPLINARY APPROACH

The current Brazilian Federal Constitution was promulgated in 1988 and contains a plead of principles to protect taxpayers, leaded by the principles of legality and equality. From it, the Legislative Branch has the competence to create and change the taxation. The Judiciary applied the Federal Constitution as well as the statutes in tax matter. On this time, the subsumption was used in the majority of the judicial decisions. Reducing the subsumption as its minimum, we could explain those decisions as: 'the statute disciplines that, in occurring the situation X, a tax must be payed; if the situation was different than X (if the situation was Y or Z, for instance), the tax must not be payed'.

However, to work properly, the law must be clear on the subsumption process of applying the rule. In other words, the interpret needs to identify the elements of the law with no doubt. If the rule is uncertain, imprecise or the words used by the legislator are indeterminate, before the subsumption, the rule must be constructed.

Actually, under the basis of an interdisciplinary approach, interpreting a law means, beforehand, understanding it in the fullness of its social purposes, in order to be able, in this way, to determine the meaning of each of its provisions. Only then is it applicable to all cases that correspond to those objectives. As can be seen, the first care of the contemporary hermeneutic consists in knowing the social purposes of the law, as a whole, because is the purpose that makes it possible to penetrate the structure of its particular meanings.[32]

The legal positivism works with some possible sense of the words used by the legislators. The interpret is not free to adopt other sense for the same words, as we can denote in the words of Paulo de Barros Carvalho[33], who says that:

> It is the human being who, in contact with the expressed manifestations of the positive

[30] CARRAZA. Roque Antonio. Curso de Direito Constitucional Tributário. Ed. Malheiros, São Paulo: 2010,p. 64.
[31] HESSE, Konrad. A Força Normativa da Constituição. Porto Alegre: Sergio Antônio Fabris Editor. 1ª ed. 1991,P. 18.

[32] REALE, Miguel. Lições Preliminares de Direito. 22ª. Ed., São Paulo: Saraiva, 1995, p. 285.
[33] CARVALHO, Paulo de Barros. Curso de Direito Tributário. 13ª. Ed. São Paulo Saraiva, 2000. p. 120.

law, produces the respective meanings. Hence the peremptory assertion that it is interpretation that gives rise to meaning, inserted in the depth of the context, but always driven by the literal formulas of the objectified law.

In this same way, Sergio Nojiri, quoting Nicola Abbagnano, states that interpretation is the possibility of referring a sign to what it designates and the operation by which a subject establishes the reference of a sign to its object. The author continues, now quoting Roberto J. Vernengo, stating that interpreting a sign means expressing its meaning, using signs different from those used originally. In other words, it is the logic of a system of signs so that a set of signs is unveiled by other signs that make understanding easier.[34]

Nevertheless, some meanings change from time to time, showing us that legal positivism fails when confronted with a post-modern society, which demands, from the interpreter, an interdisciplinary openness, that is, the literal formulas of the positive objectified law are not enough to achieve the social purposes of the constitution.

The Brazilian Federal Constitution from 1988 contain many indeterminate stipulations, included on principles of law. These principles are indeterminate and required constructions as well as ponderations in situations on which they can collide. The post-positivism works with these social values that impregnate the constitutional principles, always searching for justice. For that, the rules of interpretation applied during the positivism era do not properly work in those cases.

We can briefly say, according to Kauffmann, justice is a fundamental, absolutely irreducible concept of ethics, social and legal philosophy, as well as political, social, religious and legal life, affirming that justice in a broad sense has three aspects: equality (justice in the strict sense) where the form of justice is found; the adequacy (social justice or the common good) which is the content of justice; and legal security (legal peace) which is the function of justice. It is fundamentally linked to the idea of justice, the concept of equality, because as its highest guiding idea, to think about justice is to seek an evaluative concept of a balance, a balance between certain parameters that are set by an observer.[35]

In this way, under the post-positivism, and its interdisciplinary approach, the act of interpretation is not declaratory, but constitutive. That is, the judge, when deciding, innovates the legal system, individualizing and implementing the general and abstract rule. In this way, the judge does not declare, unravel or discover the content already expressed previously in the law, but gives it a meaning to the legal statement with the interpretation, based on multiple topics out of the ruled law.

During the long time that judges used the subsumption as a model of decisions, jurists and professors rarely mentioned judicial decisions on their works. Judicial decisions applied the *law* in a positivist sense (Constitution and statutes), as presented on item 1 of this article. It was redundant to construct the interpretation of the rules quoting judicial decisions.However, after an undefined moment of this century, the reality haschanged.

Brazilian judges have, sometimes,departed from the subsumption system and started to use more rhetoric elements to justify their decisions, even because on post-positivism, it is essential to identify the social purposes of the constitutional principles considered by the Judiciary.

For the juspositivism, only the senses of the positive law could be used to construct the rules. Moral or ethical elements, as well as politics or economics were banned for the *correct* interpretation. For the post-positivism, these elements, mainly the moral and ethics are largely considered by jurists, lawyers and judges.

As we mentioned before[36], nowadays, academic discussions on the formation of the decision of Brazilian judges is beginning, including decisions taken in tax proceedings, in the administrative and judicial spheres, even because,as we said, the classic subsumption of the fact to the norm has no longer been sufficient to demonstrate how decisions have been taken, which points to the participation of other elements, which may be interpretative, not evidenced in the decision or even non-legal.

Nevertheless, some of the current problems are in situations under which the subsumption process could be used, but judges, instead of applying precedents or even the literal text of the positive law, avoid previous interpretations and started to create new rules. On these situations, elements included on constitutional principles do not help, demanding the critics of these events a research in politics, economics or even in psychology to

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[34] NOJIRI, Sérgio. A interpretação Judicial do Direito. São Paulo: Revista dos Tribunais.1ª ed. 2005, p. 121-125.
[35] KAUFMANN, Arthur. Filosofia do Direito. 2d. Lisboa: Fundação Calouste Gulbenkian. 2004, p. 225.

[36] BECHO, Renato Lopes. Considerações sobre dados extrajurídicos que podem estar influenciando os julgamentos tributários. Revista Brasileira da Advocacia, v. 8, 2018, p. 155.

identify what or why the judges ruled the cases on that new way.

As we said before[37], one of the traits currently expected from the academic community is the multidisciplinary search for knowledge, since not always just one scientific branch is enough to know the reality, especially considering the recent transformations.

So than, if subjunction methods were identified and explored in the past, but no longer lend themselves to explaining all present decisions, we can seek to identify the elements that are influencing today's decisions, the legal science needs to be able to explain such decisions, even though it also making use of knowledge gained in other disciplines, because, one of the traits currently expected from the academic community is the multidisciplinary search for knowledge, since only one branch is not always enough to know reality, especially in light of the most recent transformations.

V.   CONCLUSION

Law is not a starting point or a point of arrival, but a path, a trajectory to be profiled every day, through the changes and challenges that societies and human historical mindsets impose on individuals who interrelate in community.

The pursuit of the scientific purity of the law, independent of all other sciences and meta-juridical values, was the product of the needs of its time and an important instrument for the study of Law.

However, such a position is not in line with the plural and multifaceted reality of modern, or rather post-modern times.

Similarly, if it were not for the process of autonomy of Tax Law before the Science of Finance and later Administrative Law, we might not have been commenting on this legal branch, which today undeniably has its own principles, rules, institutes, relations, and ways of interpretation.

But the world has changed, and with it, new needs come. The constitutionalization of the Tax Law represented the transmutation of the previous paradigms, in favor of the construction of something bigger: a free, just and egalitarian society, free from prejudice, which aims to give the individual the minimum conditions of well-being and dignity, so that it can be realized and fully attain its fundamental right to happiness.

In conclusion, it is now up to the taxpayers - and perhaps all the legal operators - the new challenge: interdisciplinary approach.

Now, if there is no doubt that reality of the Law is broader than the statutes(as legal positivists imagined) and is developing at a rapid pace, we must follow the opposite path with epistemological openness, bringing again the values of Morality, Justice, Sociology, Economics, Politics, and Culture into the Law.

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[3] BECHO, Renato Lopes. Considerações sobre dados extrajurídicos que podem estar influenciando os julgamentos tributários. Revista Brasileira da Advocacia, v. 8, 2018.

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[16] NOGUEIRA, Ruy Barbosa. *O Surgimento e Evolução do Ensino Científico do Direito Tributário no Brasil. São Paulo. 2002. Pg. 726.*

[17] *(Disponível em https://www.revistas.usp.br/rfdusp/article/download/67573/70183/)*

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[37]BECHO, Renato Lopes. Considerações sobre dados extrajurídicos que podem estar influenciando os julgamentos tributários. Revista Brasileira da Advocacia, v. 8, 2018, p. 158.

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[24] *Trabalhos da Comissão Especial do Código Tributário Nacional: Disponível   em http://www2.senado.leg.br/bdsf/handle/id/511517*

Social and Environmental Responsibility at Pratigi EPA: Shrimp farming and riverside communities in Barra do Serinhaém - Ituberá-BA

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Abstract—Analyze the role of economic agents in Pratigi's Environmental Protection Area (EPA) in order to understand the balance between environmental conservation, income generation, green marketing and entrepreneurship. In particular, aspects of environmental law on environmental damage and Corporate Social Responsibility (CSR) will be observed. The study region comprises the estuarine zone of Ituberá/BA, the socio-environmental aspects of the riverside communities and its relationship with an innovative project for the cultivation of shrimp in cages and canvas tanks in Barra do Serinhaém, conceived by Litoral Sul Maricultura (LSM) in partnership with IFREMER of France. The production model analyzed showed that there is a possibility for private capital to contribute to social entrepreneurship, also generating social and environmental benefits through its Social Responsibility.

I. INTRODUCTION

Since it is everyone's duty to defend and protect the environment from degradation and pollution, Brazilian environmental law defines that it is the responsibility of the Public Authority to protect the environment, and other agents - economic and social - must collaborate in this regard, especially those that most affect the environment, due to the effects of degradation and pollution arising from its production activities. According to Paulo Affonso Leme Machado, "the action of the collectivity, unlike that of the Public Power, is generally optional [...]" (apud SIRVINSKAS, 2012, p. 153), however, economic agents, by virtue of their conduct harmful or environmental damage, must have the environmental responsibility, already provided for in art. 14, § 1 of the National Environmental Policy[1].

The Government's inertia in the face of environmental issues in Environmental Protection Areas (EPA) translates into the difficulty of managing and inspecting an expressive territorial area, with relative demographic density and significant economic activity, all combined in a space of ecosystems endowed with accentuated

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[1]BRAZIL. Law no. 6.938/81, of August 31, 1981. Provides for the National Environmental Policy (PNMA).

environmental fragility or that suffered intense anthropic action, therefore, a region that needs the tutelage of the State for the maintenance of environmental services and conservation of natural resources and scenic beauty of its landscapes.

Given this difficulty in reconciling economy with the environment, this article discusses the conceptual basis of social and environmental responsibility of private capital, passing through the understanding of entrepreneurship or innovation, having as object of study a pioneer (and innovative) shrimp farming project (breeding of shrimp) developed by *Litoral Sul Maricultura* (LSM) in *Barra do Serinhaém*, municipality of Ituberá, *Pratigi* EPA, territory of the *Baixo Sul* of *Bahia*.

Therefore, the objective is to analyze, from the development of economic activity of shrimp farming in Pratigi EPA, the impacts on the processes of income generation and environmental conservation, environmental marketing, in addition to reflecting on the process of social entrepreneurship and formation of social capital developed with the participation of the riverside population.

As a methodological approach, a bibliographic review was carried out on the themes of social and environmental responsibility, environmental legislation in areas of environmental protection and business (and social) entrepreneurship in shrimp farming, associated with the generation of income and development of social capital. Other additional information was obtained. in loco during technical visits to riverside communities and the pilot project in *Barra do Serinhaém*, owned by Mr. Eduardo Lemos, as well as obtained through contacts with social agents in the community of *Barra do Serinhaém*.

Therefore, the topic to be addressed in the article will follow the following topic structure: ii) Aspects of Environmental Legislation, Entrepreneurship and Social Responsibility; iii) Social and environmental profile of EPA *Pratigi*; iv) Social and Environmental Liabilities of the *Pratigi* EPA; v) Coastal aquaculture and environmental damage; vi) Performance of private entities in the *Pratigi* EPA and vii) Final Considerations.

II. ASPECTS OF ENVIRONMENTAL LEGISLATION, ENTREPRENEURSHIP, ECONOMY GREEN AND SOCIAL RESPONSIBILITY

Access to an ecologically balanced environment is a right guaranteed in Article 225 of the Federal Constitution of 1988. In order to guarantee the effectiveness of this right, the Government must create protected spaces, called Specially Protected Territorial Spaces (SPTS), which includes any environmental space that provides legal protection for its natural attributes. The SPTS include theConservation Units (CU), considered the best strategy for the conservation of biodiversity and maintenance of environmental services (Leuzinger & Scardua, 2010).

In Brazil, the creation and management of Conservation Units is the role of the State, as defined by the National System of Nature Conservation Units (SNCU), as it is the driver of environmental protection and management policies for these areas.

The SNCU establishes parameters for the creation and management of protected areas in the country, within a system that presents several categories that vary in terms of the degree of protection, ranging from units that do not even allow visitation, to those that include industries and cities in their interior, as is the case of the EPA (Guerra & Coelho, 2009). In its art. 15, defines the EPA as an extensive area with a certain degree of human occupation, endowed with abiotic, biotic, aesthetic and cultural attributes important to the well-being of human populations and which aims to ensure the sustainability of the use of natural resources.

The EPA highlights the possibility of maintaining private property and the traditional lifestyle, enabling environmental protection programs to be implemented without the need for expropriations. For the Brazilian reality, this strategy has become advantageous, as the lack of financial resources or government inertia limit the implementation and consolidation of other more effective protection programs (Oliveira HH, 1995). However, the EPA is configured as a problematic area due to human occupation and the development of economic activities that, to a greater or lesser degree, bring environmental liabilities. The major obstacle in the matter is to reconcile development with environmental preservation in these areas, bringing problems regarding the management of human activities.One possibility for solving this issue lies in the effectiveness of the duty of social and environmental responsibility of companies, thus contributing to partially meet social and environmental demands, in return for the benefits of environmental marketing.

It is also necessary to consider the forms of appropriation and use of territories in the EPA based on studies of the fragility of their ecosystems and their support capacity. Law 6,902/1981 requires sustainable management of natural resources to conserve or improve local ecological conditions and ensure the well-being of human populations. Carrying capacity is based on the notion of resilience, the concept of which refers to the ability of a system to respond to externalities, through its recomposition or restructuring, establishing, for example,

the relationship between the carrying capacity of an area and its population. To this end, it establishes rules limiting or prohibiting mainly the implementation of industrial activities of high polluting power (Zanoni*et al*., 2000).

Faced with the increase in anthropic pressures on nature and its consequences, society has been demanding a reorganization in the developmental perspective, so that it has a stamp of social responsibility, commitment to sustainable development. The latter brings with it the understanding as the growth of something or the physical or material increase in production, with the purpose of maintaining itself in a continuous manner (Sartori, Latrônico, & Campos, 2014).

Sustainable development in tune with the environment requires a balance in the manipulation of ecosystems, in a way that guarantees their sustainability, their capacity for absorption and recomposition from the aggressions suffered by anthropic actions. Thus, there is harmony between man and the environment, not establishing a dichotomy between them (Meneguzzo, Chaicouski, & Meneguzzo, 2009). In this sense of considering several dimensions in development, the expression Green Economy emerged, which is explained by the encounter between economy, well-being and ecosystem (Abramovay, 2012).

Economic growth is a condition for building infrastructure and offering services that will meet the basic needs of humanity, but it is imperative to change the way in which the content of this growth materializes, setting limits, such as respect for the capacity of ecosystems and ethics in decision-making processes (Abramovay, 2012).

The Green Economy involves three fundamental dimensions which are energy efficiency, use of products and services from biodiversity, and reduction of pollutant emissions. Together they form a new paradigm for economic life, based on the idea that capital and labor can replace what is offered by nature, through eco-efficiency, reducing pressure on natural resources, that is, "increasingly less matter, less energy, less emissions...", even so, guaranteeing the reproduction of human societies (Abramovay, 2012).

In this scenario, environmental or green marketing emerges, which has become an important tool in the life of corporations, as consumers and society in general have demanded products and services from companies that reflect an idea of environmental and social responsibility, as discussed above. However, consumer distrust will require more than isolated or one-off actions from the company, but responsible business management, respecting above all the consumer and the environment. Actions aimed at improving the quality of life or

preserving the environment are no longer exclusive banners of non-governmental organizations. Private initiative discovered in the green wave an excellent locus of business and has now become, many of them, ecological partners of these NGO.

According to Gibbons, from the consultancy Good Business, it is a mistake when companies use sustainability and Corporate Social Responsibility (CSR) programs as communication tools, when in fact they are management tools that help organizations measure their social and environmental impact. The survival of the company today, in the face of the growing ecological movement, must consider its CSR as a management goal and not only as a form of communication. The corporation can take advantage of this issue, but it must satisfactorily meet this new consumer standard, more attentive to changes, demanding, analytical and that expects results and ethical behavior from companies that look after their well-being.

Within a logic in which sustainability is an important challenge in the emergence of a new economy, it seems increasingly sensible and urgent to establish connections between private capital and Social Entrepreneurship and Social Responsibility, thus bringing the ideal of sustainable development.

According to Melo Neto and Froes (2002) apud Andrade (2016), Social Entrepreneurship has the characteristics of being collective and integrated, producing goods and services for the community, focusing on finding solutions to social problems and community needs, its performance it is measured by social impact and transformation, and should generate social capital, inclusion and social emancipation (Andrade*et al*.,2016).

Social Entrepreneurship is related to third sector organizations or organizations of government actions or entrepreneurs in the social field. Social Entrepreneurship actions emerge at a time of crisis for the State in the face of neoliberalism and the concern to meet social needs. Hence the need for a large number of organizations to adopt tools and strategies from private companies, finding a way to survive, previously subsidized by the government. Private companies, in turn, encouraged the process of transferring knowledge and management tools for social intervention (Oliveira EM, 2019).

Given the understanding of development beyond profit, in the various dimensions it contemplates, companies are required to be Socially Responsible to the community, not limited to meeting only the organizational demands and interests of their employees (Oliveira et al.,2020). In this sense, social responsibility is linked to an action committed to the end of social transformation applied by an innovative management model (Melo Neto &

Brennand, 2004). Therefore, in addition to quality products, companies are required to have their benefits well publicized so that the consumer is interested in the product or service, but also social initiatives, which have in their guiding principles the company's social responsibility, with the environment, inclusion, respect for differences, among other needs. Today's consumers demand information about production, which principles and philosophy of companies.

The legal framework of CSR, as defined by ABNT, brings the ideas of responsibility in the company's decisions and activities, towards society and the environment, ethical and transparent behavior, in order to contribute to the well-being of society. The ETHOS Institute, an organization created by entrepreneurs in Brazil, also supports this understanding, whose vision should not be limited to simple aspects of social marketing or appearance, but a commitment to concrete values and actions (Oliveira EM, 2019).

It is evident the existence of the relationship of Social Entrepreneurship with the third sector and as a CSR movement. private companies, which in turn contributed to the social field by encouraging the process of transferring knowledge and management tools. Despite the ambivalences of CSR, imposed by its process of competition and accumulation, possible connections can arise in working to share knowledge, resources and efforts to achieve the goals of a fair and sustainable society (Oliveira EM, 2019).

In this way, Business Entrepreneurship can connect to Social Entrepreneurship through the so-called CSR by proposing an integration action, meeting common and ambivalent objectives, which somehow generates an innovation process that, despite the market logic, contributes in the social field, benefiting the community and the formation of its social capital.

III. SOCIAL AND ENVIRONMENTAL PROFILE OF THE PRATIGI EPA

The Pratigi Environmental Protection Area currently has 85,686 hectares and is located in the *Baixo Sul* of *Bahia* (Figure 1), covering the municipalities of *Ibirapitanga*, *Igrapiúna, Ituberá, Nilo Peçanha* and *Piraí do Norte*. It was created in April 1998 and expanded by State Decree No. 8036 of September 20, 2001, with the objective of protecting large stretches of beaches, restingas, mangroves and remnants of dense rainforest (Atlantic Forest), as well as promoting tourism, ecotourism and the ordering of economic activities in the municipalities that are part of it (Bahia, 1998).
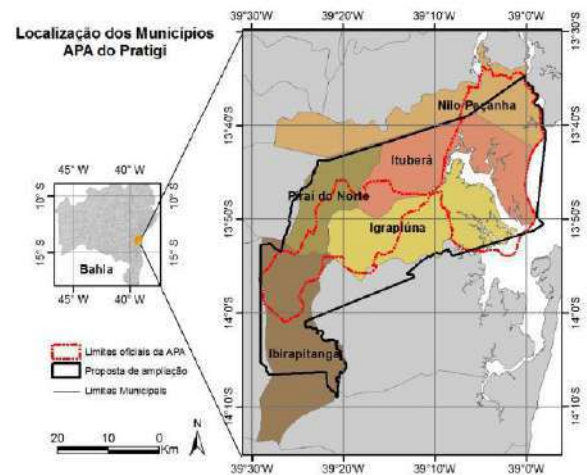
Fig. 1: Location of Pratigi EPA. Source: (Macedo, Oliveira& Rocha, 2010)

Pratigi EPA owns some of the most important Atlantic Forest ecosystems in the country, where one of the greatest biodiversity on the planet can be found, forests at an advanced stage of regeneration, hilltops with numerous springs, hydrographic basins, as well as environments such as restingas, mangroves, estuary, beaches and islands. All this biodiversity has attracted the Federal and State Governments, multilateral development agencies, NGO, private companies and investors, in addition to the local communities themselves, which have been realizing the value of the environmental assets that belong to them. As it is considered a priority area for the conservation of Atlantic Forest remnants, it is included in the Atlantic Forest Central Corridor Project and, therefore, due to its strategic position,was chosen to be the pilot area of the *Bahia BaixoSul* EPA Mosaic Integrated and Sustainable Development Program, with the support of the UN (United Nations) and the IDB (Inter-American Development Bank) (Campos*et al.*, 2008).

It is worth mentioning that the mangroves in the *Baixo Sul* region of the state represent about 58% of the total 110,000 hectares existing in the South Coast and that almost all remain with the original vegetation cover intact. This reality can be justified by the spatial distribution, generally located on islands and areas of difficult access, and of low population density. In terms of preservation, the same happens with the restingas, as they are located outside the municipal seats and many of them on privately owned islands, where extensive coconut and oil palm plantations are developed, and has served as a limiting factor to the implementation of subdivisions (Bahia, 1996). Much of the forest area is still preserved. The location of the *Pratigi*EPA, as part of a mosaic of EPA and inserted in the Central Ecological Corridor of the Atlantic Forest,

makes it serve as a connection between the other forested areas, enabling movement and ensuring the preservation of numerous species (OCT, 2011).

The *Pratigi*EPA region has a population of approximately 89,350 inhabitants (2020 Census), of which 36.4% make up the EAP (Economically Active Population) and need the sustainability of the regional economy for its survival. According to the Agricultural Census (2017), the area of agricultural establishments occupies 127,646 hectares, distributed among 9,830 properties and 8,382 owners, which highlights the prevalence of small production units, operated on a family basis and with extremely diversified agriculture in terms of permanent crops, which include oil palm, rubber, palm hearts, guaraná and cocoa, in addition to other products such as bananas, cassava and pepper. These cultures represent the family income of a large portion of the rural population, and also of urban dwellers who thus complement the family income (IBGE, 2017).

Due to the number of rivers that form eleven hydrographic basins in the *Baixo Sul* of *Bahia*, it is considered as the "water circuit", with the presence of countless waterfalls. Coastal formation, bays and estuaries are favorable environments for the production of fish, shellfish and crustaceans, making this area a great potential producer in this sector. The EPA expansion in 2001 was due to the need for environmental protection of the Juliana River Hydrographic Basin, which is part of an exuberant water complex that includes the Igrapiúna estuary areas to the mouth of the Pinaré River, including the Cachoeira da Pancada Grande, important tourist attraction in the region that is part of a Private Natural Heritage Reserve (PNHR) (CRA, 2004).

IV. SOCIAL AND ENVIRONMENTAL LIABILITY OF PRATIGI EPA

Human activities generate situations of risk and imbalance in natural systems, and due to the degree of environmental fragility, they become more vulnerable to processes that are caused by the inadequate occupation, use and management of these spaces. The coastal and fluvial-marine ecosystems, associated with the biodiversity of its fauna and flora, make the *Pratigi* EPA a region endowed with degrees of environmental fragility and vulnerability.

The environmental liability refers to any negative impact, whether foreseen or not, in the phases prior to the implementation and operation of any undertaking, perceived a posteriori, without having sought to repair it. It reflects the environmental damage resulting from the degradation character of any economic activity, especially industrial.

The initial occupation of the *Baixo Sul* region of *Bahia* is linked to sugar production, which did not achieve the success expected by the colonizers and, as a result of the failure of this activity, became economically dependent on the *Recôncavo Baiano*. Only in the 19th century, with the expansion of the demand for tropical products to supply Europe and the United States, the South Coast shows promise for the cultivation of cocoa. From that period and in the first decades of the 20th century, cocoa farming expanded and the regional economy changed with the replacement of subsistence crops by cocoa, which came to dominate the economic scenario of *Bahia*. And so, with the growing demand for cocoa on the foreign market, the price remains high for a long period, but today it is no longer the main agricultural product in the region, mainly due to the crisis triggered by the witch's broom plague(Macedo, Oliveira, & Rocha, 2010).

In this process of occupation and consolidation of the cocoa culture, the impact on native vegetation took two forms. At first, the replacement was total, with the clearing and burning of the Atlantic Forest to introduce the crop. In the second moment, the forest was partially removed and replaced by dispersed crops associated with subsistence polycultures and pastures in the middle of the forest. But with the intensification of production, the occupied parcels increased at the expense oforiginal vegetation, which today was restricted to scattered fragments. Even so, 41% of the remnants of the original Atlantic Forest remain in this area (Macedo, Oliveira, & Rocha, 2010).

However, these activities, generally associated with inadequate planting techniques, such as the use of fire and disorderly deforestation, made the soil more vulnerable to erosion, accelerating the siltation process of a large part of the riverbeds in this region. According to official data from the Coordination of Agrarian Development of *Bahia* (CAD), there is a large portion of land in the *Pratigi* area occupied by squatters who mostly practice slash-and-burn agriculture for planting bananas and cassava, resulting in a model of vulnerability for families and inefficient use of work and the use of natural resources (Campos et al, 2008).

The remnants of the Atlantic Forest are the ones that have suffered most from the predatory action of man. The purpose of wood extraction was to supply sawmills, charcoal plants and meet the expansion of cultivated areas. On the main highways that give access to this sub-region, there was a constant flow of trucks transporting wood in logs, originating from primary and secondary vegetation, verified during times of little inspection. In some cases, the

wood was extracted from unauthorized areas, with the contribution of agrarian reform settlements, which became suppliers of wood for sawmills, due to the lack of credit support from financial and government agencies (Bahia, 1996).

According to fishermen's complaint, the closed season was not respected in the coastal strip (temporary interruption of fishing), thus harming the renewal of natural stocks of the various species of shrimp. The estuarine waters and the formation of mangroves in the Southern Lowlands exert ecological and nursery functions for the development of species that have them as habitat or use it as a breeding area, however they have been constantly attacked. The degrading action was related to predatory fishing, such as the use of bombs, the use of trawling boats in the estuarine channels, the use of nets with meshes below the recommended specification, as well as the use of traditional and most harmful cambodies, the so-called line or net camboa, also widely used to encircle mangrove areas in *Maraú* and *Camamu* (Bahia, 1996).

Among other factors that cause environmental liabilities in this sub-region, strongly affecting water resources, the various urban agglomerates that release domestic effluents without any type of treatment into watercourses are listed. It is also common to observe the practice of implanting dumps in spillways in the basins, which act as a permanent source of river pollution. In the city of *Ituberá*, in addition to the *Serinhaém* river, the streams that cut through the city receive sewage "*in natura*", through rainwater drainage, and together with the effluents from the Municipal Slaughterhouse, they drain into the aforementioned river. Finally, it is worth noting the hunting of wild animals, which is a common practice in rural areas, no longer having only a subsistence character and becoming an alternative source of income through illegal trade (Bahia, 1996).

During the surveys carried out for the Management Plan, in 2004, all these environmental liabilities were confirmed, added to others, such as construction of dams and roads, capture of wild animals, contamination by agrochemicals, shrimp farming, which have caused a series of negative impacts causing, for example, damage to fauna and flora, fragmentation of natural habitats, occupation of fragile areas such as restingas and mangroves, increased surface runoff, accentuated erosion processes, siltation and contamination of soil and springs, which together constitute a picture degradation that compromises the biodiversity and natural resources of this region (CRA, 2004).

V. COASTAL AQUACULTURE AND ENVIRONMENTAL DAMAGE

Damage is any injury to a protected legal asset, and environmental damage, in turn, is any aggression against the environment derived from an economic activity of potential pollution and may also be an act of imprudence practiced by any person or by omission resulting from negligence. There is thus a responsibility to repair or indemnify the damage caused as a legal duty. However, some problems arise there, as not every asset can be recovered, and there is also a difficulty in quantifying the environmental damage. In both cases, an indemnity amount should be set for the damage caused (Sirvinskas, 2012).

To understand the idea of environmental responsibility, one must start from the analysis of damage repair theories. As there was a great difficulty in proving the guilt of the cause of the environmental damage, the legislation started to adopt the objective theory, where the demonstration of guilt is not required, just demonstrating the existence of the fact or act. In this way, the agent causing the damage is held liable regardless of having acted at fault. Thus, it has already been established in the doctrine and jurisprudence that anyone who causes damage to the environment or to a third party will be obliged to reimburse him even if the negligent or intentional conduct was committed by a third party. Remembering that every company has risks inherent to its productive activity, and for this reason, it must assume the duty to indemnify the damage caused to third parties (Sirvinskas, 2012).

As mentioned about the difficulty of quantifying or repairing the damage to the environment, given the obligation to indemnify the causer, in the case of economic agents, it is perfectly feasible for this repair or compensation to take place in the form of investments and support for environmental preservation projects, guaranteeing these companies the counterpart of green marketing. Sirvinskas (2012) states that "business [...] can be an excellent partner in protecting the environment, regardless of whether or not it is responsible for the degradation we are experiencing."

As aquaculture is an economic activity that transforms natural resources into products for society, as such, it produces impacts and environmental damage. According to Nascimento (1998), the three biggest impacts are related to the consumption of natural resources, the transformation process of these resources and the production of waste. The author emphasizes that aquaculture modifies the structure and dynamics of the ecosystem to increase the production of selected species, and from an ecological point of view, local modifications of lesser impact may

occur, as well as others on a regional scale, harmful to the point of rendering the natural environment incapable of sustaining this activity. Thus, adequate management is needed to make the activity sustainable, instead of using the ecosystem only as a repository for waste and a supplier of natural resources.

Given the logic of sustainable development, there is a need to take into account the limits of support for the ecosystem, which includes the availability of light and nutrients in the primary production of the cultivated area; the ability to renew living resources; the availability of water that supports organisms in cultivation, oxygen transport and waste removal. In addition to other resources such as land or aquatic space for the installation of marine farms, offspring (larvae) for storage and the food offered, construction material, industrial energy, chemical substances and services (Nascimento, 1998).

The implantation of marine aquaculture in tropical and subtropical regions takes place in flooded coastal areas, called mangroves. The greatest environmental impact resulting from aquaculture is the degradation of mangroves, especially for the implementation of shrimp farming projects. In Brazil, the biggest degradation factor has been the expansion of urban areas for industrial, port, tourist and housing use. Deforestation in mangroves causes coastal erosion, affects nutrient production and species reproduction. Mangroves have great ecological and socioeconomic value, as they serve as a biological filter for pollutants, store nutrients, recycle organic matter, reduce flooding, prevent sediment deposition, in short, it is a high productivity ecosystem (Nascimento, 1998).

Nascimento (1998) lists the most significant impacts related to shrimp farming: habitat destruction and loss of biodiversity in mangroves; acidification or salinization of coastal soils; use of areas to supply the resources that sustain the activity, estimated to be between 35 and 190 times larger than the area under cultivation; water requirement for replacement in the nurseries and replacement of losses and return in a more degraded form with an increase in the organic load and nutrients (onshore nurseries); threat to natural stocks to ensure the fattening of the offspring. Given this scenario of continuous expansion of aquaculture worldwide, it is necessary to search for clean technologies, in order to mitigate these impacts and ensure the sustainability of the activity (Nascimento, 1998).

Brazil, according to FAO (2007) apud Bessa-Junior (2014), is one of the countries that has shown the greatest growth in aquaculture, whose productivity grew six times between 1997 and 2003, mainly due to shrimp farming, especially in the Northeast, which holds 95% of the national production of shrimp, bringing together the best edaphoclimatic conditions for shrimp farming due to high temperatures and its relative climatic stability. In addition to these conditions, the region is home to a coastal zone with a large number of estuaries and mangroves, providing enormous potential for mariculture. According to the author, the latest census released by the Brazilian Association of Cameroon Breeders shows that the Northeast has approximately 1,428 farms, that is, 92% of farms in the country, totaling 19,610 hectares of arable land, with a production of 69,088 tons (Bessa-Junior, 2014).

Mariculture, in addition to being a relevant economic activity in food production, which has been showing great growth, is also a prominent factor in the income generation within the socioeconomic scenario, which, combined with the region's enormous potential for these activities, can bring onecontribution to local development, including improvements to the lives of fishermen and riverside dwellers. However, it is necessary to guarantee the sustainability of these activities in order to preserve the coastal ecosystems for future generations, as well as to maintain the ways of life of riverside communities and their cultural values.

VI. PERFORMANCE OF PRIVATE ENTITIES IN THE PRATIGI EPA AND SOCIAL RESPONSIBILITY

The option for the LSM shrimp farming project in *Barra do Serinhaém* is due to being the best example of the analysis of the idea of social entrepreneurship, social and environmental responsibility, income generation and local development, involving estuarine communities in Bahia's *Baixo Sul*, a region endowed with enormous ecological potential, but with low human development, mainly in the riverside populations, formed by farmers and fishermen.

O Estuário do Serinhaém faz parte da zona costeira da APA do Pratigi e está dentro dos limites de Ituberá e Igrapiúna, com uma extensão de aproximadamente 30 km (Figura 2)
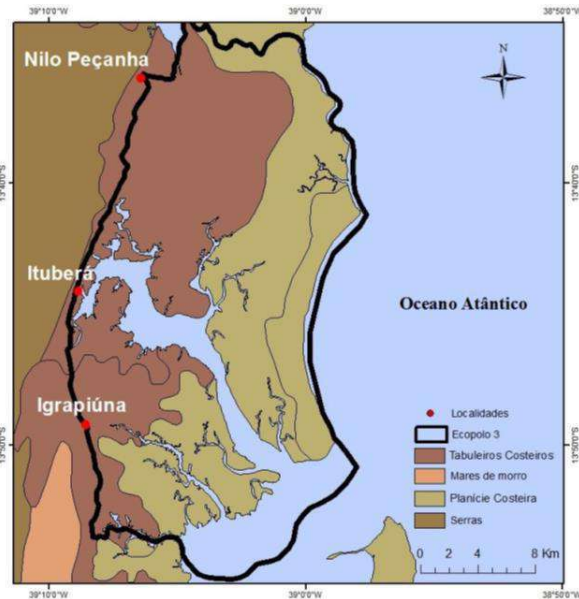
Fig. 2: Location of the Serinhaém Estuary. Source:
(Santos & Nolasco, 2017)

The first experiments in the cultivation of shrimp in cages were carried out by Eduardo Lemos, in 1985, in *Rio de Janeiro*, in *Barra de Guaratiba*. The first results led to the creation of the company *Litoral Sul Maricultura* (LSM) in 1988, with KIEPPE Investments as a partner, and thus a pilot station was implemented in *Barra de Serinhaém, Ituberá, Bahia*. In 1991, a cooperative work was established between LSM, Bahia Pesca and IFREMER[2](Ifremer, 1995).

With its vast experience and cooperative work, IFREMER was effective for the project's success, bringing an important contribution to zootechnics, which was a 90% reduction in the cost of cages and an increase in production per m² from 750 g to 2,250 g. improvements ensured the profitability of the project. *Bahia Pesca* together with *Institut Supérieur Technique d'Outre Mer* studied the regional shrimp market seeking competitive advantages of the project (IFREMER, 1995).

The innovative and pioneering experience developed by LSM brought encouraging results, whose final report published by IFREMER highlighted the main advantages and analyzes of the *Barra do Serinhaém* project in terms of

productivity, environmental quality and social development. For three years, from 1992 to 1994, satisfactory results can be verified that attest to the viability of the method with good prospects for the domestic market (Paquotte, 1996).

In analysis, biological productivity was high, with yields above 16 tons per hectare, with low negative effects on the quality of the natural environment, and local fishermen also appreciated the new practice in addition to their traditional activity (Paquotte, 1996).

The project's productivity proved to be a zootechnical success, since the yield obtained was four times higher than the average yield of the main producing countries in the world, which confers certain economic success on the innovative experience. The economic analysis showed a forecast of profitability evaluated at 27% and labor costs that reach 21%, but that one can still seek competitiveness beyond production costs, with emphasis on the good quality of the product obtained by the improvement. technical, as well as in the control of the commercialization channels (IFREMER, 1995).

The negative effects on the quality of the natural environment are very low compared to cultivation on land. These farms with floating cages, therefore, had multiple advantages from an environmental point of view: mangrove preservation; structures are mobile and shrimp are not in contact with the sediment, eliminating problems with contact with accumulated organic matter; this type of aquaculture is potentially low polluting and the residues can be consumed by fish; and there was no measurable impact on oxygen balances and organic matter concentrations in the sediment; the cages are mobile offering multiple advantages from an environmental point of view (IFREMER, 1995).

In the social aspect, with regard to the participation of the riverside community, it was found that the project would provide a complementary activity for fishermen on the spot, being practically one of the only possibilities to generate additional income. The traditional fishing activity provides a very low and fluctuating income, in addition to involving a small amount of personal capital. Thus, the work of monitoring the cages is compatible with your daily life as a fisherman, since family members can also collaborate, thus generating a complementary income (IFREMER, 1995).

The communities of the *Serinhaém* river estuary are made up of traditional populations of fishermen, shellfish gatherers and farmers, and their local production is mainly based on shrimp and crab fishing, as well as on the extraction of oil palm, palm heart, coconut, cocoa and latex. Local tourism brings a complementary income

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[2]Institut Français de Recherche pour L'exploitation de la Mer (French Institute for Research for the Exploration of the Sea) is an institutepublic of an industrial and commercial nature. It is jointly supervised by the Ministry of National Education, Higher Education and Research and the Ministry of Environment, Energy and Marine Affairs. Ifremer carries out research missions, offers expert advice and acts as a funding agency. Available
in:https://www.euromarinenetwork.eu/membership/organisations/ifremer

during the high season in December, but in the estuary region there is a lack of infrastructure in general, except for*Barra do Serinhaém*, whose village has a small network of restaurants, inns and river transport. In general, artisanal fishing has some social and environmental problems such as the impact generated by the use of fine mesh nets and bombs, and fishermen are vulnerable to changes in weather, temperature and tide variations, what affects work and daily productivity. Thus, the low yield and the intense physical wear and tear provided by artisanal fishing end up generating insufficient financial return, as well as health problems arising from poor food and hard work on boats in the sun or rain. Such difficulties also affect young people and minors, who from an early age help their parents with daily tasks.

Based on the previous successful experience, in partnership with IFREMER, LSM sought to innovate once again, expanding the results obtained with the cultivation of shrimp in cages, creating a new experimental technique, also promising, and with less impact on the ecosystem local. Thus, the participation of riverside dwellers was maintained, now with a less exhaustive work, as the tasks include monitoring the shrimp in canvas tanks located in areas with grass and palm trees, in order to create an environment with thermal comfort for the cultivation of shrimp, projecting a milder microclimate from shading vegetation. The technical training of cooperative fishermen and shellfish collectors, with estimates of reaching an average income of up to two minimum wages, will undoubtedly provide a substantial gain in the worker's earnings.

The expansion of the pilot project in *Barra de Serinhaém*, according to the testimony of its creator, Mr. Eduardo Lemos, intended to expand to the installation of up to 300 canvas tanks on properties in the estuary, in order to ensure improved productivity and competitiveness. In addition to the conservation aspect of the mangrove area, in a way guaranteed by the need for thermal comfort maintained by the palm trees and grass, shrimp waste serves as fertigation, used to maintain the project's vegetation cover environment, which reduces impacts if they were returned directly into the estuary channel.

Given the socioeconomic and environmental situation, LSM's shrimp farming project has the potential to remedy part of the region's socio-environmental difficulties, providing less exhaustive work with higher yields, combined with a lower environmental impact in the area, while ensuring local productivity more sustainable. Odebrecht supported the project in expanding the pilot project in Barra do Serinhaém, participating in the infrastructure and training cooperative fishermen and

shellfish collectors, also acquiring properties in the estuary region for the installation of canvas tanks. The project combines productivity and efficiency, ensuring a competitive product in the market, with satisfactory and stable financial returns throughout the year.

VII.   FINAL CONSIDERATIONS

In general, conventional shrimp farming projects have serious social and environmental impacts in the regions where they are installed. Shrimp farms cause conflicts with artisanal fishermen and shellfish collectors, as they disrupt the extractive productive system, which cannot compete with large-scale production. Business mariculture will also have impacts on mangrove areas, especially on soils and aquatic environments, compromising the sustainability of these fluvial-marine ecosystems with the deposition of waste and deforestation in forest areas. However, the methodology developed by the company LSM has shown positive points by reducing the environmental impacts on the estuary ecosystem and contributing to the strengthening of social capital by generating income and work for local communities.

The possibility of reconciling a shrimp farming project with the work of riverside communities allowed for the development of a business entrepreneurship process, also establishing connections in the social field. Even if the business mission is profit, private capital can collaborate with actionsgeared towards social entrepreneurship, which contributes to the social, economic and environmental quality of life. This posture defines the idea of socially sustainable companies or Corporate Social Responsibility (CSR), bringing other benefits, for example, from environmental marketing, a highly positive and advantageous vision for the public image of the business.

The economic exploitation of shrimp farming in the *Pratigi*EPA with the effective participation of riverside communities in *Barra de Serinhaém* is an innovative business venture in terms of production in cages and canvas tanks, and its proposal is the social commitment to local communities in the generation of income and mitigation of environmental damage in mangrove and sandbank areas. The training of local workers has the advantage of having the experience of fishermen and shellfish gatherers, therefore, they can also add traditional knowledge to the project, in addition to contributing to the creative potential of these individuals, with innovative knowledge and practices that strengthen the social capital of these communities. This exchange of knowledge can be enriching, allowing such communities to still exercise their role as social entrepreneurs.

In this sense, Nature Conservation Units are powerful tools for environmental management and protection, however, the Government, which is responsible by law for ensuring a balanced environment and a healthy quality of life, has become negligent or ineffective in this task, as analyzed in the Pratigi Environmental Protection Area management problem.

Generally speaking, the EPA suffer from the difficulty of managing and monitoring ecosystems in areas of human occupation, where economic activities are also included. As a result, there is a low effectiveness of environmental legislation, thus generating environmental liabilities, mostly resulting from these predatory economic activities and the urbanization process, which has harmed the quality of life of traditional and riverside communities, which suffer directly with the negative impacts.

Economic agents, endowed with technical and financial capacity, can be included in the EPA, through sustainability programs, where they can fulfill their Social and Environmental Responsibility. The Environmental Law understands that every company has risks inherent to its production activity, and for this reason, it must also assume the damages caused to society and the environment, carrying out its due environmental compensation.

Sustainable development is linked to several dimensions such as economic, social, environmental, political, and its practices are imbued with social responsibility, thus these are the guiding principles of companies that must work at EPA *Pratigi*. In this sense, social entrepreneurship is on the way with the aim of guaranteeing the transformation of the reality of the riverside communities surrounding EPA *Pratigi*, such as quality of life, job and income generation and, above all, environmental conservation. Thus, the results of such initiatives can reflect as environmental marketing, attesting that these organizations are concerned with the well-being of society and take care of the environment. In addition, we were able to prove, through the performance of the LSM company, that such income and job generation projects can promote economic growth and local development, taking advantage of the region's potential for mariculture, which makes expansion, maintenance and dissemination of such initiatives.

In this way, Corporate Social Responsibility becomes an important instrument for the protection of the environment, with the potential to contribute to social entrepreneurship in local communities and also serving as a complementary and co-participatory measure, given the low effectiveness of public authorities in actions of environmental protection, complying with what the Federal Constitution recommends about the duty of all to defend and protect the environment.

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Efficiency of rhamnolipid colloidal gas aphrons to remove cadmium and zinc from metal-contaminated soil samples

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Abstract— Soil contamination by metal wastes represents a threat to the environment and to human health. Rhamnolipids have been recognized for its metal removal properties and presenting high biodegradability, however their application is sometimes hampered due to downstream cost production. In contrast, colloidal gas aphrons (CGAs) can serve as a cost-effective alternative to reduce the consumption of biosurfactants while also being significantly efficient in flushing off heavy metals in remediation processes. However, data concerning rhamnolipid CGAs, such as bubble diameter, stability, and percolation through porous media under water-wet conditions, are scarce. Until now, only a few studies have demonstrated the possibility of using biosurfactant CGAs to remediate metal-contaminated soils, and even fewer studies have compared its efficiency to previous methods where regular foam is applied. Therefore, a rotational central composite design was developed considering several variables and stability and bubble diameter as response parameters. Rotation speed and agitation time had a significant effect on the stability of aphrons, reaching over 600 s of stable CGA. Alkaline pH has no significant effect on the stability of rhamnolipid CGA´s. Flow rate experiments showed a significant pressure drop when rhamnolipid CGAs were pumped through the remediation column. Soil column experiments demonstrated that rhamnolipid CGA exhibited a 38 % removal rate for cadmium and a 53 % removal rate for zinc after a percolation of 10 pore volumes at pH 9.0. Extraction of cadmium and zinc was highly influenced by the number of pore volumes percolated. Based on the present results, it can be demonstrated that colloidal gas aphrons can display a similar soil remediation efficiency when compared to previous studies that applied regular foam as a metal extraction agent. The application of rhamnolipid CGAs in metal-contaminated soils is imperative for a more efficient and environmentally friendly metal remediation process.

I. INTRODUCTION

Soil contamination by metal wastes represents a threat not only to the environment but also to human health, especially through accumulation in food chains or contamination of water bodies [1]. As a result, metal contaminants have raised several concerns worldwide while also increasing the demand for new methods to remove toxic metals from contaminated soils in an environmentally friendly way while also diminishing time operation and financial resources to promote a satisfactory remediation of a metal-contaminated terrain [2].

Soil washing is an *ex-situ* remediation method frequently used to address this type of contamination, and it is best suited to completely remove heavy metals from solid matrices while also allowing the return of socioeconomic activities of the terrain [3] However, many metal extraction agents are considered harmful to the soil microbiota or affect its chemical properties [4].

Under economic aspects some soil remediation methods use synthetic surfactants with metal extracting properties in certain contaminated areas, but most synthetic surfactants have a low biodegradability [5], which represents a drawback considering the socio-environmental context of the remediation process.

Biosurfactants are natural compounds derived from bacteria, yeast, and plants, and these natural substances have been recognized to be more biodegradable than synthetic surfactants while also presenting a lower critical micellar concentration [6] . Rhamnolipids are one of the most promising biosurfactants for application in metal remediation steps due to several reports regarding their powerful tensioactive properties and interesting metal extraction properties [7].

However, the high costs related to its large-scale production represent a major downside for its application in field remediation steps. One way to increase the economic viability of a soil washing procedure with rhamnolipids is to test the efficiency of rhamnolipid extracts produced with agro-industrial wastes as raw materials and without any purification steps Considering the strong tensioactive properties of biosurfactants, it is possible to physically modify the composition of rhamnolipid micelles into a temporally colloidal state to increase their metal remediation properties.

Colloidal gas aphrons (CGAs) or microfoams are composed of highly stable microbubble dispersions, and the current literature has reported their effectiveness in remediating or mitigating oil spills in soils and sediments [8]. The application of CGAs in remediation methods is desirable due to their higher efficiency in removing contaminants from solid matrices while using less surfactant solution [9]. However, there are only a few studies regarding the stability and bubble diameter of rhamnolipid CGA and even fewer reports about percolation of rhamnolipid CGA through porous media under water-wet conditions.

In the present study, several parameters were evaluated to test the best stability and bubble size diameter for the generation of CGAs using a rhamnolipid extract solution produced with agro-industrial substrates. Afterwards, a series of soil column experiments were performed to better understand the percolation of rhamnolipid colloidal gas aphrons and extract solutions through porous media and the efficiency of rhamnolipid CGA to extract metal contaminants from soil samples.

II. MATERIALS AND METHODS

2.1. Rhamnolipid production

A genetically engineered *Pseudomonas aeruginosa* strain LFM 634 [10] was used for rhamnolipid production. This modified strain, denoted 1201, was inoculated on Luria Bertani medium (HiMedia, Mumbai®) and incubated at 30 °C under agitation (180 rpm) for 24 h. Afterwards 5 mL of the bacterial growth was inoculated into a 1-LErlenmeyer flask containing 300 mL of a pre-inoculum medium with the following composition (per liter): 1 g $NaNO_3$, 3 g KH_2PO4, 7 g K_2HPO4, 0.2 g $MgSO_4.7H_2O$, 5 g of yeast extract, 5 g of peptone, and 30 g of glycerol. Growth conditions consisted of incubation at 30 °C in a rotatory shaker at 180 rpm for 40 h. The absorbance of the bacterial growth was measured at 600 nm (Spectrophotometer MultiSpec – 1501; Shimadzu Corporation®, Japan), and the absorbance value was converted in cell concentrations (g/L) [11]. Subsequently, 30 mL of the pre-inoculum was added to a 1-L conical flask containg 270 mL of a minimal medium for rhamnolipid production. The minimal medium for the rhamnolipid production displayed the following composition (per liter): 30 g glycerol and 5.5 g $NaNO_3,$ respectively (C/N ratio of 15). The medium was also supplemented with the following composition (per liter): 7 g K_2HPO_4, 3 g KH_2PO_4 and 0.2 g $MgSO_4.7H_2O$. The fermentation was carried out for 168 h at 180 rpm and 30 °C. After the removal of bacterial cells by centrifugation (8.000 rpm/ 15 min.) the crude broth was stored at -22 °C prior to use in the remediation tests.

2.2. Rhamnolipid characterization

2.2.1. Rhamnolipid quantification by High-Performance Liquid Chromatography

Rhamnolipid (RL) in the crude extract was quantified indirectly by HPLC using rhamnose as the reference. The RL molecules were hydrolyzed with 10 mmol L^{-1} H_2SO_4 and heated at 100 °C for 4 h to release the rhamnose molecules; the reaction was stopped by adding NaOH (10 mmol L^{-1}). The samples were filtered with 0.22 μm syringe filters and analyzed by HPLC. L-rhamnose standards (Sigma-Aldrich) were also filtered and injected at concentrations of 100 to 5000 mg L^{-1} to prepare a standard curve. The rhamnose concentration was converted to RL using a factor calculated from the data for RL congeners quantified by means of mass spectrometry (MS). Rhamnose was analyzed via HPLC using an Agilent Technologies 1260 Infinity system with a Bio-Rad HPX-87H Ion Exclusion Column, 300 mm × 7.8 mm at 45 °C, with the mobile phase consisting of an aqueous solution of H_2SO_4 (5 mmol L^{-1}) at a flow rate of 6 mL/min and a refractive index detector (RID).

2.2.2. *Determination of rhamnolipid congeners by mass spectrometry*

Total RLs were extracted as described previously [12], with minor modifications. Briefly, cells were removed from the medium by centrifugation (10,000 rpm/10 min), and the supernatant was acidified to pH 3–4 with concentrated HCl. The RLs were extracted with a 1/3 volume of ethyl acetate. The organic extract was dried with anhydrous sodium sulfate (Na_2SO_4) and evaporated using a rotatory evaporator. The evaporation residue was dissolved in methanol/chloroform/2-propanol at a ratio of 1:2:4 containing 7.5 mmol L^{-1} ammonium acetate (CH_3COONH_4). Finally, the mixture was centrifuged at 10,000 rpm for 5 min to separate the impurities, and the supernatant was filtered through 0.22-μm syringe filters and stored. The extracted biosurfactant samples were analyzed by direct injection in a Linear Trap Quadrupole (LTQ) Orbitrap XL mass spectrometer (Thermo Fisher Scientific) equipped with a nanoelectrospray ion source using capillaries of a PicoTip Emitter (Glass Tip, 1P-4P, New Objective), with an ionization voltage of 3.5 kV and capillary transfer temperature of 180 °C. Each independent data-acquisition cycle consisted of a scan in Orbitrap under a mass-energy resolution of 60,000

(FWHM, m/z 400) with an m/z range of 100–2000 Da, followed by fragmentation by tandem mass spectrometry (MS–MS) of the most abundant precursor ions by induced collision dissociation (ICD) in the linear trap or in the high-energy collision-induced dissociation cell (HCD). All samples were prepared in methanol at a ratio of 1:1 (v/v) containing 0.1 % glacial acetic acid. The chemical formula calculation from the measured values of m/z and extracted ion current data (EIC) was performed using Xcalibur 2.0 (Thermo Fisher Scientific). High-resolution EIC was obtained by processing the MS complete scanning data using potential rhamnolipid ions with 10 ppm mass tolerance [13].

2.2.3. *Surface tension and critical micellar concentration determination*

The following parameters were analysed to compare the respective tensioactive properties of the products: surface tension (ST) and critical micellar concentration (CMC). The ST was determined using the pendant-drop technique [14], all measurements were carried out in a DSA 100S Goniometer model OF 3210. The results were expressed as the mean value of at least ten pendant drops at 23 °C and 55 % relative humidity. Based on the ST values of serially diluted crude rhamnolipid extract solutions, the CMC was determined by plotting the surface tension versus the concentration of RL in the solution, [15].

2.3. *Production of rhamnolipid CGA*

2.3.1. *Statistical Experimental Design (DOE) of the CGA parameters*

Based on previous studies regarding the stability and average bubble size diameter (Bd) of CGAs [16], a rotational central composite design (RCCD) with five central points (c) was established based on the following variables: rotation (6000-12000 rpm), pH (6-9), and agitation time (30-120 s). The response parameters were stability and average bubble size diameter (table 1). Statistica software, version 7.0 (StatSoft, USA)., was used to develop and analyse the experimental designs.

Table 1. Rotational central composite design for determination of the optimum stability and bubble size diameter.

Assays	Rotation (rpm)	pH	Agitation time (s)
1	7214	5.8	48
2	7214	5.8	102
3	7214	8.2	48
4	7214	8.2	102
5	10786	5.8	48
6	10786	5.8	102
7	10786	8.2	48
8	10786	8.2	102
9	6000	7.0	75
10	12000	7.0	75
11	9000	5.0	75
12	9000	9.0	75
13	9000	7.0	30
14	9000	7.0	120
15 (c)	9000	7.0	75
16 (c)	9000	7.0	75
17 (c)	9000	7.0	75
18 (c)	9000	7.0	75
19 (c)	9000	7.0	75

(c) Central points of the RCCD

2.3.2. Generation of rhamnolipid CGAs

The initial volume of the rhamnolipid extract was 150 mL. All experiments were conducted at room temperature (25 ± 0.2 °C). An automatic high-speed disperser was used to generate the microbubble dispersion (Ultra Turrax IKA T25 Digital Staufen, Germany) with a maximum speed of 24000 rpm. The disperser was maintained at a fixed height based on the lab shelf during all the CGA experiments [17].

2.3.3. Stability and bubble size measurements

After the rhamnolipid was stirred for a specific amount of time, the dispersion was transferred to a 150 mL graduated cylinder for measurement of the drainage liquid of the CGA. The stability of the microbubble system was quantified as the time taken for half of the liquid to drain from the dispersion, i.e., the half-life (L1/2). For stability measurements each RCCD assay was performed six times [18]. (Fig.1)

For bubble size measurements, after generation of a microbubble dispersion, a 3 mL aliquot was placed in a cavity glass slide under a light microscope (Axioscopo, model-40, Zeiss, Germany) operating under standard mode with 4 X magnification and coupled to a photographic camera (Axiocam ICC-1, Zeiss). A total of 5 photographs were taken for each RCCD assay and a total of 300 bubbles were counted per assays. The respective diameter was measured using Microscope software axiovision® version 4.6.3 (Zeiss). Afterwards, the average bubble size diameter was recorded for later analysis [16]. (Fig. 1).
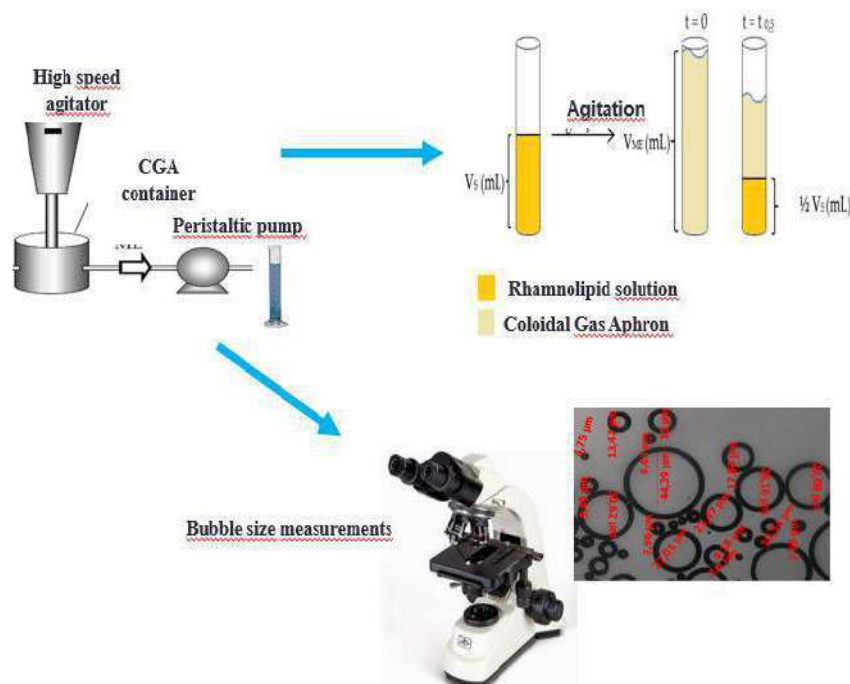
Fig 1. Schematic design of the stability and bubble size measurements of rhamnolipid CGA.

2.4. Physicochemical properties of the soil samples

To establish an artificial contamination protocol simulating a short-term contamination site, a sandy soil sample, classified according to the USDA soil classification [19], was kindly provided by Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA AGROBIOLOGIA). The sample was air-dried for 24 h and sieved with a 2 mm-mesh sieve to separate the coarse sand and stone.

Additionally, the physicochemical properties of the soil sample were characterized using standard methods [20] and are listed in Table 2. The amount of Cd and Zn in the sandy soil was extracted following the United States Environmental Protection Agency method 3051A [21] and analysed by inductively coupled plasma optical emission spectrometry (ICP OES) (Table 2).

Table 2. Physicochemical characteristics of the soil samples

Soil type	Sandy
pH	5.1
C $^{(\%)}$	1.2
Porosity (%)	44
CEC (cmolcdm^{-3})	6.3
Al (mg kg^{-1})	7.3
K (mg kg^{-1})	34
Ca (mg kg^{-1})	330
Mg (mg kg^{-1})	106
Cd (mg kg^{-1})	1.2
Zn (mg kg^{-1})	22

C $^{(\%)}$: Total soil organic carbon content; CEC: Cation exchange capacity

2.4.1. Soil artificial contamination

To establish a contamination protocol simulating a short-term contamination site, salts of Cd $(NO_3)_2.4H_2O$ and Zn $(NO_3)_2.6H_2O$ were used to prepare two separate solutions of cadmium (40 mg L^{-1}) and zinc (1000 mg L^{-1}). Then, 4 kg of sandy soil was weighed in a plastic container and mixed with all three metal solutions. The mixture was stirred for 3 weeks and then allowed to stand for 3 months.

To simulate field conditions, the contaminated soil was percolated by artificial rain in a column washing system [22], with modifications. The artificial rain was based on a variety of inorganic salts [23]. The contaminated soil was packed in a 20-cm plexiglass cylinder. For every 3 cm of sandy soil that was loaded into the column, nylon nets 5 cm in diameter with a pore size of 3 mm were inserted to prevent flow channelling when the artificial rain was percolated through the column. Based on previous assays, the contaminated soil was percolated with exactly four times its pore volume (4 PV) with artificial rain to mimic natural soil leaching conditions (fig.2).
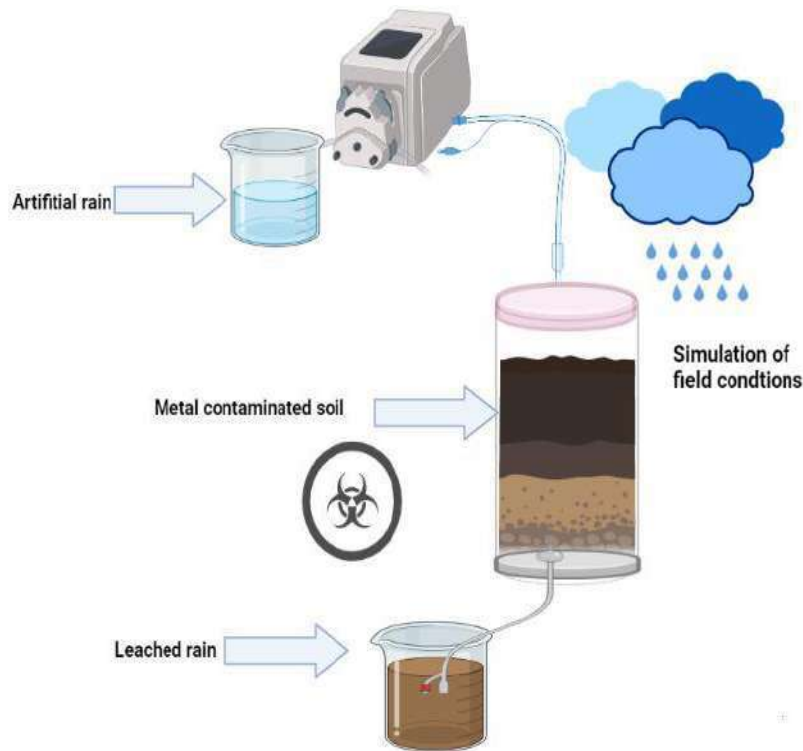
Fig 2. Schematic design of the percolation of metal contaminated soil by artificial rain.

The calculated pore volume was 135 mL for every 574 g of soil. After percolation by artificial rain, the contaminated soil was mixed once again and allowed to stand for 96 h at 25 °C. The soil samples were then dried at 40 °C for 24 h and extracted following the USEPA 3051A method [21]. The concentrations of Cd and Zn in the contaminated soil samples were analysed by ICP OES.

2.5. Percolation assays

2.5.1. Flow rate assays

Percolation assays were performed by packing another remediation column with sandy soil (soil mass: 125 g/L PV=38 mL) and then percolating it with either rhamnolipid CGA or rhamnolipid extract solution at different flow rates (10, 15, 18, 30, 40, 45, 49, 58, 64, 78, 115 and 130 mL min^{-1}). A pressure gauge was installed at the entry of the soil column, and once the desired flow rate was selected, the peristaltic pump was turned on. After the pressure inside the column was stabilized (3-5 s), the pressure build-up was recorded. Each flow rate was tested in triplicate.

2.5.2. Soil remediation assays

Two separate soil column experiments were performed to evaluate the metal remediation efficiency of rhamnolipid CGA and rhamnolipid solution in its liquid state, considering the starting pH 9.0 and number of pore volumes (PV: 4-10) (fig 3). In the first set of experiments based on previous experiments regarding the stability and bubble size diameter of rhamnolipid CGAs, the rotation speed and agitation time were maintained constant (12000 rpm/120 s).
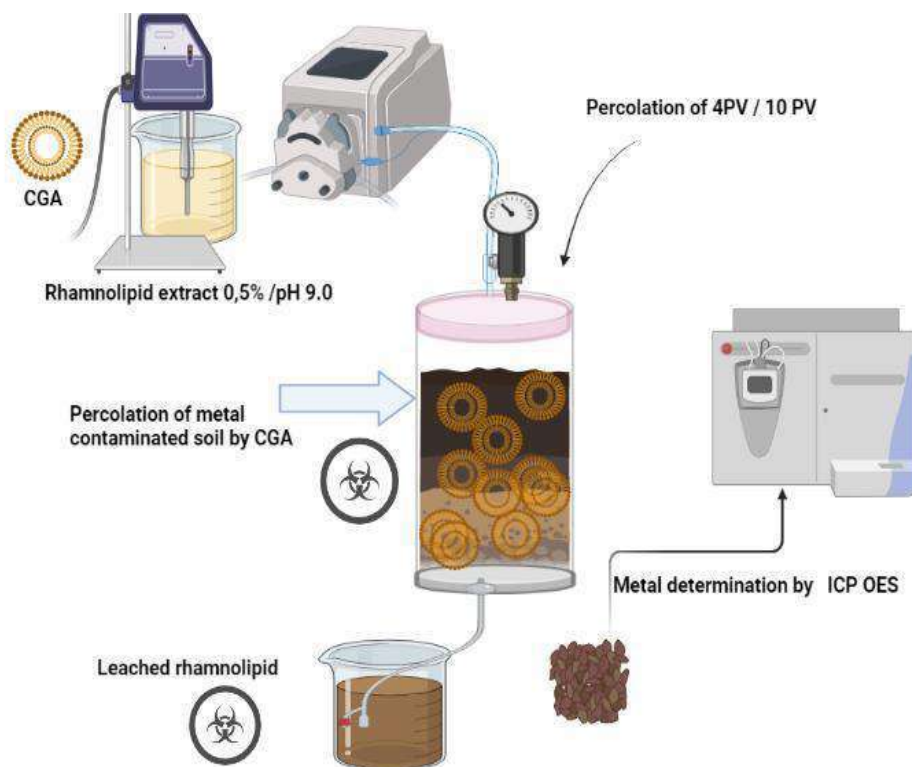
Fig.3. Schematic design of the percolation of metal contaminate soil by rhamnolipid CGA.

In the second set of experiments, the rhamnolipid extract in its liquid state was tested for its efficiency in removing metal contaminants from short-term contaminated sites. Finally, the contaminated soil was percolated by deionized water adjusted to pH 9.0 at the exact corresponding number of pore volumes of the rhamnolipid solution and CGA (negative control). The amount of contaminated soil submitted to remediation assays was 125 grams, the column height was 5 cm, and the calculated pore volume was 38 mL.

Then, all remediated soil samples were homogenized separately and dried at 40 °C for 24 hours. All remediated soil samples were submitted to extraction procedures according to the USEPA 3051A method [21]. The concentrations of Cd and Zn in the soil samples were analysed by ICPOES. The results and standard deviation are expressed as the mean average of triplicate assays. The following data were statistically analysed using ANOVA and averages *post hoc* compared using HSD-Tukey test (5 % of probability), using *Statistica*7.0 software. Finally, the results were converted to percentage values, and removal rates were defined as the percentage of metal removal from the rhamnolipid CGA or rhamnolipid solution and deduced from the removal rate of water at pH 9.0 (negative control).

III.   RESULTS AND DISCUSSION

3.1 Characterization of the rhamnolipid extract

Quantification of rhamnolipid in the crude extract by HPLC demonstrated a concentration of 5.0 g L^{-1} (0.5 %) of the biosurfactant and a CMC of 72 mg L^{-1}. MS analysis revealed the presence of several congeners within the rhamnolipid extract, with fatty acid chain lengths ranging from C_8-C_{10} to C_{12}-C_{10}. The most abundant di-rhamnolipid congener was Rha-Rha$C_{10}C_{10}$, while the most abundant mono-rhamnolipid congener was Rha$C_{10}C_{10}$. The proportions of mono- and di-rhamnolipid congeners were 15 and 85%, respectively (Table 3). There have been reports of different rhamnolipid congeners with application in the remediation of metal contaminants. Until now, few works have demonstrated the characterization of rhamnolipid extracts with metal binding properties. which opens the perspective for new insights regarding the remediation of metal wastes from soil samples. In a previous study by our group, several microscale assays demonstrated that a rhamnolipid extract produced using agro-industrial wastes without any purification steps, presenting 85% di-rhamnolipid congener and 15% mono-rhamnolipid congener exhibited metal binding activity towards cadmium and zinc [24].

Table 3. Identification of rhamnolipid congeners produced by P. aeruginosa. 1201 through mass-spectrometry analysis.

Molecular ion m/z [M-H]	Relative quantitative (%) [a]	Rhamnolipid congener		
393.2	14.02	Rha-$C_{12:2}$Cl		
394.2	3.01	Rha-$C_{12:1}$Cl	Rha-$C_{12:2}$K	
475.3	20.17	Rha-C_8C_{10}	Rha-$C_{10}C_8$	
503.3	90.55	Rha-$C_{10}C_{10}$	Rha-C_8C_{12}	Rha-$C_{12}C_8$
539.3	67.71	Rha-C_8C_{10}Cl	Rha-C_8C_{12}Cl	Rha-$C_{12}C_8$Cl
541.3	22.91	Rha-$C_{10}C_{10}$K	Rha-C_8C_{12}K	Rha-$C_{12}C_8$K
621.3	18.02	RhaRha-C_8C_{10}	RhaRha-$C_{10}C_8$	
649.4	100.00	RhaRha-$C_{10}C_{10}$		
685.4	39.74	RhaRha-$C_{10:1}C_{10}$K	RhaRha-$C_8C_{12:1}$K	RhaRha-$C_{10}C_{10}$Cl
687.4	14.68	RhaRha-$C_{10}C_{10}$K		

Rha: Rhamnose. [a]: Calculated by addition of [M-H]$^-$ and fragments produced by *in-source* fragmentation.

3.2 Stability and bubble size diameter of rhamnolipid CGAs

Colloidal gas aphrons are influenced by several parameters, and even a subtle change in certain conditions can promote different outcomes regarding the stability and bubble size diameter of the macrofoam dispersion. In the present study, an RCCD was developed considering the parameters that could play a role in CGA stability and bubble size diameter. Rotation speed had a significant effect on the stability of aphrons, as well as agitation time. Rhamnolipid CGAs reached its maximum half-life (600 s) when 10786-12000 rpm was applied over a period of 102-120 s. Increasing the rotation speed and agitation time specially between 75 and 120 seconds, resulted in higher stability values (fig. 3a). Additionally, between 5000 and 8500 rpm within a stirring time of 30-120 s, an increase in the half-life of rhamnolipid CGA was observed with an average half-life of 400 s (Fig. 3a).

Several parameters may influence the stability and average bubble size of microfoams and ultimately affect their field applications. Previous studies have focused on observations based on fixed conditions of rotation speed, stirring time and pH. However, the application of an RCCD is useful to understand how different variables may simultaneously affect important CGA properties. To date, there has been scarce information regarding the behaviour of rhamnolipid CGA when submitted to binominal stirring time and stirring speed. Both parameters are of special interest to reduce time and energy to promote microfoams with satisfactory stability. According to the stability results presented by [16], a rhamnolipid CGA generated under fixed conditions of 8000 rpm for 180 s at an initial concentration of 0.4 % reported an average stability of 400-500 s. These stability values are in accordance with the present results; however, based on the data presented, it is also possible to obtain microfoams with a satisfactory half-life even under stirring times of less than 180 seconds, evidencing the possibility of optimizing the generation of stable colloidal dispersions using shorter time intervals, which is desirable for field applications.

According to [25] stirring time does not have an influence on the half-life of aphron dispersions. However, based on stability assays performed with a synthetic surfactant (cetyltrimetyl ammonium bromide 0.4 %), the authors reported a significant increase in the stability of the CGA as the stirring speed was elevated from 5000 to

5500 rpm, within the same time stirring of the present study (30-120s).

In the present study, considering the higher stirring speed range tested in the present study (5000-8500 rpm) and the same stirring time tested, the stability of the CGA dispersions was similar (~300 s); however, when the biosurfactant was submitted to higher velocities under 30-120 s, a significant improvement in the half-life of the CGAs was observed (Fig. 3a). Thus, it can be inferred that stirring time influences the half-life of CGAs under stirring velocities between 9000 and 12000 rpm. Moreover, the binomial stirring speed and stirring time may play a role in the stability of a rhamnolipid CGA, especially under higher stirring velocities and stirring times between 30-120 s.

Recently, [26], reported the influence of stirring speed on the stability of CGAs generated from synthetic cationic and anionic surfactants. It was demonstrated that optimum half-life values were obtained between 11000 and 12000 rpm, and by further agitation at 13000 rpm, there was a significant reduction in the stability of the CGA suspensions. Until now, there has been scarce information regarding the influence of the maximum stirring speed and rotation time on the half-life of CGAs; however, it can be inferred that rotation speeds above 12000 rpm may play a role in the stability of microfoams, especially under stirring conditions above 102 seconds.

Regarding the influence of pH (5.8-9.0), no positive or negative influence was observed on the stability of the rhamnolipid colloidal gas aphrons (Fig. 3b). This was also observed by previous authors when experimenting with synthetic anionic surfactants [27,28]. However, other studies have demonstrated that the stability of rhamnolipid CGA and reported that alkaline conditions could have a negative influence on the stability of rhamnolipid CGA [16]. The authors discussed the negative influence of alkaline pH on the stability of CGAs based on the previous study [29], who reported that the dissociation of rhamnolipid at pH 8.0 promotes electrostatic repulsion between adjacent ionized carboxyl groups of the molecule. The authors further stated that when rhamnolipid CGAs were generated under alkaline conditions, these electrostatic repulsions promoted a significant reduction in the concentration of rhamnolipid at the bubble surface and decreased the viscosity and elasticity of the bubble surface, which ultimately led to bubble coalescence.

However, [16] used NaOH to prepare alkaline solutions of rhamnolipids and generate rhamnolipid microfoams under alkaline conditions, whereas in the present study, NH_4OH was used to subject the rhamnolipid extract to these same conditions. Thus, having not observed any significant changes in the stability of the rhamnolipid microfoams, it is possible that the partial dissociation of NH_4OH may have played a role in the stability of rhamnolipid microfoams, as the hydrophilic region of the rhamnolipid molecule was not fully dissociated under the alkaline conditions tested, resulting in less electrostatic repulsion between the hydrophilic portions and thus not promoting any significant modifications in the viscosity and elasticity of the microbubble surface. Additionally, there has been previous studies demonstrating the influence of sodium chloride (NaCl) upon the micellization process of rhamnolipids at pH 6.8. The presence of electrolytes with a total dissociation property, promotes an increase of size and number of rhamnolipid micelles due to reduction of the electrostatic repulsion between hydrophilic heads of the biosurfactant molecule [30]. But again, its not confirmed if the same effect is possible to occur under strong alkaline conditions, and if it could imply in a reduction the stability of rhamnolipid CGA.

Regarding average bubble size diameter of the rhamnolipid CGA dispersion, it wa observed that the higher and lower bubble size of the rhamnolipid CGAs ranged from 60-220 µm (Fig. 3c). The average bubble diameter was affected by the rotation speed and agitation time. The average bubble size diameter of rhamnolipid CGA fluctuated between 100 and 60 µm within a agitation time of 30 to 75 s and rotation speeds of 6000 and 12000 (Fig. 3c). These average sizes for a rhamnolipid CGAs are in accordance with results presented previously [16], however, within the agitation time of 102 and 120 s as more rotational kinetic energy was applied towards the rhamnolipid extract bubble size average was affected, producing larger rhamnolipid CGAs, and reaching over 220 µm. However, between 10786 and 12000 rpm, the size of the rhamnolipid CGA decreased by 120 µm, demonstrating a saturation tendency towards the amount of rotation speed, which can influence the average size of rhamnolipid CGAs. Other researchers also reported that higher velocities and agitation time could affect bubble average diameter, as more shear forces could influence the average bubble diameter within the microfoam dispersions [26]. The authors reported that at 13000 rpm, there was a reduction in the bubble size average of the CGAs produced using the synthetic surfactants SDS and Triton-X, which is in accordance with the results in the present study.
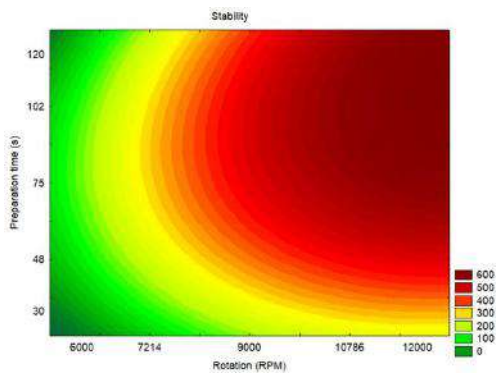
Fig. 3a. Response surfaces for stability of rhamnolipid CGA. Rotation speed versus rotation time.
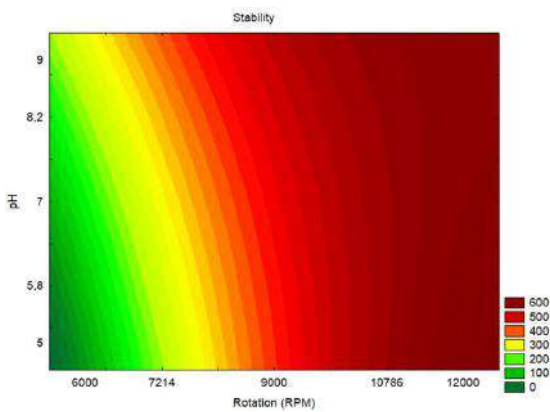
Fig. 3b. Response surfaces for stability of rhamnolipid CGA. Rotation versus pH.
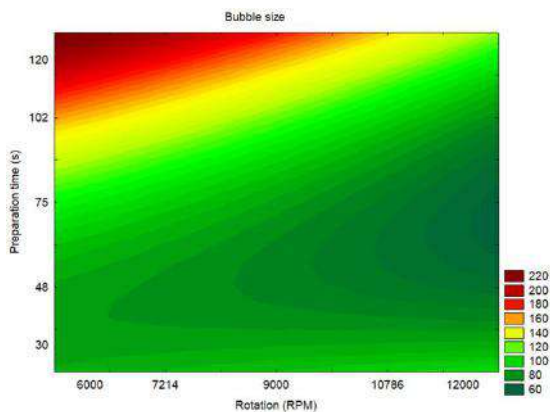
Fig. 3c. Response surface for bubble size diameter rhamnolipid CGA dispersion. Rotation versus agitation time.

3.3 Soil washing experiments with the rhamnolipid CGA dispersion and rhamnolipid extract solution.

3.3.1 Flow rate experiments

In the present study, several flow rate assays were conducted to evaluate the performance of a rhamnolipid CGA and a rhamnolipid extract in a liquid state when submitted to metal-contaminated soil. After selecting the best conditions for CGA stability and average bubble diameter, a series of percolation experiments were conducted under different flow rates, and the respective pressure build-up was recorded to better evaluate the suitable flow rate for percolation of the rhamnolipid extract and rhamnolipid CGA through the remediation column. Between the flow rates of 30 and 130 mL min^{-1}, a significant pressure drop was always observed when rhamnolipid CGA was pumped through the remediation column (Fig. 4) compared to the rhamnolipid extract solution. However, this was not observed under a flow rate of 10-12 mL min^{-1}; thus, this was the flow rate throughout the rest of the remediation assays. Additionally, the remediation assays, when performed under a low flow rate (10-12 mL min^{-1}), led to a significant amount of time dispended and were significantly laborious, while increasing the flow rate to 20-30 mL min^{-1} generated pressure build-up, channelling, and obstruction points inside the remediation column. The effect of pressure build-up of a nonaqueous GCA when percolated trough porous media was reported elsewhere [31]. The authors also reported that as the volume of CGA fluid increased, the pressure drop across the porous media also increased.
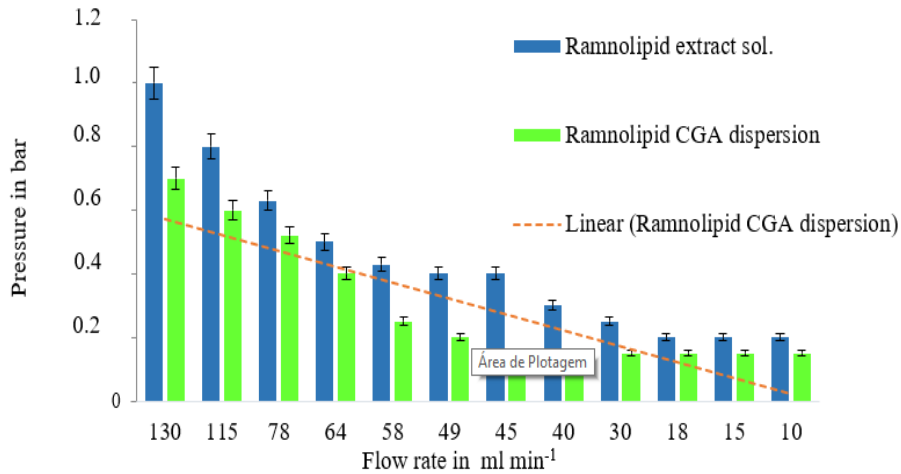
Fig.4. Pressure drop of rhamnolipid CGA in comparison to rhamnolipid extract. Down flow mode.

Also there has been reports of the influence of channelling and pressure build-up when flow rates above 18 ml min^{-1} were applied to a packed remediation column containing a soil sample contaminated by arsenic [32].

3.3.2 Metal remediation efficiency of rhamnolipid CGA dispersions

A sandy soil sample was artificially contaminated to simulate a short-term contamination site and percolated by artificial rain to simulate field conditions. The final concentrations of cadmium and zinc were 39 and 511 mg kg^{-1}, respectively. Percolation of 4 PV of rhamnolipid CGA dispersion resulted in a removal rate of 13 %, which was considered inferior in comparison to the negative control and thus considered a insignificant remediation, however after percolation of 10PV a remediation of 38% was observed (fig. 5a). The removal rate of zinc after 4PV was 42% and after 10PV 53 % (fig. 5a). The rhamnolipid solution at pH 9.0 exhibited the following removal rates for cadmium: 39 and 46 % and for zinc: 62 and 67 % (fig. 5b). Throughout the experiment, the average time to percolate 4 pore volumes of CGA dispersion or rhamnolipid extract solution was 3-4 hours, and percolation assays of 10 pore volumes took an average of 6-8 hours.
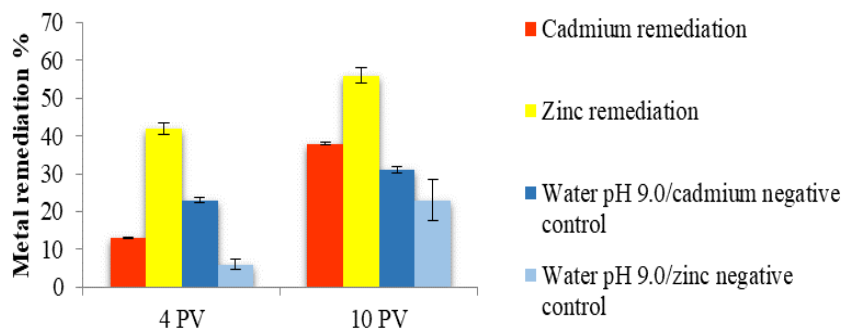
Fig. 5a. Metal remediation percentage of Rhamnolipid CGA (0.5%) pH 9.0; PV: Pore volume.
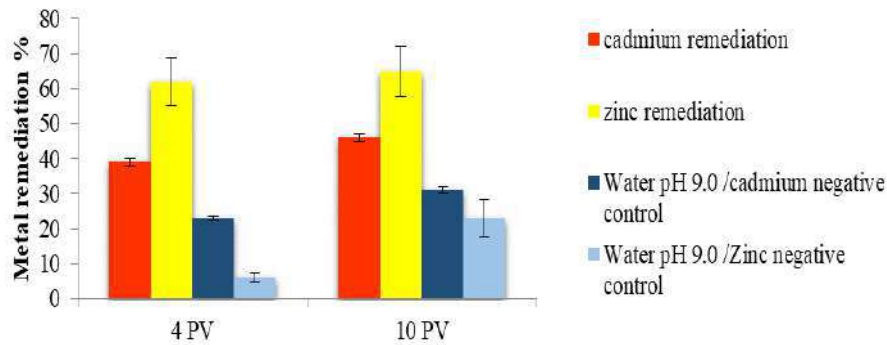
Fig. 5b. Metal remediation percentage of Rhamnolipid solution (0.5%) pH 9.0; PV: Pore volume.

Colloidal gas aphrons are composed of 40-70 % gas content, high stability, and resistance towards shear forces [16]. Regular foams, which are formed by the expansion of gas content involved in a thin and continuous surfactant liquid phase, have been successfully applied in the soil remediation process [33]. However, their low stability is a drawback for field applications since foams are a thermodynamically metastable system [34].

CGAs have been reported as a more stable foam structure due to their triple shell conformation, where the internal film containing a surfactant monolayer displays its hydrophobic tail oriented towards the gas phases and the external film consists of a double-layered hydrophilic shell facing the aqueous medium [35]. Until now, few studies have demonstrated the possibility of using biosurfactant microfoams to remove metal from soil samples, and even fewer studies have compared its efficiency to previous methods in which regular foam was applied.

In a soil flushing experiment with metal-contaminated sand [36], demonstrated the efficiency of regular foam produced with biosurfactants to remove cadmium from the contaminated site. The authors reported a removal rate of cadmium of 20% when the biosurfactant surfactin was applied, while rhamnolipid foams removed 40% of cadmium from contaminated sand samples after percolation of 24 pore volumes. Based on the present results, it can be demonstrated that colloidal gas aphrons can display a similar soil remediation efficiency when compared to previous studies that applied regular foam as a metal extraction agent, however spending less surfactant solution to achieve almost the same results in terms of soil remediation. This is due to its unstable characteristics and higher tendency towards coalescence of regular foams when compared to colloidal gas aphrons.

Maity et al. [37] reported a metal remediation efficiency of 56 % towards zinc after 48 hours of contact of saponin foams with metal-contaminated soil samples. In the present study, 10 pore volumes were percolated in approximately 6-8 hours, demonstrating that while both methods could result in significant remediation percentages of Zn, rhamnolipid CGA dispersion are less time-consuming, which can be inferred in a more practical approach for metal removal in large scale remediation methods. Mukhopady et al. [32] compared the remediation efficiency of colloidal gas aprons and a saponin extract to remove arsenic from soil samples, when percolated in down flow mode. According to the authors in both situations percolation in a descendent mode was favored by gravity and thus the water flow properties of colloidal gas aphrons implicated in a similar remediation between the saponin extract and the saponin colloidal gas aphrons. This was also demonstrated in the present study. The rhamnolipid extract and the rhamnolipid colloidal gas aphrons when percolated in down flow mode exhibited a similar remediation efficiency for cadmium and zinc after the percolation of 10 PV.

Based on the present results, it can be demonstrated that water flow conditions also played a role in the remediation of rhamnolipid solution and rhamnolipid CGA. Column remediation assays demonstrated a similar percolation pattern; hence, remediation of cadmium and zinc was considered similar. Recently, Pasdar et al. [38], used schematic micromodel patterns to study the role of sodium dodecyl sulfate and sodium dodecyl benzene sulfonate CGAs in controlling fluid invasion under water and oil-wet conditions. Microscopic observations revealed that CGA dispersions perform better under oil wet conditions than under water wet conditions, which is a condition more suited for metal-contaminated terrains.

3.3.3 Influence of number pore-volume

The number pore volume had a significant influence on the extraction of metal contaminants. The continuous washing procedure by a biosurfactant with metal binding properties such as the rhamnolipid molecule affects metal mobilization by permitting continuous contact of the biosurfactant with the soil samples, which contributes to metal desorption In the rhamnolipid extract solution

experiment and the CGA rhamnolipid experiment, the number of pores progressively increased, and the percentage of cadmium and zinc was removed from the soil (Fig. 5). Recently in a metal contaminated sandy loam sample, Ugwu et al. [38] demonstrated the extraction of 63% of Cd after percolation of 10 PV of a rhamnolipid solution. In a column flushing experiment, Wang and Mulligan [39], reported a significant amount of arsenic, copper, lead, and zinc removal from a mine tail sample after percolation of a 70-pore volume of a 0.1 % rhamnolipid solution with an initial pH of 11.0. Tang et al. [40], also observed that after multiple washes with two biosurfactants, considerable amounts of copper, zinc, chromium, lead, nickel, and manganese were removed from metal-contaminated sludge.

IV. CONCLUSIONS

The increasing extraction of metal ores has led to a worldwide demand for new methods to remove or mitigate the hazards of metal contaminants from soils. Such methods need to be in line with future strategies aimed at reforestation or resumption of existing socioeconomic activities. The development of natural substances with significant biodegradability and metal extraction properties has become extremely interesting for these strategies.

In the present study, a rhamnolipid extract produced with agro-industrial waste was submitted to modification of its physical structure into CGA dispersion, and several parameters were evaluated to determine the best condition for application in an *ex-situ* soil washing method. Based on the present results, high rotation speeds during a short period of time can influence the stability and bubble diameter of rhamnolipid CGA. Additionally, alkaline conditions did not play an important role in the stability and bubble diameter of the CGAs. The binomial rotation speed and agitation time increases the average size of the rhamnolipid CGA to a point were afterwards the rhamnolipid microbubbles start to decrease its average size, demonstrating a saturation tendency towards the amount of rotation speed and agitation time which can produce large rhamnolipid CGAs with an the average size of 200 μm**.**

Soil column experiments regarding the pressure build-up behaviour of the rhamnolipid CGA and the rhamnolipid extract demonstrated that during percolation under several flow rates, a significant pressure drop was observed when flow rates between 30- and 130-ml min were applied for the rhamnolipid CGA. The rhamnolipid microfoam exhibited a superior efficiency for metal remediation of metallic contaminants (cadmium and zinc) when compared to previous studies regarding metal

remediation of regular foams. Likewise, soil column experiments demonstrated that the rhamnolipid extract was also efficient in removing cadmium and zinc from a short-term contaminated site.

Ultimately, this study opens the prospect of applying a rhamnolipid extract as microfoams in remediation processes of metal-contaminated soils. In addition, there is increasing knowledge about parameters related to the remediation efficiency of rhamnolipid microfoams and features related to microfoam percolation through porous media, such as low-pressure accumulation and efficient and rapid remediation of metals from contaminated soils.

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Itinerary for patients with Acute Chagas Disease: From illness to coping in an Amazonian municipality

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Abstract— Objective: This study aims to understand the path from illness to coping with Acute Chagas Disease (ACD) by those who experience it. Method: Qualitative, descriptive study carried out in the city of Abaetetuba, Pará, Brazil. Twenty patients with Acute Chagas Disease followed at a health clinic in 2018 participated in the study. Home visits were made to collect information through a semi-structured interview script with open and closed questions. For data analysis, thematic content analysis was used. The research complied with Resolution No. 466/12 of the Brazil National Health Council. Results: Most participants are aged between 20 and 39 years (40%), 50% are female, 60% had no personal income, 50% declared themselves to be Catholics, 65% reported being under current treatment for ACD and 5% had complications. When analyzing the interviewees' statements, three categories and their approaches emerged: 1) The meaning of having and living with ACD (The knowledge of patients about the disease; the impact of the disease on the patient and religiosity as a form of hope); 2) The carrier's relationship with their social groups (The positive aspects; the negative aspects and the repercussions of the illness on the family); 3) The influence of food culture related to patients with ACD (Our açaí, daily health).Conclusion: It is concluded that this research not only demonstrates that ACD has a great biopsychosociocultural thickness, due to its significance for those who experience it, but also is fraught with stigmas for being inserted in a cultural environment of eating habits based on the consumption of açaí pulp.

I. INTRODUCTION

Chagas Disease (CD) is a human infection produced by the flagellate protozoan *Trypanosoma cruzi (T. cruzi)*. It has a biphasic clinical course, consisting of an acute phase (clinically apparent or not) and a chronic phase, which can manifest in indeterminate, cardiac, digestive or cardiodigestive forms [1].

The transmission cycle of the disease is based on the transmitter vector, the triatomine. However, after numerous national campaigns and multinational initiatives, transmission through this medium is partially controlled. In 2006, Brazil received from the World Health Organization (WHO) the certificate of eradication of transmission by the most relevant domiciled vector, Triatoma infestans. This, however, does not represent the eradication of the disease, which continues to happen through outbreaks mediated by other forms of transmission, such as the oral route [2].

CD in Latin America affects between 18 to 20 million people and more than 90 million who live in endemic areas are at risk of becoming infected, causing disabilities in infected individuals and death. For many decades, CD was a strictly rural disease. However, socioeconomic changes, rural exodus, deforestation and urbanization have transformed the epidemiological profile of the disease, making it a more urban and peri-urban phenomenon [3].

Were recorded 112 outbreaks in the national territory between 2005 and 2013, involving a total of 35 municipalities in the Amazon Region. The probable source of infection was the ingestion of foods contaminated with *T. cruzi*, including: açaí, bacaba, jaci (coquinho), sugarcane juice and babassu palm hearts. Most outbreaks occurred in the state of Pará with 75.9% and 12.5% of cases and, to a lesser extent, the states of Amazonas with 4.5%, Tocantins and Bahia with 1.8% each [4].

The North region contributed with the highest proportion of cases in the country (91.1%), having been registered in the state of Pará about 75% of all cases in Brazil, and more than 50% had symptoms onset between months from August and November for the years 2005 to 2013, a period that coincides with the açaí harvest in Pará [4].

In this context, the municipality of Abaetetuba is the most prevalent due to its epidemiological relevance, standing out in the national and international scenario for its hyperendemic profile, in which Acute Chagas Disease (ACD) is a serious public health problem. When comparing with the capital, Belém, which has an estimated population for 2018 of 1,485,732 people [5],

there is a greater burden of illness, however, the municipality of Abaetetuba, which has an estimated population for 2018 of 156,292 people, according to the demographic census of Brazilian Institute of Geography and Statistics (IBGE) 2010 [6], has greater magnitude due to proportionality. The municipality of Abaetetuba concentrates 14.8% of CD cases registered in the Amazon [7].

For the millions of patients with CD, there are still numerous challenges, such as living with a chronic, stigmatizing disease, with evolutionary potential to develop mega viscera and various complications, to which are added social problems, confirming the morbid potential of the association between human infection and the socioeconomic status of those infected. The population affected by this disease is predominantly composed of migrants from endemic rural areas, with little or no qualification for specialized work, particularly in the tertiary sector, and who cannot be held responsible or bear the burden of this disease alone entails to them [8].

In this sense, it is possible to say that the way of understanding ACD can support negative or positive attitudes towards the disease. Sudden death is an unusual event in these cases, but when patients are asked questions about the meaning of the disease, the answers differ from the available scientific knowledge. This event becomes the mark of the disease, the other clinical presentations lose importance and the ACD becomes the one "that kills suddenly" and becomes the icon and the stigma of the disease, that is, it starts to be represented as its worst consequence [9].

From this context, the following research question emerged: How is the path from falling ill to coping with Acute Chagas Disease by those who experience it? From this question, we sought to know the phenomena and categorize subjectivity, life stories, culture, myths and prejudices, similar to those that occur with other stigmatized diseases in different contexts (regional, social, etc.), as the imaginary of ACD is linked to death, the fear of not healing and cultural prejudice.

Thus, this study aims to understand the path from illness to coping with Acute Chagas Disease by those who experience it.

II. METHOD

The research complied with Resolution No. 466/12 of the National Health Council and the Declaration of Helsinki, which regulate and standardize research involving human beings, and was submitted to the

Research Ethics Committee of the Undergraduate Nursing Course at the Pará State University and approved under opinion 2,288.005.

This is a study with a qualitative, descriptive approach, in which 20 patients with ACD participated in a municipal clinic that cares for, treats and monitors patients with ACD in Abaetetuba, Pará, Brazil.

The following inclusion criteria were applied: Patients with ACD, being monitored at the municipal health service residing in Abaetetuba; Above 12 years of age. For the exclusion criteria: Person with cognitive deficit that makes it impossible to answer the interview questions.

Data collection took place between October 2017 and September 2018 through semi-structured interviews containing open and closed questions, organized in a script, which sought to know the sociodemographic profile and subjective questions for the apprehension of the object of study.

The approach and invitation to participate in the research took place during monitoring in the municipal health network. The interviews took place in the participants' homes, avoiding interrupting the institution's and patients' routine. The interviews were recorded in electronic media with consent. Subsequently, the information was transcribed in full, so that no information was lost.

The interview took place after participants over 18 had signed the Informed Consent Term or the Informed Consent Term by those responsible for the minors.

For data analysis, thematic Content Analysis was used, which consists of a set of techniques that analyze communication, describe the contents of the messages and provide, on the part of the researchers, the inference of the knowledge contained in the captured messages, according to the following steps: pre-analysis; exploration of the material; treatment of results, inference and interpretation [10].

The results were analyzed and organized into three analysis categories that emerged as a function of the 463 Record Units (RUs) found.

III.   RESULTS

The results show that the most prevalent age group among the participants is between 20 and 39 years old (08/40%), 10 participants were female and 10 male, in terms of income, it was found that 12 (60%) participants had no personal income. With regard to religion, 10 (50%) declared themselves Catholic, 13 (65%) reported

being treated for CD and only 01 (5%) participant had complications.

Category I - The meaning of experiencing Acute Chagas Disease

As for the thematic categories, by analyzing the content of the respondents' answers, Category I was constructed, called "The meaning of living with Acute Chagas Disease", which has 197 RUs and corresponds to 42.54% of the RUs found. This category identifies Having and Living with ACD based on knowledge (Figure 1), limitations, fear of death and seeking refuge in their beliefs, listing the following sub-themes: Knowledge about the disease; the impact of the disease on daily life and religiosity as a form of hope.

Knowledge about the disease

In this analysis, it was possible to infer that there is a lack of information offered to patients with ACD by health professionals and/or when available, they are incomplete, as it was found that 75% of patients reported not knowing the disease or that the knowledge acquired comes from search other sources of information.

> *"I don't know anything about the disease, I had heard about it, that it gives people a lot of fever. I know about the barber too". (P1)*

> *"Nothing, I don't know anything about the disease, I just heard comments, so-and-so has it." (P4)*

> *"I don't have certain information to know about the problem of the disease, I don't know, I just heard the woman say that it's a problem with a barber that gives all this problem there". (P8)*

This analysis showed that for 60% of patients, the knowledge acquired comes from lived or witnessed experiences. Knowledge based on common sense is ingrained in the daily lives of those who have and live with ACD and guides how the disease will be seen by the patient.

> *"[...] I was with a hospitalized sister-in-law, I saw one die with this Chagas disease, I put it in my head". (P4)*

> *"[...] I looked for cases of people who had caught the disease, underwent treatment and now live normally, in this case I found people, friends of mine I didn't know they had and who undergo treatment and live normally". (P7)*

Regarding their knowledge, it appears that patients had three basic knowledge about the disease, deeply rooted in social daily life: "the transmission of the disease through açaí or by the barber", the "disease that has no cure", and the "disease that kills".
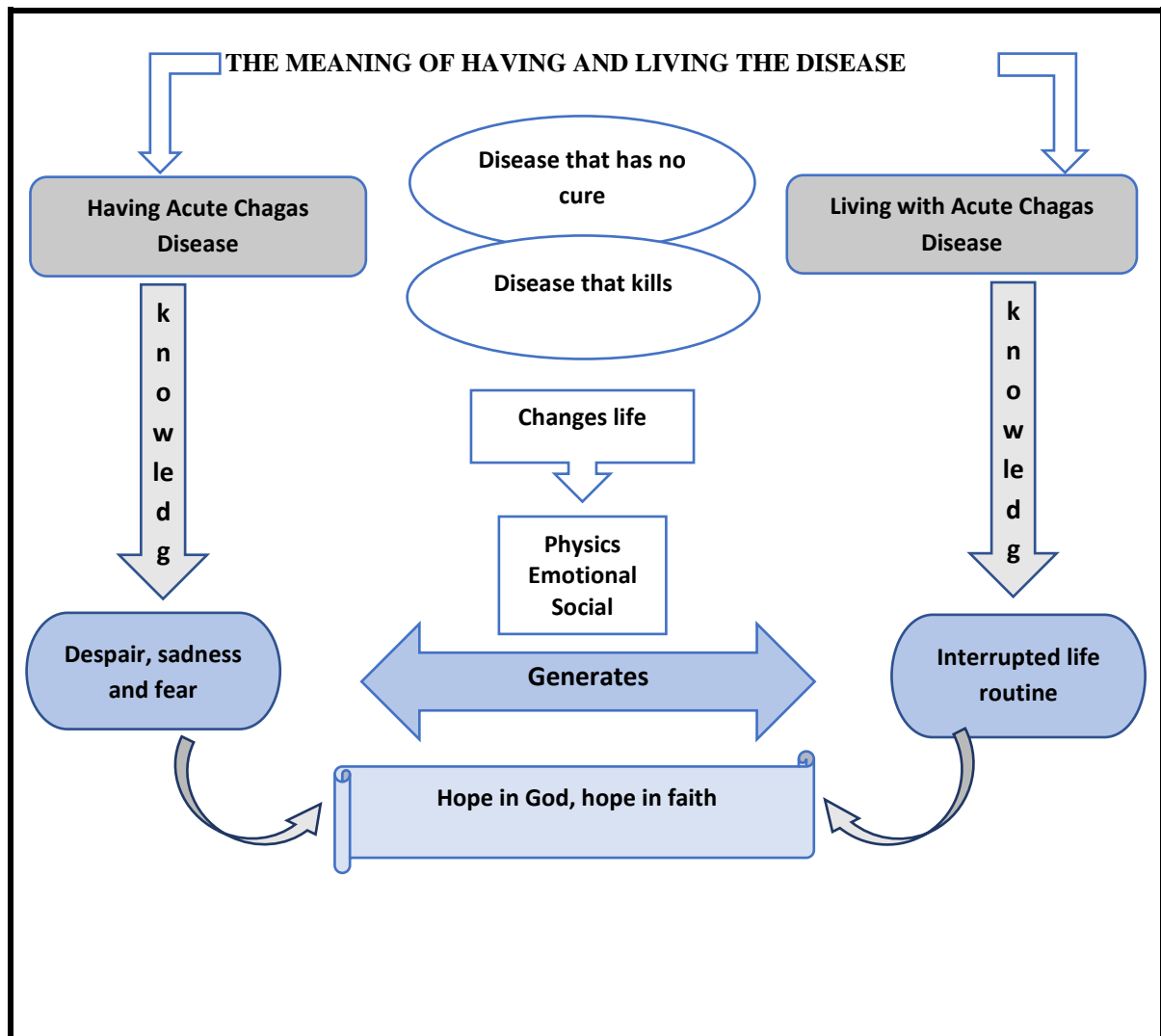
Fig.1: Diagram representing the meaning of Having and Living with Acute Chagas Disease.

Source: Prepared by the author.

The impact of the disease on daily life

Now, participants' testimonies are addressed from the diagnosis of the disease, the changes and the impact on their daily lives. Regarding the diagnosis, 70% of patients say they did not suspect the disease.

> *"[...] it didn't cross my mind that it was Chagas Disease". (P3)*

> *"I didn't suspect it, I thought it was a fever, that it wasn't going away". (P6)*

As for the reaction to the positive result for DCA, patients experience various feelings that resulted from the news. The emotional impact is evident in the testimonies of patients, such as fear, sadness, concern, among others.

> *"[...] it's all over for me, it made me very sad to know that I had it, really sad. This sadness came*

that I was already starting to become depressed, now with this disease it made me sadder". (P4)

> *"[...] I was very scared because it was a very big psychological reaction[...] The shock didn't just come to me, it came to the whole family". (P9)*

It is evidenced in the reports of 40% of patients with ACD that during the course of the disease, the concern with the possibility of no cure is very significant.

> *"[...] I heard that this disease has no cure... This disease has a cure"? (P1)*

> *"[...] I knew that CD had treatment, I just didn't know that it had no cure". (P7)*

The analyzes reveal the existence of a network of meanings associated with ACD that is associated with ideas about manifestations, repercussions and treatment, and configures the representation of a disease that

imposes progressive limitations, "the wanting to do and not being able to".

"It changed my routine, because he said I can't walk, play soccer and do anything that makes my heart race. He spoke to me. It's bad, for now I'm adapting. The person can't stay still, because it makes me want to work, because I used to work on a motorcycle taxi, then he said I couldn't push anything, so I stay". (P2)

"[...] I went to try to work and I couldn't do it anymore [...] I went to wash clothes, but I have to stop for a while because of the arrhythmia when I go over my limit and I get tired and I get short of breath [...] When I was feeling really bad, I knelt on the bed and started crying and I said that I couldn't stand the despair anymore, I even told God to take my life". (P11)

Religiosity as a form of hope

In the narratives, it was identified that 50% use the belief in God and the practice of faith to cherish their fears and uncertainties, in addition to the hope of a cure. The term "God" within the URs found was expressed 57 times.

"[...] God gives us strength, courage for us to overcome, stay in that faith, and I thank God I have a lot of faith in God [...] I can do it as I have it, every time it's good, I say it's okay, thanks to God [...] I have a God up there, who takes care of everything, he solves all the problems, he gives the cure, he does everything, so I believe in God that I'll get out of this and get well". (P3)

"[...]. But first act faith in God and fight to win". (P4)

Category II - Relation of the bearer with his social group

This category has 150 RUs which corresponds to 32.39% of the RUs found. It discusses how ACD patients report social interaction and social interaction with their family, friends and society in general (Figure 2).

The participation of this network of social groups presents itself as a source of positive as well as negative events, which translate to the patient a reading of stimuli and support for the search for quality of life or attitudes that interfere in the course of illness.
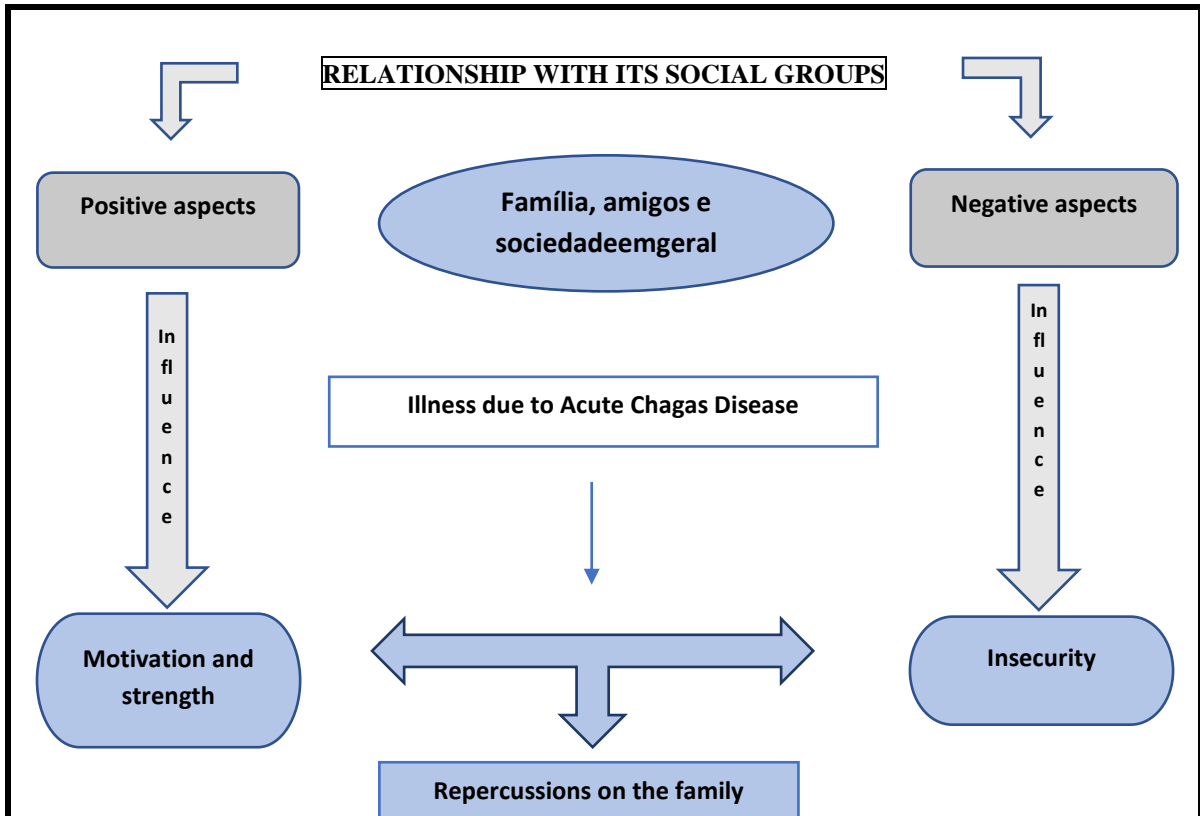
Fig.2: Representative scheme of the bearer's relationship with his Social Groups.

Source: Prepared by the author.

The repercussion and the affect network

Family and friends not only form a support network but also play a very important role in this process. The strength and encouragement that patients receive from this support network makes them stronger in the face of illness, however, in this nucleus, the family is the most important element to overcome the challenges, as seen in the following statements:

> *"[...] my family says that I have to take the medicine, be in this care, that I have to take the medicine every eight hours, a lot of concern". (P6)*

> *"My family and friends are taking it normally, they are always giving strength to follow the treatment and do everything right, it won't be a problem, in that sense, but the relationship really became normal, for those close to me I said and there was the support from all". (P12)*

Coping and social stigma

It is understood that CD is, from this point of view, a social disease experienced with stigma and prejudice that seem to be rooted in society, as seen in the statements.

> *"[...] I went to the office and sat in the chair and people didn't want to sit next to me, because I was transformed, I was completely unknown, it was full of red plaques, so much so that my body was all covered up". (P13)*

> *"CD for me is, today, since when it hit me it has a kind of prejudice for me, CD and HIV hardly some want to accept." (P19)*

Repercussions of the illness on the family

In this research, the term "family" has a frequency of 50 citations in the identified URs.

> *"The shock didn't just come to me, it came to the whole family, there was despair in the family [...] my family members see me as an act of faith, of me remaining strong". (P9)*

> *"[...], I'm not really worried about things, about suffering, I know that suffering exists, but the concern now that it's killing my family". (P15)*

Category III - Influence of food culture associated with the transmission of Acute Chagas Disease

With regard to the food issue associated with oral transmission of the disease, the regional Amazonian context in which the illness due to ACD occurs, influencing the transmission, is discussed. This category has 116 RUs, which corresponds to 25.05% of the RUs found, and describes how the influence of food culture in the daily carrier is presented, characterized by the reports

in the interviews, demonstrating how the insertion of contaminated food and illness.

In the speech of the carriers, it is possible to identify that there are references to food, which in their understanding can be a vehicle for oral transmission of ACD and mention foods such as sugarcane juice, flour, mango and açaí.

> *"[...] it could be from the sugarcane juice, it could be from his shoe, it could be from the flour too". (P2)*

> *"We start to worry more about what we're going to buy on the streets, after I had the disease I didn't drink sugarcane juice anymore, because it's also transmitted by it, I get a little suspicious." (P16)*

Our açaí, the health of every day

This unit addresses with greater focus the cultural issue of oral transmission of ACD as a result of the contamination of the açaí fruit by *T. cruzi,* as the cultural representation of the consumption of this fruit is evidenced in the participants' narratives. The term "açaí" within the listed RUs was the most cited by all interviewed participants, with a frequency of 114 citations.

Açaí is a ubiquitous food in Abaetetuba, sold at every corner by artisan scouts and consumed at any time of the day, constituting the main dish of the residents, which is the municipality's cultural identity. For 95% of the participants, the consumption of açaí pulp is characterized as the main form of contamination.

> *"[...] Açaí, which could have been açaí, we drink açaí, at lunch, at dinner and sometimes we make porridge in the morning with rice, then we drink that porridge". (P3)*

> *"It could have been through açaí, it's the only explanation there is." (P6)*

For some of the participants, the fear of not being able to consume açaí anymore leads them to apprehension and means the break of a daily routine of eating. However, the concern to look for a place that offers the necessary hygienic care, which uses fruit whitening as a control for the protozoan *T. cruzi,* is noticeable.

> *"[...] the first time I went to the doctor and came back worried, so I thought – am I going to continue taking açaí? [...] that doubt, where did it go? Where did I go wrong? Since then, the only thing I didn't cut was only the açaí that I couldn't cut, but I policed it to go to a place that has a more adequate sanitation to the açaí manufacturing process". (P7)*

> *"[...] The doctor said I wouldn't be able to take açaí for a while, then the day I went to Belém, the*

nutritionist told me that I had to take the açaí, then I said Dr. take it all away but don't take my açaí, because we are so used to having lunch and having açaí dinner. (P14)

The consumption of açaí pulp with the guarantee of proper cleaning of the fruit should be encouraged, as it is a nutrient-rich food. However, CD is addressed in groups and in the social environment, published in the regional media as having its main form of contamination in the consumption of açaí, and consequently, it is related to the appearance of cases. However, for many, the strength of the eating habit overwhelms any other concern, which thus favors the emergence of cases of the disease, even if somehow these groups have contact with information about the possible transmission of CD through the pulp of the açaí contaminated by *T. cruzi.*

It is known that CD is linked to social, historical and cultural aspects, aimed at understanding the social interaction of people who experience them as a disease present in the environment, considering that it is inserted and belongs to social groups with identity and close cultures, share the same cultural eating habits, and even though they are aware of the possibility of oral transmission of the disease when adequate hygienic-sanitary conditions are not offered, the force of habit prevails.

IV. DISCUSSION

The knowledge of ACD patients about their condition, both in terms of biomedical knowledge and common sense, influences the course of illness and coping with the disease. Health professionals have a specific perception, and not necessarily similar to that of ACD patients, of what is relevant and problematic, what causes or prevents a problem, and the type of action that this problem requires. This view is determined by your body of biomedical knowledge. As for patients, lay people of a community or group, this perception is determined by networks of symbols that articulate biomedical and cultural concepts, the latter based on knowledge acquired through observation, and the exchange of experiences, which determines characteristic forms of thinking and acting in the face of a health problem [11].

The knowledge of health professionals is based on scientifically proven aspects, what the literature affirms as true, often being the opposite or despising common sense, starting to deny or treat as wrong the way common people, popular knowledge , understand and explain the world [12].

For CD patients, the result is almost always a limited view, possibly due to the lack or scarcity of material, cultural and symbolic resources, in which knowledge is passed on to the patient following the informative model, restricted to diagnosis and therapy [11].

The approximation with the ACD patient must be based on experience and subjectivity, which requires the possibility of dialogical relationships and socialization of knowledge, within the possibilities and limits of the subjects at each moment, favoring greater interaction between professional and patient to better deal with the disease by those who experience it and who cares for it. Thus, the health education process of CD patients is their social relationships, whose social support is a way of dealing with the health issue, understanding the problems in the field of the community itself and also enabling the socialization of the notion of individual autonomy and collective [11].

It is noticed in the speeches a very great fear of dying (60%), as for the vast majority it is the "disease that kills suddenly". However, in an 11-year historical series of positive cases in the state of Pará, 26 patients with ACD (1.3% of positive cases) died.13. These data, however, do not reflect the popular imagination about the fear of death, hence the need and importance of the health professional's participation to act in this reality.

Corroborating the findings of this research, studies show a picture of anxiety related to death, due to situational factors evidenced by fear of loss of physical and/or mental capacities and fear related to loss of control and unpredictable results secondary to the lack of knowledge of the evidenced pathology by the patient's verbal reports [14].

Regarding cure, cases of ACD are indicated for immediate specific treatment and long-term follow-up in order to identify a serological cure. In a study considering 179 patients treated with Benznidazole in the acute phase of CD by oral transmission and who had a follow-up under a research protocol for an average period of 5 to 6 years, there was serologic cure in 26.3%, more evident during the fourth year after treatment. Another 2.7% evolved with mild to moderate chronic heart disease, and 73.7% persisted with reactive serology, but with a significant decrease in antibody levels [15].

The high persistence of reagent serology demonstrated in the study indicated above in an average period of 5.6 years, leads to interpreting how long it can take to discharge according to serological criteria, since the cure is serological negative and can be understood by the patient as a disease that has no cure. The results presented are in line with the representativeness of the research

participants' narratives, which are evidenced with scientific evidence, configuring the representation of a serious disease that cannot be cured [15].

For ACD sufferers, the burden of having and living with the disease is similar to diseases considered "incurable", such as cancer and acquired immunodeficiency syndrome (AIDS). For the limitations in daily life, conditions that make it impossible for them to follow their daily routine of activities, and these changes in the daily lives of patients are not always related to effectively installed limitation, as sometimes it results from projections of possibilities of existing in the present and in the future. The existence of limitations, whether they are work, leisure, home activities, among others [11].

As can be seen, patients with ACD, in addition to living with the threat of a possible death, still face limitations imposed not only by the disease, but also by physical limitations, but also limitations arising from society, which causes them even greater social suffering , and because of that, they end up being labeled as vulnerable and professionally limited. The disease is accompanied by an idea of vulnerability that can trigger discriminatory attitudes and behaviors that hinder the social and professional insertion of patients [16].

Despite the emotional impact caused by the diagnosis, it was then observed that each person has a unique way of dealing with the disease and treatment, as well as the impact on their lives, due to the discovery. In this study, many of them showed that they use religion and faith as coping strategies for the disease. For some participants, the traditional drug treatment, alone, is unable to respond to their desires and, therefore, they seek spiritual treatments and religious practices, to the point of abdicating the medicines because they believe they are cured. Others, however, extol the importance of drug treatment.

It is necessary to undergo treatment when diagnosed with CD and not abandon it, even if faith and belief are added to the treatment, in addition to continuing with monitoring by health professionals. Religion and belief in God through faith allow the carriers' personal experiences to become intelligible and bearable. Religion and belief symbolically handled as a supporting pillar for coping, given the elements derived from it insecurities, fears and risk of death, ensure the understanding of having and living with a disease and fostering confidence in the cure of the disease [17].

Faith can be a great ally in coping with illnesses, it is good for immunity, improves the response to treatment processes, and can even help fight depression and anxiety. In religion, if the belief is in God or in any other entity, the

ultimate purpose is to face the disease, seek strength to win, strength to fight for life [18].

The support and care of family and friends, even though they are also shaken and weakened, is of essential importance for the adaptation to the new condition experienced by patients with ACD [19].

For patients with ACD, the family support network has made a great contribution to seeking care and motivates them in the face of illness, with the family being a symbolic and cultural framework that helps them to build their conception of the disease [16].

ACD patients, in addition to suffering an abrupt change in their health status, both physical and psychological, suffer the repercussions of the disease in their life context, in social life. After the initial impact of knowledge about the diagnosis, indifference and marginalization from society and family members can occur. CD is surrounded by prejudice and stigmas and popular cultural domains that condition the social relationships of its patients [11].

In a study with 308 patients with CD, it was found that the social stigma is still very evident, since the lack of knowledge about the pathology causes prejudiced behavior towards the patient, and also highlights that health promotion and education practices minimized this situation, affecting their quality of life [20].

It can be seen, then, when observing the interviewees' statements, that there has been little evolution so far, with regard to prejudice against patients, so it is understood that it is necessary to take even more care and, even better. , of people who develop CD, facing physical aspects and those related to the stigma and prejudice experienced.

Care must include the patient and their family members, understanding that directing eyes only to the individual who is sick is to fail to notice the whole family, in which each individual has a way of understanding the disease and facing the problem. In general, the family feels responsible for the care and they are sensitive to reactions of adaptation and recognition of the impact of the illness, which also change the relationship with each other and with the social environment [21].

Family members and patients use mechanisms to react to threats arising from real and imaginary situations resulting from the illness, creating ways to cope with the disease [21].

The fear of death and the arrival of a disease popularly known as incurable lead the family to a threshold of feelings and attitudes that denote the repercussions of the disease. Because of this, in the course of illness, there is emotional instability with psychological changes to the

family and the patient in the way of thinking and relating, leading to changes in behavior patterns [11].

Corroborating the results of this study, CD has a strong impact on the family aspect, as it affects their daily lives, but it emphasized that the patient reflected the importance of family support at this time, which has a positive impact on the treatment [16].

According to the SUS Informatics Department of Brazil (DATASUS) of the Ministry of Health, in the State of Pará, in a historical series from 2007 to 2017, there were 1,388 cases of CD by oral transmission, which corresponds to 98.16% of all cases that occurred and in the city of Abaetetuba there were 232 cases in the city, corresponding to 73.41% of the total cases in the period, demonstrating the high incidence of cases of ACD by oral transmission [13].

Nowadays, oral transmission is one of the main forms of the disease in Brazil, particularly in the Amazon region. The consumption of raw or undercooked meat from wild animals infected with *T. cruzi* is mentioned as one of the forms of transmission, being proven in experimental studies with animals [22].

Practices are constituted through various habits and are influenced by social determinants such as low education, few financial and housing conditions [23], in addition to cultural factors, linked to meanings and values of a set of sociocultural relationships that link people and groups to each other [17].

The pulp of the açaí fruit is the daily food for thousands of people in the North of Brazil and, especially in the State of Pará, especially in the municipality of Abaetetuba, whose price is affordable and due to its high nutritional value24. In this region, sales and consumption are carried out immediately after processing, almost always without any heat treatment or hygiene [25].

In the North region, oral transmission predominates, which mainly involves açaí, however the contamination occurs due to lack of hygiene, and the correct handling of food prevents the transmission of the disease and its consumption should be normal on a daily basis day [26]. In the process called "bleaching", the açaí fruits must be submitted to thermal treatment with water at a temperature of 80°C for 10 seconds and, soon after cooled to room temperature, in order to guarantee the quality of the product [27].

V. CONCLUSION

The results demonstrate that ACD has biopsychosociocultural thickness, as it has significance for those who experience it, in which they trace a painful path and often without perspectives, which, in the initial view of the patient, is an illness based on a path of no return. The disease is accompanied by stigmas and cultural values that condition the carrier's social relationships, based on the perception of their health status in physical, psychological and social aspects.

The disease has shown to have great limiting power in the quality of life of patients by adding misconceptions, especially about death, causing anticipated suffering, in addition to generating physical and psychological repercussions. This understanding is built on common sense knowledge, shared by their peers.

Furthermore, the research shows the impact of ACD on public health in the North region and the challenges in coping with the disease, since it recognizes the need to include the theme in the community system and social groups, reinforcing the need for professionals healthcare professionals pay more attention to the changes that ACD brings about in the socio-psychological scope of the patient.

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Threats and vulnerabilities associated with cybercrime with children and adolescents

Ameaças e vulnerabilidades associadas aos cibercrimes com crianças e adolescentes

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Abstract— This scientific initiation article will address the main threats found in the virtual world, especially those that tend to reach children and adolescents, who currently use the tools available on the internet continuously and devolved. We will also show the penal aspects established in Brazilian law, as well as a statistic of the number of crimes of this kind practiced throughout the year 2018 and in the first months of 2019, making an analysis of growth or reduction of these. At the end of the day we will reflect, based on the studies and data collected, on the dangers that this public is considered vulnerable, when they navigate the world wide computer network without control and without the necessary expertise to detect a possible crime.

Resumo— Este artigo de iniciação científica irá abordar as principais ameaças encontradas no mundo virtual, em especial aquelas que tendem a atingir crianças e adolescentes, que, na atualidade, utilizam de forma contínua e desvigiadas as ferramentas disponíveis na internet. Mostraremos, também, os aspectos penais dispostos na lei brasileira, assim como uma estatística do número de delitos dessa espécie praticados em todo o ano de 2018 e nos primeiros meses de 2019, fazendo uma análise de crescimento ou de redução destes. Ao final faremos uma reflexão, com base nos estudos e dados colhidos, sobre os perigos a que estão sujeitos, esse público considerado vulnerável, quando navegam pela rede mundial de computadores sem controle e sem a expertise necessária para detectar um possível delito.

Palavras-Chave— Internet, Crianças e adolescentes, Cibercrimes, Vulnerabilidade, Tipos penais.

I. INTRODUÇÃO

Na era digital, cada vez mais presente na vida cotidiana, os aparelhos de televisão, de rádio, e até mesmo a velha e conhecida agenda, foi dando lugar a um equipamento, que se tornou, praticamente, indispensável nos lares atuais, o computador. Por outro lado, os smarts phones também se tornaram acessórios da vida das pessoas, já que estes fazem o papel de computadores portáteis.

Começaremos falando sobre a vulnerabilidade que perfaz o público infanto-juvenil quando, sem nenhum temor, exploram vários ambientes virtuais disponíveis na rede mundial de computadores, acreditam em que não correm perigo algum.

Em um segundo momento, mostraremos,de forma conceitual, as ameaças mais conhecidas do mundo virtual, e que vêm fazendo muitas vítimas, em especial aquelas na faixa etária que englobam as crianças e os adolescentes.

Em continuidade, falaremos quais potenciais risco de se concretizarem as ameaças existentes no uso desenfreado da internet, em especial, por aqueles que estão em pleno desenvolvimento psicológico e, por isso, são considerados vítimas perfeitas de cibercrimes.

Logo após, descreveremos os delitos que estão tipificados na legislação especial criminal brasileira, hora denominada Estatuto da Criança e do Adolescente, que por sigla ECA, trazendo as condutas consideradas delituosas e suas respectivas sanções.

Com base nos dados estatísticos, no item quatro, faremos a análise comparativa entre os meses de janeiro de 2018 a abril de 2019, para entender o fenômeno criminal, e suas tendências de crescimento ou diminuição, na medida em que as pessoas acessam o cenário virtual, e acabam por serem vítimas, já que muitas vezes desconhecem ou não se preocupam com os perigos que estão por trás dos ecrãs.

Em seguida, iremos mostrar alguns casos registrados no banco de dados da polícia judiciária, fazendo análise e, posteriormente, reflexões das vulnerabilidades e dos modos de execuções dos ditos cibercrimes.

Finalmente, será trazida uma reflexão sobre os perigos atuais e iminentes a que estão sujeitos, aqueles que consideramos como público vulnerável em decorrência de vários fatores que foram mostrados no transcorrer do artigo.

II.   MÉTODO

A metodologia aplicada foi qualitativa, caracterizada pela análise de outros artigos, documentos oficiais que trazem informações relacionadas ao tema abordado, bem como, análise de dados extraídos de sistema interno da polícia civil.

A partir dessasinformações, extremamente relevantes, podemos perceber o qual vulnerável é o público infanto juvenil, que por vezes, acreditam ter a expertise para navegar no mundo virtual sem que sejam alvos dos algozes cibercriminosos.

O estudo contou com um volume considerável de artigos científicos, de forma que de cada um foi extraído o conhecimento necessário para desenvolver informações relevantes para compor nossa pesquisa científica.

A partir do conteúdo explorado, extraímos diversas informações que vão desde a vulnerabilidade infanto-juvenil, perpassando pelas ameaças associadas, especialmente, as crianças e aos adolescentes, incluindo a probabilidade dessas ameaças se tornarem fato criminoso, e, finalmente, análises de dados e reflexões sobre o tema.

Por fim, mostramos a conclusão que foi tirada após o estudo e que certamente contribuirá para a sociedade em geral, uma vez que a conectividade, atualmente, atinge grande parte da população mundial, independente da classe social, principalmente, as crianças e os adolescente que estão a cada dia mais envolvidos com a era tecnológica.

III.   VULNERABILIDADE INFANTO-JUVENIL

É de suma importância ressaltar que os sujeitos passivos da vulnerabilidade tratada neste capítulo têm idades que foram pré-definidas no artigo 2° do ECA[1] (Estatuto da Criança e do Adolescente), que traz "*Art. 2º Considera-se criança, para os efeitos desta Lei, a pessoa até doze anos de idade incompletos, e adolescente aquela entre doze e dezoito anos de idade*". Ressaltando ainda que o artigo 3° do mesmo estatuto traz os direitos fundamentais que derrogam esse público, assim descrevendo,

> *Art. 3º A criança e o adolescente gozam de todos os direitos fundamentais inerentes à pessoa humana, sem prejuízo da proteção integral de que trata esta Lei, assegurando-se-lhes, por lei ou por outros meios, todas as oportunidades e facilidades, a fim de lhes facultar o desenvolvimento físico, mental, moral, espiritual e social, em condições de liberdade e de dignidade.*

O fluxo de informações proporcionado pela internet é imensurável, e tendo em vista essa facilidade é que os algozes agem nesse ambiente virtual, trazendo riscos, em especial, para o público infanto-juvenil, pois

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[1]BRASIL. Lei n° 8.609, de 13 de julho de 1990. Recuperado em 25 de abril de 2018, from http://www.planalto.gov.br/cciv_l_03/leis/L8069.htm.

estes tendem a explorar o cyber ambiente de maneira destemida e sem nenhuma forma de cuidado, o que faz com que, muitas vezes, eles contribuam com sua própria vitimização.

Os criminosos que agem no mundo virtual e que comentem delitos contra as crianças e os adolescentes se prevalecem de alguns fatores que fazem parte da personalidade desse público, quais sejam: a autoconfiança de que nada de ruim acontecerá; o prazer de desafiar os pais; a sensação de terem esperteza suficiente para navegar na internet; busca por aventuras e por experiências novas; a exposição da vida pessoal; dentre outros[2].

Este público se torna mais vulnerável, na medida em que os seus pais ou responsáveis legais, perdem o controle e deixam de monitorar o acesso à internet de seus filhos, que, em razão da falta de maturidade e da imensidão de conteúdo trazido pelo mundo virtual, acabam atraídos pelos criminosos que se utilizam desse cenário para prática de delitos.

Devido à gama de informações fornecidas pela própria vítima, os abusadores criam a melhor estratégia para atraí-las, seja criando perfis de pessoas da mesma faixa etária, ou verificando as preferências de sua presa para então realizar uma aproximação.

Quando estamos tratando, exclusivamente, do público adolescente que está em pleno desenvolvimento da sexualidade, temos que estes se tornam ainda mais vulneráveis, devido a esta fase de suas vidas, ou seja, a puberdade. Além disso, destacamos que,por falta de uma melhor orientação, os de classes mais baixas são os mais atingidos[3].

Constatamos assim que os fatores de vulnerabilidade que existem, em especial, nos infanto-juvenis, se dão por fatores biológicos, sociais e comportamentais. Porém a falta de orientação, tanto por parte dos pais como do poder público, tende a fortalecer a

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[2]SILVA, Rosane Leal da; Veronese, Josiane Rose Petry. *Os crimes sexuais contra criança e adolescente no ambiente virtual*. Recuperado em 19 de abril, 2019, from http://www.ambito-juridico.com.br/site/index.php?artigo_id=6634&n_link=revista_artigos_leitura.

[3]BRETAN, Maria Emilia Accioli Nobre, VIOLÊNCIA SEXUAL CONTRA CRIANÇAS E ADOLESCENTES MEDIADA PELA TECNOLOGIA DA INFORMAÇÃO E COMUNICAÇÃO: ELEMENTOS PARA PREVENÇÃO VITIMAL. Recuperado em 25 de abril, 2019, from https://www.teses.usp.br/teses/disponiveis/2/2136/tde-22042013-111456/publico/TESE_COMPLETA_MARIA_EMILIA_A_N_BRETAN_FD_USP2012.pdf.

facilidade de ataque a estas vítimas, em se tratando de um ambiente virtual fértil para a prática de delitos.

VULNERABILIDADES	SIGNIFICADO
Relativo à idade	O acesso às ferramentas tecnológicas com idades cada vez mais baixas.
Relativo à falta de preparação	Não maioria dos casos, crianças e adolescentes ingressam no mundo virtual sem antes ter uma orientação.
Relativo à falta de monitoramento	Os pais ou responsáveis legais, muitas vezes, não se preocupam em monitorar os acessos dos filhos.
Relativo à falta de políticas de segurança específicas	O governo não se preocupa em fazer campanhas de prevenções para os cibercrimes, e muito menos, alertas para o acesso irrestrito de crianças e de adolescente, mostrando os riscos reais.
Relativo ao vício digital	Nos dias atuais, crianças e adolescentes trocaram as brincadeiras tradicionais pelos equipamentos eletrônicos, em especial smartphones e computadores.

IV. AMEAÇAS CIBERNÉTICAS ASSOCIADAS ÀS CRIANÇAS E AOS ADOLESCENTES

As tecnologias vêm despertando o interesse das pessoas há alguns anos, todavianão podemos negar que a maior afinidade e a facilidade em lidar com essas inovações vêm das crianças e dos adolescentes.

A facilidade de desenvolver as atividades diárias, seja no âmbito educacional, profissional ou ainda para o momento de entretenimento, utilizando as ferramentas tecnológicas disponíveis na internet, vem crescendo a cada dia, apesar de ainda ter certa rejeição do público com maiores idades.

Neste cenário, em que os pais, não raras vezes, perderam o que há de mais importante na sua relação com os filhos, ou seja, o diálogo, o computador vem se tornando o melhor e mais fiel amigo das crianças e dos jovens, fazendo com que estes exponham todos seus

sentimentosaos amigos virtuais[4].

Dentre os diversos delitos que podem ser praticados contra os sujeitos passivos em destaque no presente artigo, temos aqueles ditos mais gravosos, pois lesam bem jurídico denominado dignidade sexual. Assim, denominamos os crimes desta natureza como pedofilia infanto-juvenil, já que as vítimas desse ato criminoso podem ser tanto crianças como adolescentes.

É importante conhecermos o conceito dado pela Organização Mundial de Saúde em se tratando do termo pedofilia, que segundo esta é a "Preferência sexual por crianças, quer se tratem de meninos, meninas ou de crianças de um ou do outro sexo, geralmente pré-púberes ou no início da puberdade[5]". Assim, podemos dizer que se trata de um desvio de conduta sexual (parafilia), ou seja, o criminoso possui uma perversão sexual, caracterizadas por fantasias, anseios ou atividades incomuns que trazem sofrimento clinicamente significativo ou propiciando comportamentos sociais e ocupacionais inadequados, tendo como objeto de desejo a criança.

Não se pode negar que a facilidade encontrada por esses pedófilos, em conseguir se aproximar das vítimas mais vulneráveis, teve um crescimento significativo após a explosão das tecnologias que estão diretamente ligadas à internet, justificando assim a criação de novos tipos penais, que foram acrescidos no Estatuto da Criança e do Adolescente, os quais estão voltados aos delitos praticados na rede mundial de computadores.

No Brasil, discute-se a necessidade de uma legislação ainda mais completa sobre os crimes praticados por meios da internet, todavia existem doutrinas que divergem deste pensamento, pois acreditam em que haverá um excesso de normas, sendo tais imposições desnecessárias[6].

Por outro lado, as ameaças crescem a cada dia, tendo em vista uma combinação perfeita para os criminosos, a qual se dácom facilidade que os meios

virtuais proporcionam,juntamente com a dificuldade de localização dos criminosos, a falta de uma legislação mais específicae o tratamento brando que a normal penal traz, ao fazer o enquadramento em legislação penal.

De acordo com a Organização dos Estados Americanos (OEA), por meio de sua agência especializada em crianças e adolescentes, o Instituto Interamericano da Criança (IIN)[7], foi divulgada uma publicação sobre as principais ameaças que podem atingir crianças e adolescentes, das quais podemos citar: abuso sexual de crianças e de adolescentes na Internet; cyberbullying; exposição a conteúdos inapropriados; grooming (estratégia para ganhar confiança de criança e adolescente, usada para fins libidinosos); happy slapping (uma forma de cyber-violência, em que é filmado e depois postado na internet, o ataque humilhante); sexting (forma de pressionar crianças e adolescentes a enviar fotos de teor sexual); sextortion (extorquir uma pessoa, com ameaças de enviar suas fotos íntimas) etc.

Inferimos, então, que as ameaças trazidas pelo uso de tecnologias ligadas à internet podem ter as mais diversas variações, que pode culminar com delitos menos graves como injúria, calúnia e difamação, até os mais gravosos, que são os praticados contra a vida e a dignidade sexual das crianças e adolescentes.

V. OS RISCOS DE CONCRETIZAÇÃO DAS AMEAÇAS EM FACE À VULNERABILIDADE INFANTO-JUVENIL

A vulnerabilidade nos reporta à ideia de sensibilidade ou de fraqueza relacionada à determinada área, fazendo com que aumente a possibilidade de ser afetado de alguma forma. E, em se tratando de mundo digital, este fator negativo pode interferir das mais variadas maneiras, na saúde física e, principalmente, mental das crianças e dos adolescentes[8].

Com advento das redes sociais, os riscos aumentaram significativamente, tendo em vista que agora há uma interação "real", crescendo assim as ameaças

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[4]EISENSTEIN E, Estefenon S. *Computador: ponte social ou abuso virtual?*. Adolesc Saude. 2006;3(3):57-60. Recuperado em 09 de abril, 2019, from http://adolescenciaesaude.com/detalhe_artigo.asp?id=136.
[5] Conceito extraído da Classificação Internacional de Doenças (CID) da Organização Mundial de Saúde (OMS). Recuperado em 25 de abril, 2019, from http://cid10.bancodesaude.com.br/cid-10-f/f654/pedofilia.
[6]SILVA, Aurélia Carla Queiroga; BEZERRA, Margaret Darling; SANTOS, Wallas Tomaz. RELAÇÕES JURÍDICAS VIRTUAIS: ANÁLISE DE CRIMES COMETIDOS POR MEIO DO USO DA INTERNET. Recuperado em 25 de abril, 2019, from http://egov.ufsc.br/portal/sites/default/files/3952-21333-1-pb.pdf.

[7] MENDOZA, Miguel Ángel. *Os 10 principais riscos na Internet para crianças e adolescentes*. Recuperado em 03 de maio, 2020, from https://www.welivesecurity.com/br/2018/05/21/principais-riscos-na-internet-para-criancas-e-adolescentes/.
[8]FONSECA, Franciele Fagundes; SENA, Ramony Kris R.; SANTOS, Rocky Lane A. dos; ORLENE, Veloso Dias; COSTA, Simone de Melo. *As vulnerabilidades na infância e adolescência e as políticas públicas brasileiras deintervenção*. Recuperado em 30 de março, 2020, fromhttps://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-05822013000200019.

virtuais, deixando a vulnerabilidade do público infanto-juvenil ainda mais evidente, pois, estão em fase de desenvolvimento psicológico, o que, muitas vezes, contribui para a ação dos algozes.

Podemos fazer uma reflexão, analisando o posicionamento de Pereira (2015),

> Ao permitir a entrada de menores de idade em sites cujo objetivo é a interação social através da publicação de atividades rotineiras e exposição de fotos, acontece a superexposição da criança ou adolescente que inconscientemente atrai diversos outros perigos para si, mostrando-se vulnerável a atuações de marketing, de criminosos ou até mesmo da espionagem da sociedade.

Os posts publicados nas redes sociais, embora pareça algo norma e inofensivo, podem ser um forte fator de risco para os menores de idade, já que, muitas vezes, os pais, de maneira inconsciente, colocam fotos de nudez ou que identifique sua morada, criando assim riscos, seja com maior ou menor possibilidade de ocorrência.

Devido ao grande bombardeio de informações e conceitos que são impostos pela sociedade, podemos verificar que uma simples postagem de um adolescente, por exemplo, pode gerar uma série de críticas, transformando-se assim no conhecido e venenoso ciberbullying, o qual, na maioria das vezes, atinge o psicológico de forma avassaladora[9].

A pedofilia infantil, podemos citar, também, como um risco iminente de ocorrer, caso fotos de nudez ou sensuais caiam nas mãos de pedófilos. Esses têm a seu favor a possibilidade de propagação de tais imagens, nas denominada deep web, ou seja, uma rede obscura na qual ocorrem os mais variados delitos na internet.

Outro problema muito presente no acesso desse público sem expertise é que esta inexperiência é aproveitada pelos criminosos, agindo de forma a

convencer, em especial, as criançasa fornecer dados relacionados a cartões de créditos de seus pais. Para isso, criam personagens que irão interagir com essas crianças, com objetivo de obter tais informações.

O ciberespaço é considerado ambivalente, ou seja, potencialidade e risco são bem definidos, assim, a preservação dos direitos fica iminentemente comprometida. Este acesso fica ainda mais perigoso, quando as tecnologias ligadas à internet se tornam rotina na vida de crianças e de adolescentes, fazendo deste, muitas vezes, uma fuga dos problemas do mundo real. Todaviaestes acabam por ingressar em um perigoso mundo virtual, em queas situações desastrosas podem tornar a vida desses vulneráveis ainda mais devastada[10].

Inferimos então que, por se encontrarem em processo de desenvolvimento físico e psíquico, crianças e adolescente não conseguem ter a percepção dos riscos em potencial os quais estão expostos, sendo estes os mais variáveis, como por exemplo, ciberbullying, crimes contra honra, aliciamento para fins sexuais,pedofilia e muitos outros.

VI. INSERÇÕES E ALTERAÇÕES DO ESTATUTO DA CRIANÇA E DO ADOLESCENTE POR MEIO DA LEI 11.829/08

A lei 11.829/08 traz alterações nos artigos 240 e 241 da lei 8.069/90 (Estatuto da Criança e do Adolescente - ECA), assim como inserções de novos artigos, quais sejam 241-A, 241-B, 241-C, 241-D e 241-E,que vem a aprimorar o combate à produção, à venda e à distribuição de pornografia infantil, bem como criminalizar a aquisição e a posse de tal material e outras condutas relacionadas à pedofilia na internet[11].

No artigo 240 e seus parágrafos e incisos, o ECA vem a discorrer sobre as condutas tipificadas como crimes e suas respectivas sanções para aquele que dirigi, filma, produz ou fotografa, cenas de sexo explícito ou pornográfico, que tenha a participação de criança ou de

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[9]FEUSER, Bruna Ceccone; PAVEI, Fernando; NETO, Pedro Zilli; ZOMER, Ramirez; PAVEI, Rodrigo. *A VULNERABILIDADE DA CRIANÇA E DO ADOLESCENTE NAS REDES SOCIAIS: NECESSÁRIA CAUTELA PARA A SEGURANÇA DO PÚBLICO INFANTO-JUVENIL*. Recuperado em 01 de maio, 2020, from http://periodicos.unibave.net/index.php/constituicaoejustic a/article/view/115.

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[11] MACHADO, Thiago José Ximenes. *Cibercrime e o crime no mundo informático: A especial vulnerabilidade das crianças e dos adolescentes*. Recuperado em 13 de maio, 2019, from https://bdigital.ufp.pt/handle/10284/6089.

adolescente. O parágrafo primeiro traz o delito por equiparação, ou seja, iráincorrer nas mesmas penas, quais sejam, de 4 (quatro) a 8 (oito) anos de reclusão em conjunto com multa, o sujeito que agencia, facilita, coage ou intermedia esse envolvimento de menores. E o segundo e último parágrafo vem a trazer as causas aumento de pena, quando o crime for cometido por aqueles agentes que, devido a sua profissão ou grau de parentesco, possuem maior proximidade com vítima.

O artigo 241 da lei supracitada apresenta punição semelhando àqueles que praticam as condutas de vender (inclusive utilizando a internet) ou expor o material pornográfico no qual há envolvimento de crianças ou de adolescente em cena de sexo explícito ou pornográfica, aplicando, inclusive, as mesmas penas descritas no artigo 240, quais sejam, 4 (quatro) a 8 (oito) anos de reclusão associadas com multa.

Com a inserção do artigo 241-A, os legisladores tiveram a expertise direcionada, principalmente, aos meios virtuais de comunicação, em especial a internet, tendo em vista o crescimento de sua utilizaçãodesde o final dosanos 90,e que vem aumentando a cada dia. Assim,a lei traz uma punição também aos os que praticarem a conduta de transmitir, disponibilizar, publicar, divulgar etc., fotos, vídeos e outros materiais que contenham cena de sexo explícito ou de pornografia com crianças e adolescente. Vale destacarque será aplicada a mesmasanção ao responsável legal do website, caso este seja notificado oficialmente, e não desative o acesso ao conteúdo proibido, que é reclusão de 3 (três) a 6 (seis) anos, cumulado com multa.

Seguindo para o artigo 241-B, não foi esquecidoaquele que adquirir, possuir ou armazenar (em computadores, celulares e outros), os materiais ilícitostrazidospelos artigos anteriores, podendo ter pena de 1 (um) a 4 (quatro) anos de reclusão e multa. No parágrafo primeiro, o legislador entendeu que a pena deve ser reduzida de dois terços, caso a quantidade de material encontrado seja pequena. E o parágrafo seguinte, dispõeda atipicidade do fato, quando a posse ou o armazenamento desse conteúdofor feita com a finalidade de comunicar as autoridades competentes. Todavia existe um rol de agentes que podem praticar a conduta de possuir ou armazenar, quais sejam, agente público no exercício de suas funções, membro de entidade, legalmente constituída, que inclua, entre suas finalidades institucionais, o recebimento, o processamento e o encaminhamento de notícia dos crimes referidos neste parágrafo,ainda faz parte destes, orepresentante legal e os funcionários responsáveis de provedor de acesso ou serviço prestado por meio de rede de computadores, até o recebimento do material relativo à notícia feita à autoridade policial, ao Ministério Público ou ao Poder Judiciário. E finalmente temos a solicitação para que os agentes elencados anteriormente mantenham o sigilo para que a investigação tenha êxito.

O artigo 241-C da lei em comento vem a punir a adulteração, a montagem ou a modificação de imagens, utilizando-se de todo e qualquer meio de produção que envolva crianças ou adolescente em cenas de pornografia ou sexo explícito, tendo uma reprimenda que vai de 1 (um) a 3 (três) anos de reclusão e multa.Em seu parágrafo único,traz as condutas equiparadas, as quais terão as mesmas punições, para quem vende, expõe à venda, disponibiliza, distribui, publica ou divulga por qualquer meio, adquire, possui ou armazena o material produzido na forma do artigo 241-C.

Com pena semelhante ao artigo anterior, o artigo 241-D vem a punir o ato de "Aliciar, assediar, instigar ou constranger, por qualquer meio de comunicação, criança, com o fim de com ela praticar ato libidinoso". Logo, é de suma importância se faz entender o verdadeiro conceito de ato libidinoso, para tal nos aproveitaremos das palavras de Rogério Sanches[12] (2016, p. 213 – 214), que assim se manifesta:

> A expressão "ato libidinoso" é bastante ampla, porosa e, se não interpretada com cautela, pode culminar em séria injustiça, como já registrada pela nossa jurisprudência quando os Tribunais subsumiam ao tipo, o simples beijo lascivo. Deve o aplicador aquilatar o caso concreto e concluir que o ato praticado foi capaz de ferir ou não a dignidade sexual da vítima com a mesma intensidade de uma conjunção carnal. Como exemplo citamos o coito *per anun*, *inter femora*, a *fellatio*, o *cunnilingus*, ou ainda a associação da *fellatio* e o *cunnilingus*, a cópula axiliar, entre os seios, vulvar etc.

As condutas equiparadas vêm dispostas no parágrafo único do mesmo artigo, a qual será aplicada a mesma sanção para aquele que facilitar ou induzir criança

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[12] SANCHES, Rogério Cunha. *CÓDIGO PENAL para concursos. 9ª ed. Revista, ampliada e atualizada*. Editora: Jus Podivm, 2016.

a ter acesso a material contendo cena de sexo explícito ou pornográfica com a finalidade de com ela praticar ato libidinoso, ou ainda, praticar as condutas descritas no artigo 241-D com o fim de induzir criança a se exibir de forma pornográfica ou sexualmente explícita, inclusive por meios virtuais.

No último artigo, qual seja o 241-E, que foi incluído pela lei 11.829/08 nos depararemos com a explicação relacionada à expressão "cena de sexo explícito ou pornográfica", a qual na sua literalidade traz "compreende qualquer situação que envolva criança ou adolescente em atividades sexuais explícitas, reais ou simuladas, ou exibição dos órgãos genitais de uma criança ou adolescente para fins primordialmente sexuais".

Induzimos assim que a legislação especial se preocupou com os delitos praticados, em especial por meio de ferramentas disponibilizadas na internet, apesar de

muitos estudiosos do direito penal acharem que as sanções ainda são muito brandas, tendo em vista o grau de reprovabilidade da conduta e o dano que esta pode vir a causar, não só à vítima imediata, como àqueles que fazem parte de sua vida.

VII. ESTATÍSTICA DE REGISTRADOS DOS CIBERCRIMES ENVOLVENDO CRIANÇAS E ADOLESCENTES PRATICADOS NO ESTADO DO PARÁ ENTRE JANEIRO DE 2018 E ABRIL DE 2019

Com base em dados que foram colhidos a partir do sistema de registro de ocorrências e procedimento da polícia judiciária do Estado do Pará, denominado SISP (Sistema Integrado de Segurança Pública), analisaremos os números apresentados de janeiro de 2018 a abril de 2019, relacionados à comunicação de crimes praticados contra crianças e adolescentes por meio da internet.
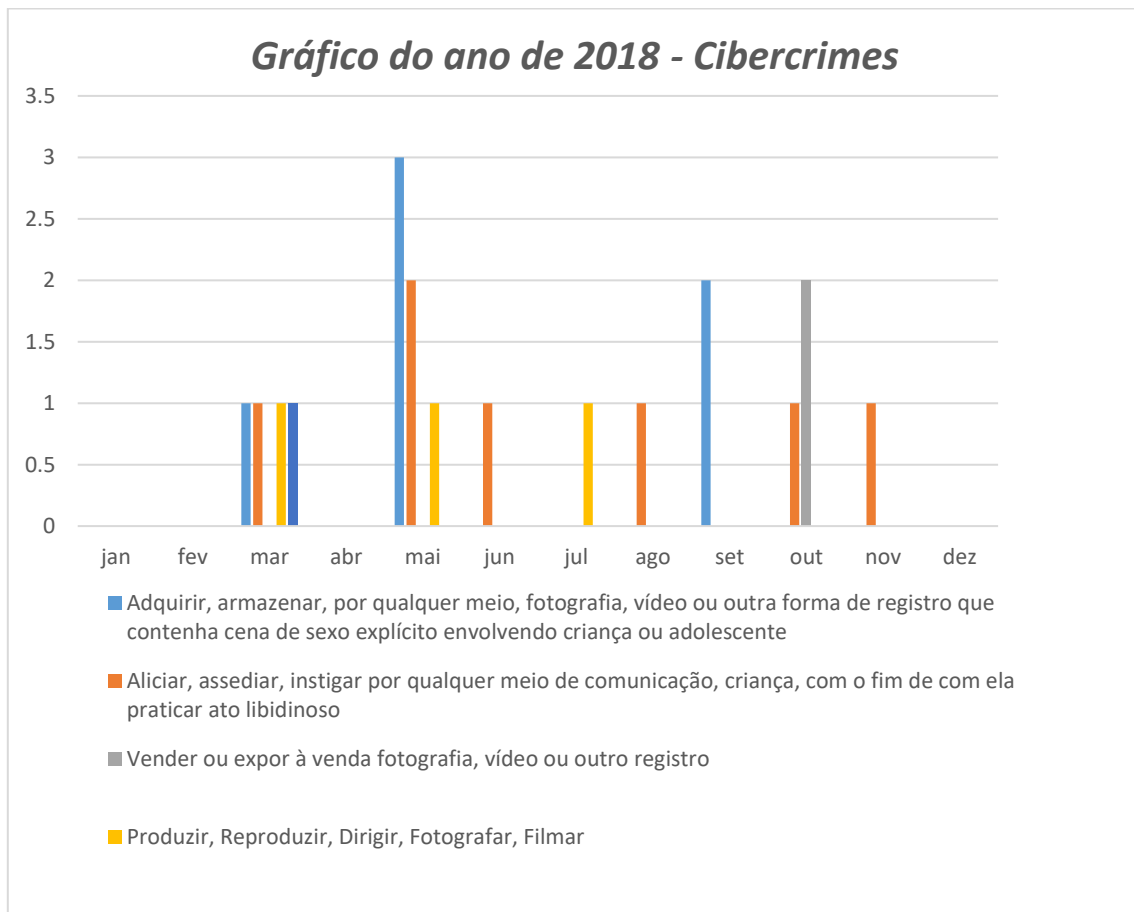
Fig.1 - Dados do sistema da polícia civil do Estado do Pará

O gráfico mostra os dados do ano de 2018, dentre os quais selecionamos os diretamente relacionados à dignidade sexual das crianças e dos adolescentes, e que são praticados por meios de ferramentas computacionais e

foram registrados nas delegacias especializadas em crimes tecnológicos.

Durante o ano de 2018, tivemos, no Estado do Pará, ocorrência do delito somente nos meses de março (1 ocorrência), maio (3 ocorrências) e setembro (2

ocorrências) da prática do crime de adquirir, de armazenar, por qualquer meio, fotografia, vídeo ou outra forma de registro que contenha cena de sexo explícito envolvendo criança ou adolescente, descrito no artigo 241-B do ECA.

Já nos meses de março (1 ocorrência), maio (2 ocorrências), junho (1 ocorrência), agosto (1 ocorrência), outubro (1 ocorrência) e novembro (1 ocorrência) de 2018, foram registradas a prática da ação criminosa descrita no artigo 241-D do ECA, que trata de aliciar, de assediar, de instigar por qualquer meio de comunicação, criança, com o fim de com ela praticar ato libidinoso. Estes praticados, principalmente, por meios de redes sociais e de aplicativos de mensagens instantâneas.

Foi registrado somente no mês de outubro (2 ocorrências) de 2018, o delito de vender ou expor à venda fotografia, vídeo ou outro registro que contenha cena de sexo explícito ou pornográfica envolvendo criança ou adolescente, disposto no artigo 241 do ECA.

Em se tratando de crime voltado a produzir, reproduzir, dirigir, fotografar, filmar público em estudo, tivemos registros nos meses de março (1 ocorrência), maio (1 ocorrência) e julho (1 ocorrência).

O delito que teve mesmo ocorrência no ano de 2018 foi o de simular a participação de criança ou de adolescente em cena de sexo explícito por meio de adulteração, de montagem ou de modificação de fotografia, vídeo ou qualquer outra forma de representação visual, onde somente foi registrado 1 (uma) prática no mês de março.

Partindo agora para uma análise dos quartos primeiros meses do ano de 2019, tendo em mente os mesmos delitos comentados anteriormente, foi reproduzido um gráfico que demonstrará as respectivas ocorrências.
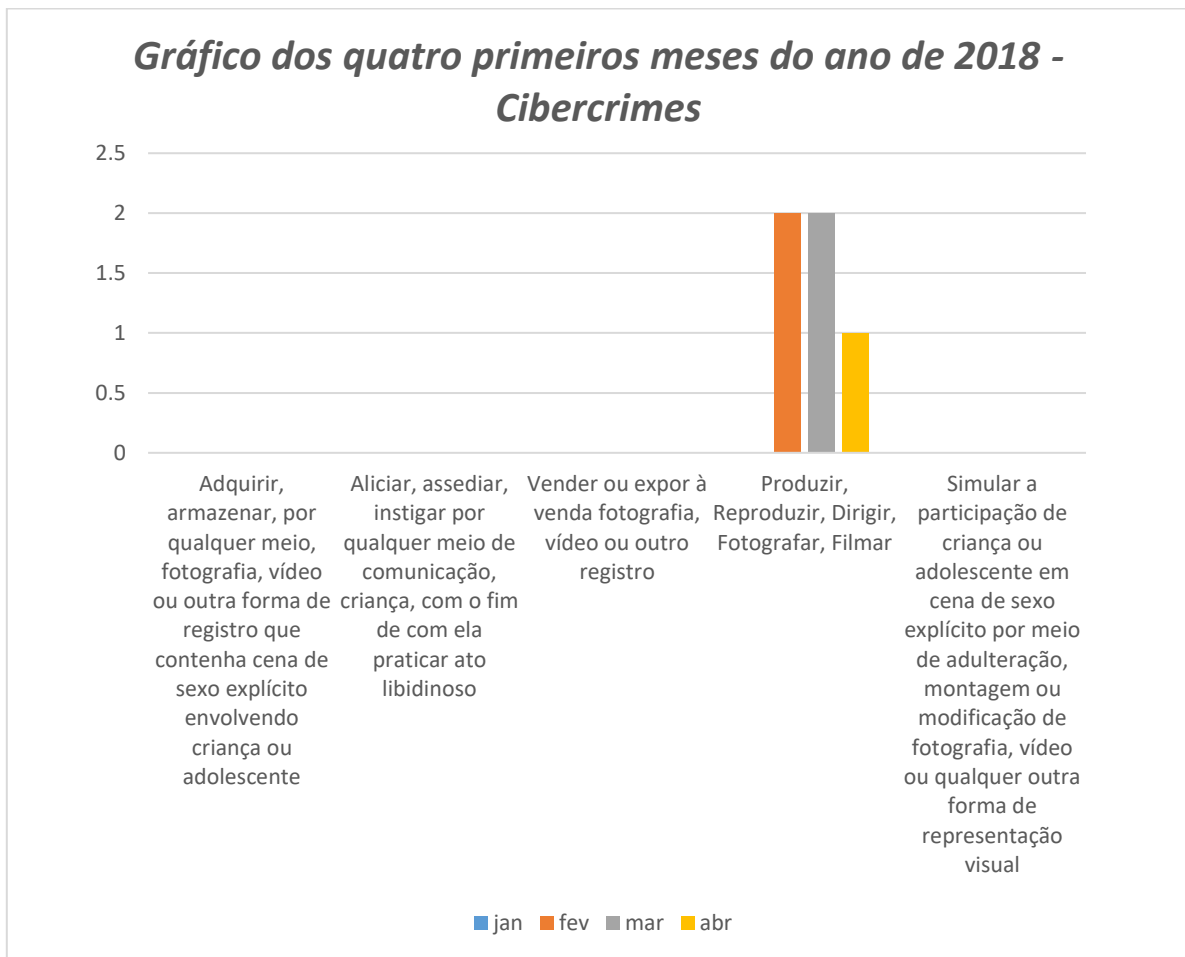
Fig.2 - Dados do sistema da polícia civil do Estado do Pará

Continuando a análise, podemos observar, claramente, que houve uma queda de quatro dos cincos delitos mostrados, em que somente ocorreu o aumento da prática do crime no delito de produzir, de reproduzir, de dirigir, de fotografar, de filmar crianças e adolescente em cena de sexo explícito ou pornográfica. Neste foram contabilizadas 5 ocorrências, sendo 2 (duas) no mês de fevereiro, 2 (duas) no mês de março e 1 (uma) no mês de abril.

Vale ressaltar que o número relativamente baixo de cibercrimes praticados contra crianças ou adolescente, se dá por um fenômeno denominado cifra escura, a qual ocorre quando os delitos não chegam ao conhecimento das autoridades, seja por medo do criminoso, ou pelo fato de achar que a justiça ficará inerte e o autor não será punido.

VIII.   REFLEXÃO DOS CUIDADOS DO ACESSO À INTERNET FEITO POR CRIANÇAS E ADOLESCENTES

Atualmente, sabemos que a internet tem como realidade um vasto terreno nocivo, e que devido ao grande número de programas utilizados como mecanismo para proteção dos usuários, os criminosos especializados nos ataques virtuais conseguem camuflar as suas ações, passando por cima das barreiras protecionais, já que a obscuridade e a extensão espacial proporcionada pelo acesso torna a segurança difícil ou até mesmo impossível de ser combatida de forma absoluta.

Partindo da ideia de que as crianças e os adolescentes acessam a rede mundial de computadores sem nenhum temor, o melhor caminho seria, de fato, a orientação no uso desenfreado, assim como mostrar os riscos e ensinar a identificá-los, fazendo com que sejam criados por esses usuários, os seus próprios mecanismos de defesa. Tendo em vista que, na atualidade, a internet e seus perigos são incontornáveis, a prevenção se mostra mais eficiente do que a proibição[13].

Um aspecto extremamente relevante, que explica o porquê as crianças e os adolescentes mergulham na imensidão dos espaços virtuais, diz respeito à sensação de controle que estes exercem sobre si mesmos. Assim, acreditam em que não há nada de mais em publicar, por exemplo, uma foto expondo partes do seu corpo ou até mesmo sexualizando. Todavia esse tipo de postagem atrai os pedófilos e, com base nas informações colhidas, tem condições de se aproximar da vítima e obter sucesso no seu intento.

Outro aspecto importante é que muitas imagens, vídeos e publicações inadequadas, podem influenciar de maneira negativa na formação de crianças ou de jovens, em que a visualização destes conteúdos pode ser internalizada como prática de condutas normais, como exemplo, os vídeos de violência ou até mesmo de pornografia envolvendo práticas sexuais com crianças, animais, dentre outros.

Como tudo na vida, temos dois lados, o bom e o ruim. Assim acontece com a internet, que se mostra uma ferramenta com vasto conteúdo valoroso, basta que seja explorada com responsabilidade e as devidas orientações daquele que possuem mais expertises no assunto, fazendo assim com que as chances de ser uma vítima em potencial reduzam drasticamente.

Muitos países do mundo vêm investindo na criação de mecanismo de proteção online para crianças e adolescentes, com objetivo de coibir a exposição destes. Todavia sabemos o quão difícil é ter esse controle, pois, apesar das redes sociais não autorizem menores de idade criar perfis, isso é facilmente burlado.

O Brasil ainda se mostra muito carente com relação as legislações que tratam sobre os crimes praticados por meios virtuais, apesar de termos lei que dispõe sobre o tema, estas, ao nosso ver, devem evoluir muito. Por outro lado, nos parece que seria necessária a criação de normas de proteção, quando se tratar do acesso de menores à rede mundial de computadores, incluindo responsabilização aos pais omissos[14].

Findamos assim, com ideia de que a melhor maneira de se resguardar contra os diversos ataques advindos da internet é criarmos técnicas de prevenção, nas quais podemos orientar nossas crianças e adolescente, para que estas possam explorar o mundo virtual de forma saudável e contributiva para seu desenvolvimento psíquico intelectual.

IX.   CONSIDERAÇÕES FINAIS

Não podemos negar que a criação e a evolução da rede mundial de computadores nos proporcionaram inúmeras facilidades e comodidade que abrangem, praticamente, todas as áreas e atividades de nossas vidas. Assim, milhares de pessoas são atraídas e adentram este mundo virtual, porém de grande e considerável efeito no mundo real.

As crianças ganharam uma nova ferramenta de aprendizagem, facilitando e inovando a forma de aprender. Pois, com a gama de informações encontradas em sites educativos, ficou muito mais fácil obter informações relacionadas ao mundo acadêmico.

Os adolescentes, por sua vez, encontraram na internet uma nova forma de se relacionar com o mundo e,

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[13] MONTEIRO, Ana Francisca Cunha. A INTERNET NA VIDA DAS CRIANÇAS: COMO LIDAR COM PERIGOS E OPORTUNIDADES. Recuperado em 25 de junho, 2019, fromencurtador.com.br/abqKT.

[14] PEREIRA, Marília do Nascimento. *A SUPEREXPOSIÇÃO DE CRIANÇAS E ADOLESCENTES NAS REDES SOCIAIS: necessária cautela no uso das novas tecnologias para a formação de identidade*. Recuperado em 10 de maio, 2020, from http://coral.ufsm.br/congressodireito/anais/2015/6-14.pdf.

assim, descobriram um universo no qual suas opiniões e paixões podem ser demonstradas por meios virtuais. Além de terem mais recursos para pesquisas e métodos que influenciaram significativamente no aumento de seus conhecimentos, os quais serão de grande valia para seu desenvolvimento acadêmico, profissional e psicológico.

Embora muitas vantagens tenham sido apresentadas com a chegada de recursos tecnológicos, em especial, os que fazem parte da internet, não podemos deixar de destacar os males existentes, pois em toda criação teremos os pontos positivos e negativos.

As crianças e os adolescentes viraram alvos dos algozes, que se aproveitando desta fase, no primeiro momento de total inocência e depois achar que de tudo sabe e está preparado para a vida. E em ambas as fases, encontraremos malfeitores dispostos a se utilizar de tal vulnerabilidade para praticar suas condutas criminosas.

Concluímos que os cybercrimes atingem internautas do mundo inteiro, porém alguns países já dispõem de lei e políticas de prevenção. No Brasil, as leis que foram sancionadas são muito brandas, somadocom a falta de material humano especializado para aprofundar as investigações e localizar os criminosos. Além disso, temos uma carência de políticas de prevenção que, ao nosso ver, deveriam começar pelos pais e pelas escolas, com objetivo de reduzir a chance do alvo infanto-juvenil ser vítima de crimes,os quais poderão trazer efeitos negativos por toda sua vida.

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Analysis of the Geochemistry of the background sediments the Cotunguba River, Feira Nova-pe, according to parameters of the Conama Resolution 344/2004

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Abstract— The release of untreated effluents in accordance with current legislation, as well as carrying them through rains, pesticides used in farms and agricultural areas, aims to analyze the quality of sediments and the level of toxicity with trace metals. Existing on the Cotunguba River, Feira Nova - PE, since, together with the Capibaribe River, they feed the Carpina Dam, a source of water supply for approximately 250 thousand inhabitants. The analysis of the samples of these sediments took place through collections in 4 strategically positioned points, previously treated in the Environmental Analysis Department of the University of Pernambuco and sent to the Sediment Analysis Laboratory of the University of Ontario - Canada, for cataloging the minerals as well. As for detecting trace metals with potential for pollution, using the methods FUS-ICP (Plasma Coupled by Fusion Induction), TD-ICP (Plasma Inductively Coupled by Total Digestion) and INAA (Instrumental Neutron Activation Analysis), adopted in the CONAMA parameters. At all collection points, it was observed that the level of sediment contamination, for some elements, already has levels above the recommended, in particular, mercury and lead, giving rise to mitigation actions, while, in others, the level of toxicity behaves within the parameters set by the environmental control bodies, both in Brazil and in the world. The consolidation of the results indicates that although one of the metals (Hg) is above the recommended parameters, most of them are below or within the range of acceptability for this type of contamination.

I. INTRODUCTION

In the history of urban formation, rivers were important sources of immediate supply, both for the populations installed on its banks and for those who used it on an interim basis. From the end of the 18th century, when urbanization occurred more intensively, in European countries and northern western countries, an imbalance in these environments was promoted, resulting in many cases of

their degradation. In Feira Nova, Agreste of Pernambuco, this process, although it occurred only from the 80s of the 20th century, was no different and the advent of urbanization has severely affected the homeostatic pattern of environmental systems in almost all of it. Above all, endangering the "life and function" of river courses in the entire urban area and part of the municipality's rural area.

This paper presents an analysis of the Cotunguba River, with the perspective of understanding the environmental dynamics of the river ecosystem from the perspective of environmental geochemistry. Being one of the main tributaries of the right bank of the Micro Bacia do Médio Capibaribe, in addition to being one of the courses that feed the dam in the municipality of Carpina, the second largest dam in the State of Pernambuco with approximately 270 million m3 (APAC, 2013). It supplies around 250 thousand inhabitants and its coverage area involves six municipalities (Carpina, Feira Nova, Lagoa do Carro, Lagoa de Itaenga, Limoeiro and Passira).

According to Kopen, the Climate the Agreste of Pernambuco is classified as As', which in itself already has low rainfall, something that varies between 600mm and 800mm per year. These climatic characteristics already position most rivers as intermittent. In addition, constructions of small dams, which serve as a water reservoir for cattle or for irregular irrigation, considerably decrease the flow of water in River. Only during the rainy season do these dams overflow, while , in the rest of the months, they serve as fetters for the natural sequence of the river, as well as for the purpose of the same.

As a consequence, practically, there was a considerable extinction of riparian forests because the owners of these localities used the trunks of trees to make fences for cattle raising or to isolate their properties, further aggravating Rivers existence. Today, they are rare. the locations where the river has an area covered by its riparian forests.

Sediment exploration, which occurs through sand and clay miners for civil construction, should also be considered. This activity has been increasing on the banks of the river under study, both in the area occupied by it and belonging to the municipality of Feira Nova, more recently, and in the municipality of Passira. In the latter, for at least two decades.

The use of the river for disposal of solid waste and domestic and industrial effluents has been another problem in the urban area of the municipality. Even though the city is being sanitized, it does not treat waste properly and this corroborates the degradation of River, because when it reaches the urban area, this environmental aggression is visible.

Another important environmental issue is the disposal of industrial waste from the flour industries, a significant economic activity in the municipality. Considered one of the largest producers in the State, culturally and officially recognized the "Terra da Farinha", according to State Decree of December 2013, nº 1730/13 (PERNAMBUCO, 2013). Other industries installed in the region also contribute to the disposal of waste on the riverbed.

II. LITERATURE REVIEW

2.1 The Improper Release of Effluents in Rivers

The advent of industrialization dating from the end of the 18th century, added to the urbanization process, aggravated by the intensification of the rural exodus, the continuous growth of cities and the search for jobs and services, marked a new phase in the way man started to relate with the environment and the resources it offers (SANTOS, 2006). Because these large centers are mostly located on the banks of important rivers and as the use and occupation of these spaces took place, their original structure was gradually being compromised (SOUZA, 2000).

One of the biggest problems faced by these rivers is the improper discharge of effluents into their waters (SOUZA, 2000). It is important to note that it is not a question of not discharging these effluents, because, in view of so many demands and the dizzying growth of the world population in the last century, it would be practically impossible not to use this instrument. However, what is being questioned is how these effluents are being discharged and where they are being discharged, according to what is determined by CONAMA Resolution 430/2011 (BRAZIL, 2011), whose content deals with the conditions and standards of effluent discharge in receiving water bodies. In practically all the resolution, it is sought to parameterize the discharge of these effluents, pointing out the ways to carry out these processes.

CONAMA aims to regulate these launches, parameterizing launch standards (CONAMA, 2011), but which in most cases is not respected. Perhaps because they perceive the fragility of the inspection process, even the perspective of impunity. The fact is that although the country has one of the most current and complete environmental legislation on the planet, what is identified in practice is very different from what is found in theory.

Studies that prove that these parameters are almost always not respected are not uncommon. In the measurements made, there is an excessively higher launch than those predetermined by CONAMA. These releases are noticeable, for example, with regard to domestic sewage, as according to the Brazilian Institute of Geography and Statistics,

practically 60% of all Brazilian cities are without basic sanitation (BRASIL, 2017).

2.2 Sediment Analysis in Rivers.

To assess the level of pollution or contamination of water slides, at least two collection instruments are usually used. The first and most common, in addition to presenting faster results, occurs in the analysis of water. The second, with more consistent and accurate results, occurs when the sediments of these bodies are analyzed (ARINE, 2000)

The record of effluents discharged into rivers is easily identified in an analysis of the water in that space, however, if the release is punctual and sporadic and depending on the quantity released and the flow of this water body, results may occur that may differ from the real situation of what you want to observe. For that, the periodicity of the water body analyzes must occur in a very short interval between one sample and another, because, as already said, there may be divergences between the results, as well as, a false result (ARINE, 2000).

On the other hand, when the analysis takes place in the sediments of these bodies of water, the chances of success in these exams are considerably greater. This is due to its ability to retain and accumulate contaminating species from the water column. Sediments have been widely used to indicate the level of pollution and environmental contamination, since they integrate all the processes that occur in the adjacent aquatic and terrestrial ecosystem (SOUZA, 2013).

In general, these effluents are transported to the sediments by leaching caused on the continents, mainly as adsorbed or co-precipitated species such as Fe/Mn oxy-hydroxide films and in organic matter. With the reduction of oxy-hydroxides, these metallic elements are deposited in aquatic systems (FORSTEN AND WITTMANN, 1983, p. 486).

The concentrations of contaminants in sediments are much higher than in waters, which makes it possible to use them as a good indicator of environmental contamination, both current and past, also enabling knowledge of the main sources of pollution, (JESUS et al., 2004).

Bryan and Langston (1992) affirm that the concentrations of metals in sediments can, in some cases, exceed the orders of magnitudes present in the waters in five times and that the transformation into organo-metallic compounds, depending on the medium, can greatly increase the its toxicity, especially in the case of lead and mercury.

The identification of these contaminants in sediments is an important step in the mapping of polluting sources, since it is possible to build a process of environmental characterization of the main polluting agents (JESUS et al., 2004). The actions that may result from the mapping of

these trace metals present in the sediments, can result in important mitigating interventions in the recovery of the environmental balance of these ecosystems (VOLPATO et. Al., 2017).

It is also important to consider that, based on the results presented in the analysis of these sediments, in finding a number above what determines the parameters of CONAMA, in its resolution 430 of 2011, both the government and the private sector can, through educational actions, mitigating and remedial actions, seek to resolve these problems.

Among the main polluting agents found in sediments and, which cause concern because they pose health risks, the most common or recurring agents, according to Arine (2000), Souza (2013) and Volpato (2017), are: cadmium, lead, arsenic, barium , mercury, sewage, hydrocarbons, POPs, among others.

The presence of these trace metals in sediments also plays a testimonial role in a polluting process (CARVALHO, 2014). It is possible to verify from which period the contamination was installed and, therefore, it is possible to map the probable sources of this pollution. With this mapping in place, actions to mitigate or eliminate these polluting sources become easier and more effective. It is true that despite the contribution of the Brazilian environmental legislation, the application, monitoring and results, almost always do not follow its contemporaneity.

The evils resulting from both water pollution and sediments are diverse and have direct and complex implications, whether in the physical environment or involving humans. This occurs through the distribution of water to the population or through the irrigation process of agriculture. The fact is that the final consumer of these services is impacted and becomes a potential victim of the harm arising from these polluting processes. The WHO already lists a series of side effects in the world population, resulting from the use and/or exposure to these agents. Pathologies that range from allergies, skin irritations, infections, to more aggressive diseases, such as, for example, cancer, malformation and mutations. (WHO, 2015).

III.   MATERIALS AND METHODS

The work was initially based on cabinet studies, with bibliographic review, covering themes such as, for example, management of water resources, effluents and solid waste based on the concept of environmental diagnosis through the identification of geochemical parameters in sediments in the river bed of the Cotunguba River. In a methodological perspective, applied with the qualitative axis (insofar as it identifies the environmental forces), having in Minayo

(2008) its main theoretical and quantitative reference (when it allows the measurement of the levels of toxicity concentration of polluting elements in river sediments) , based on what Marconi and Lakatos (2010) propose.

With the obtained data, cartographic materials were processed using specific software (Q-GIS, Google Earth), based on data from SIRGAS 2000. These data made it possible to locate the study area, as well as the sediment collection sites. for laboratory analysis, in addition to the

territorial layout of the Cotunguba basin, for a better understanding of the studied space.

In the second stage of this work, sediments were collected that were removed from the riverbed in four different points, properly georeferenced, using a GPS equipment, model GARMIN, version ETREX 10, taking into account the social, economic and spatial importance of the points demarcated for collection, as can be seen in figure 1 and table 1.
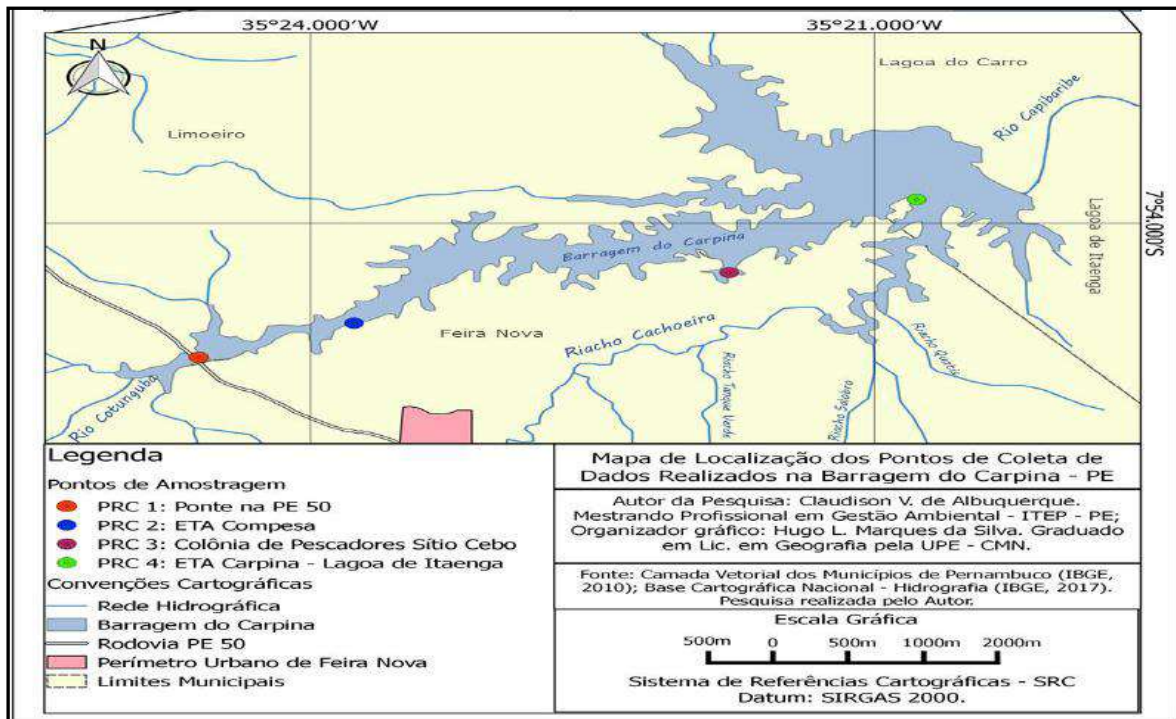
Fig.1: Map of the Cotunguba River, marking the collection points.

Source: Author / 2019.

Table 01 - Points of Collection of the Sediments Samples of the Cotunguba River.

POINT	LONGITUDE WEST	SOUTH LATITUDE
PRC 01	35º, 24' e 36,6"	7º, 55' e 17,5"
PRC 02	35º, 22' e 21,1"	7º, 54' e 22"
PRC 03	35º, 17' e 13"	7º, 52' e 48
PRC 04	35°,20' e 23"	7°,53' e 33"

Source: Author / 2019.

The choice of visit points considered the different sectors studied in order to contemplate a region of about 10km in length. Samples were also collected for laboratory analysis of the following trace metals: Cd, Cr, Hg, Ni, Pb and Zn.

The collected sedimentary material, "04 samples", was packed in plastic bags, identified with a label and transported to the Environmental Monitoring Laboratory of the University of Pernambuco, for drying in an SLL

greenhouse, model VDO9210, for 72 hours at a temperature of 35º.

After drying, the sample was sieved, then disaggregated, comminuted and homogenized in a mortar. The material was properly packed, packed in polyethylene jars, sealed, labeled and sent to the Chemical Analysis Laboratory of the University of Ontario - Canada (ACTLABS) for analysis and identification of the composition of the sediments, both

of natural components, as well as of elements introduced by the anthropic action, figure 02. A part of this treated,

disaggregated and comminuted material was kept in a dry and ventilated place to be used as a proof, if necessary.

Fig.2: Preparation of Comminution, Packaging and Labeled Sediments for laboratory analysis

Source: Author / 2019.

The other 50% of the samples were sent to the Department of Soil Sciences at CTG / UFPE for granulometric analysis. All analyzes were performed on the total sediment (ST).

Fig.3: Photo Mosaic with the preparation of the sediments for granulometric analysis.

Source: Author / 2019.

The methods used to obtain the results were those of FUS-ICP (Plasma Coupled by Fusion Induction), where an oxidized sample is dissolved in a borate flow and then diluted in aqueous nitric acid; o TD-ICP (Plasma Inductively Coupled by Total Digestion), when a sample is

digested via the sequential addition of hydrofluoric, perchloric and nitric acids. The acids are evaporated and the residue is reconstituted in aqua regia and; INAA (Instrumental Neutron Activation Analysis), whose samples are bombarded with neutrons to generate radioactive

nuclides. Measurement of energy and intensity of alpha particles generated by subsequent decay is used to quantify the various elements present in the original sample.

IV.   RESULTS AND DISCUSSION

4.1 Analysis of the Cotunguba River Sediments According to the CONAMA Parameter Resolution 344/2004.

The parameter to be used for analyzing the results of this work is that of CONAMA resolution / 344 of 2004. It establishes two levels of pollution for sediments, with level 1 for the unpolluted and level 2 for the tolerable limit of pollution with medium impact. Regarding the trace metal parameter for sediments, CONAMA uses the standards referenced by USEPA and EC, whose main references are Long et al (1995/1998) and Thomas (1987). Table 2 shows how the numbers of the river under study behave.

Table 2- CONAMA / 344 parameters. Pollution degree of sediments according to concentration of metallic species. Comparison with the sediments of the Cotunguba River.

POLLUTANTS	LEVEL 1	LEVEL 1	PRC-01	PRC-02	PRC-03	PRC-04
Cd – ppm	0,6	35	<0,5	<0,5	<0,5	<0,5
Cr – ppm	37,3	90	45*	25	37	58
Hg – ppb	0,17	0,480	8	<0,5	7	9
Ni – ppm	18	35,9	18	7	7	12
Pb – ppm	35	91	34	61	28	13
Zn – ppm	123	315	64	41	48	42

Level 1 - Unpolluted; Level 2- Tolerable limit, with medium impact. * limit above the tolerable.
Source: Author / 2019.
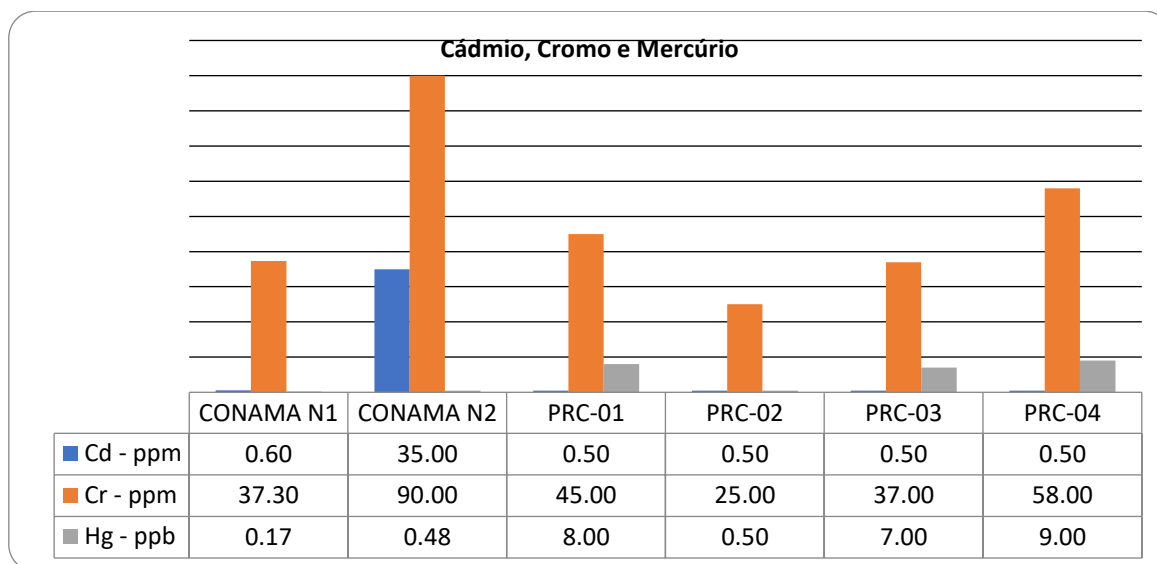
Graph 1 - Comparative Analysis of Cd, Cr and Hg with the CONAMA parameters.
Source: Author / 2019.

The cadmium element, as well as in other parameters, appears below the recommended minimum, therefore, presenting indices that do not cause damage to the biota and fit within level 1, that is, they are considered as unpolluted sediments. The chromium element, on the other hand, is above the minimum acceptable in points 01 and 04, while in point 03, it borders the minimum limit, except for point 02, which has a content well below the determined level.

Mercury, on the other hand, presents high rates in all analyzed points. The lowest incidence is in point 02, however, in the others, it is practically 1,800% higher than the other samples.
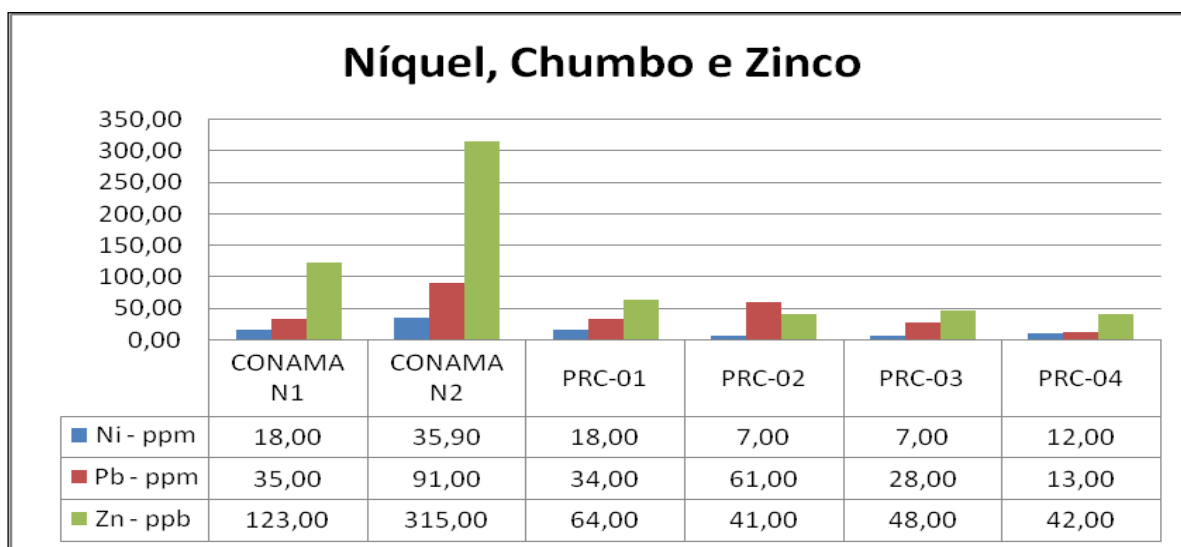
Graph 2 - Comparative Analysis of Ni, Pb and Zn with the CONAMA parameters.

Source: Author / 2019.

Nickel levels show indices within the standard of uncontaminated in practically all samples, and in point 01, the toxicity content is already at the beginning of what CONAMA considers polluted, even if it is in the basic contamination pattern. As for lead, they already present some samples within level 1, with levels of pollution, but all within what it considers to be of medium impact, because in none of the cases analyzed, the numbers exceed the maximum values, however, it must be considered that point 02 is on average 50% more polluted than point 01, more than 100% in relation to point 03 and practically 400% more polluted than point 04. Finally, zinc behaves in all samples below the minimum standard pollution, with a certain stability between points 02, 03 and 04 and with an index slightly above the other samples in 01.

When analyzing the other hydrographic basins in Pernambuco and the country, using the CONAMA / 344 resolution, it can be seen that practically all of them fit into level two, with medium impact situations, when the elements in question are Cd and Zn. When the element under study is Cr, the numbers are very considerable and appear above the maximum tolerable limit, as is the case of the Cabo Basin (ARAÚJO, 2014), with almost 90% of content above the average, São Francisco (PEREIRA , 2017), something around 70% more. This can be seen in more detail in graphs 3 and in table number 3.

3.2 Analysis of the Cotunguba River with the other Pernambuco Basins

In addition to the analysis of sediment samples collected in the Cotunguba River having been parameterized with RESOLUTION 344/2004 of the National Environment Council - CONAMA, the results of the river under study were also compared in Table 3 and Graph 3, with the results obtained with other hydrographic basins in the state of Pernambuco and Brazil.

Table 3 - Comparison of the level of sediment pollution in the main hydrographic basins in Pernambuco and Brazil.

Metais Traços	Capibaribe (Belo Jardim)	Amazonas	Cabo	São Francisco	Cotunguba
Cd – PPM	SP*	39	20	SP	<0,5
Cr – ppm	SP	SP	160	154	41,5
Hg – ppb	SP	SP	SP	SP	7
Ni – ppm	SP	40	70	50	11
Pb – ppm	93	SP	72	134	34
Zn – ppm	SP	127	450	279	49

	Paiva 2005	Siqueira et al 2006	Araújo 2014	Pereira 2017	

Source: Author / 2019. SP – No Parameters for the case study.

Only the rivers whose studies took place under the same geochemical conditions were analyzed and compared, that is, hydrographic basins versus hydrographic basins, since the processes and dynamics are similar, as there are no different geological and chemical factors. Although studies and results from estuarine areas are cited here, the intention is not to make analogies between them, but only to demonstrate that regardless of the river segment (source, tributaries, sub-effluents, mouth, estuaries, etc.), the effluent inputs and trace metals have already reached them.

	Capibaribe (Belo Jardim)	Amazonas	São Francisco	Cabo	Cotunguba
Cd - ppm	0	39	0	20	0,5
Cr - ppm	0	0	154	160	41,5
Hg - ppb	0	0	0	0	7
Ni - ppm	0	40	50	70	11
Pb - ppm	93	0	134	72	34
Zn - ppm	0	127	279	450	49
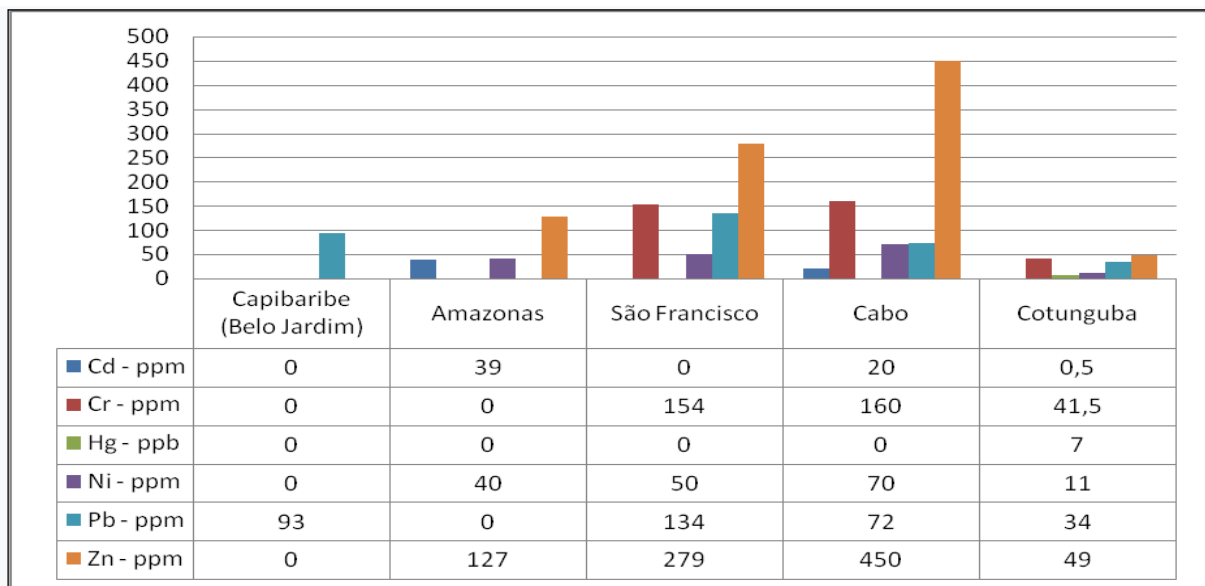
Graph 3 - Comparison of the pollution level of the sediments of the Cotunguba River with the other hydrographic basins of Pernambuco and Brazil.

Source: Author / 2019. * the number 0 represents the absence of parameters for the river under study.

When comparing the numbers obtained by the results of the sediments samples from the Cotunguba River with the other rivers already studied in the state and in the country, by parameters of institutions such as USEPA, EC, CONAMA, among others, considerable variations in content are perceived at certain times. of toxicity between rivers for similar elements, even though anthropic factors are the cause of the main inputs.

In the general picture, in practically all the elements of the other rivers in analysis are above that presented by the study in question. Some aspects point to possibilities for understanding the peculiarities of some river systems and uniqueness when analyzing these resources holistically. Therefore, some elements need to be presented:

a) Industrialization Factor: all rivers analyzed, with the exception of Cotunguba, run through at least one area with industrial concentration. As already said, the control of effluent emissions does not respect what the legislation determines and they end up dumping their waste into these rivers, compromising the quality of their water and sediments. Undoubtedly, the most affected of them is the Capibaribe River, which from the municipality of Santa Cruz do Capibaribe, through Toritama and Caruaru, the so-called textile pole, has no control over the discharge of its effluents into the riverbed. As the river approaches the coast, the tendency is to worsen, as it also receives effluents in the city of Limoeiro, Paudalho, São Lourenço da Mata, Camaragibe until it reaches Recife. Not very different, we have the rivers that make up the Cabo Basin in the municipality of Cabo de Santo Agostinho, São Francisco Basin, in the stretch between Petrolina and Juazeiro and the Amazon River, just after the confluence between the Negro and Solimões Rivers, which ends suffering from the same problems. As Cotunguba is not exposed to this factor, part of the elements indicates numbers within the acceptable range and well below the other rivers in the State.

b) Basic Sanitation Factor: another point that must be considered is the issue of basic sanitation, since just over 40% of the country has an effective public sanitation policy, with the North / Northeast being the region with the lowest index and the Southeast and Southeast regions. South and those with the best results in this segment (BRASIL, 2015). It should be noted that the failure to effectively treat sanitation causes serious and diverse problems to health, the environment and why not affirm, also, the economy. On the other hand, the lack of environmental awareness among the population, further aggravates these aspects.

In view of all this, in several municipalities where rivers were analyzed in Pernambuco, including the study in question, it was found that practically 100% of domestic sewage is discharged directly into the river. The fact that Cotunguba is located in a sub-region, with low population density, justifies smaller launches in relation to the other rivers mentioned, which in several cases, cut municipalities with populations in the hundreds of thousands of inhabitants. Naturally, with the constancy with which this process occurs, even though some elements have a small content, their accumulation ends up being extremely harmful to the life of the river and to those who depend on it.

c) Deforestation: it is also necessary to consider that, with the expansion of agriculture, especially the monoculture of sugar cane and livestock, deforestation has accelerated in recent centuries. According to IBAMA (2011), in Pernambuco, it reached 93% of the entire Atlantic Forest. However, this problem was not restricted exclusively to the Atlantic Forest biome, much less to the Brazilian colonial period. The advance of deforestation in other ecosystems has been a recent action, especially in areas close to estuaries and marine vegetation, for the exploration of tourism. Even in regions with a lower density of vegetation cover, such as Agreste and Sertão, the advance of deforestation is real. All of this directly contributes to carrying effluents that, when decanted into rivers, intensify the process of pollution of their sediments.

c) Agriculture: another factor that must be considered in this context is the issue of agriculture. In addition to the deforestation process, which it demands, it is also associated with this, the use of agricultural pesticides (POPS), to control pests in animals, as well as the use of fertilizers and pesticides in crops aimed at feeding cattle. The indiscriminate use of these products contributes to the contamination of sediments, through the process of leaching and carrying, making most of the rivers in Pernambuco, especially those located in the Zona da Mata do Estado, be polluted. The irregularity of the rains ends up being an aggravating factor for the intensification of the pollution process, occurring a decrease in it, when the rains are more constant, as stated by Lima (2008), when observing that in the areas where the Botafogo River was perennial the pollution content was less than the areas where the river was intermittent.

The collected samples make it possible to identify the current situation of the environmental conditions in which the region finds itself. Especially when considering the following factors: territorial dimension of the mouth of about 10 km in length, intermittent regime and uniqueness of the multiple uses of the river, based on irrigation, urban supply, mining and effluent convergence. This allows a diagnosis aimed at a qualitative analysis, identifying its main inputs. Consider also that for the analysis of bottom sediments, great diversity of samples is not necessary.

The general context of the situation of the sediments of the Cotunguba River in the section that approaches its mouth, indicates changes in the environmental balance, all of which are the result of anthropic actions. The deforestation of riparian forests and the basin's surroundings, the direct release of effluents (domestic and industrial) into the river, the indiscriminate use of fertilizers and pesticides in agriculture, those of pesticides in livestock and the disposal and storage of solid waste produced by the population of the cities that make up the river basin are the main causes for this scenario.

V.   FINAL CONSIDERATIONS

Sediments are important sources for identifying the most diverse forms of pollution, especially trace metals. Corroborating with this, the study of the material of the Cotunguba River, in the municipality of Feira Nova - PE, brings valuable information and in certain points of concern regarding the level of contamination by trace metals in its sediments, resulting in serious problems to human beings. and the entire existing ecosystem in its surroundings.

Anthropic actions arising from the advancement of urbanization and industrialization, the absence of more effective public policies and the non-compliance with existing laws in the country, as is the case with the law on solid waste and the discharge of effluents, showed, through the samples, that were collected and analyzed, that practically all the analyzed points have at least one highly polluting chemical element, above the parameters acceptable by the control bodies (CONAMA).

The presence of trace metals such as chromium, mercury and lead in the PRC1, PRC3 and PRC4 samples, well above the tolerance levels and the most diverse evils caused to all biota, resulting from direct or indirect contact with these elements, give rise to urgent actions and effective in order

to mitigate the impacts caused by them and ceasing the continuity of their launches in the waters of the Cotunguba River and, consequently, in their sediments.

 Appropriating this information, equips the public authorities with instruments that make it possible to act with more objectivity and effectiveness in preventing actions of this nature. In addition, it also equips civil society (control agencies, non-governmental organizations and the press), important actors in the process of collecting and inspecting actions, both from their peers and their representatives.

However, it is also important to consider that one should not expect only the actions of the public authorities. A continuous work of environmental awareness of the population that resides in the municipalities that are part of the river's hydrographic basin and that uses the waters of the dam, including mainly, the riverside, needs to be implemented urgently, because part of the contamination process that has occurred , in a systematic and continuous way, has been caused by the referred population, even if it does it without intentionality.

Despite so many problems and disastrous consequences, it cannot be said that the history and / or function of this river has come to an end, as some mitigating actions can be taken with the aim of reversing the situation and recovering its "health" and restoring environmental balance. For that, it is enough that the public power is positioned in order to fulfill its role. It should be noted that sewage, in addition to being the main polluter, according to COMPESA data, around 66% of them in the state are not treated before being discharged into rivers, a number that, here in Feira Nova, reaches 100%, since there is no sewage treatment plant, it does not inspect and prevents other agents from doing so. This directly contributes to the wasting of the river.

It is also of considerable concern that, with all this polluting action, the water that is offered to the population supplied by the dam, is not of a satisfactory quality and that meets the requirements of CONAMA legislation for use and supply. Therefore, a study of the river sediments, as well as a good job of characterizing the area, can contribute considerably for the services provided to improve, directly influencing the quality of life of people, the main object of public power, as well as reducing costs and processes in their treatment and offer.

On the other hand, it is not possible to think only about the supply of water to the population and the cost that this may incur on the supplying company. But we need, as stated by Leff (2013), to think about posterity, to treat this issue as a micro situation, but not to forget that it is part of the macro and that ecosystems are integrated, especially those of limnocycles that are today the most susceptible to pollution processes. Therefore, taking care of the surroundings of this

river, mapping potential polluters and verifying through laboratory analysis the situation of sediments in this river, in addition to seeking public awareness and the population in general to raise awareness of care, to maintain and ensure that populations may also enjoy, as this is the real concept of sustainability.

The continuity in the research process in the river in question, deepening and broadening the discussions, is fundamental for the reestablishment of its balance. Aware that this work is just a kick-off and that there is still much to be studied, it is anxious for other studies to emerge and that, with their contributions, may point out ways and measures that aim at Cotunguba's life and sustainability.

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A Solar PV Array Based Multipurpose EV Charger

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Abstract— *This paper describes an electric vehicle battery charging mechanism with solar PV array based multipurpose EV charger. Multipurpose EV charger consists of two converters, one is bidirectional DC-DC converter (BDDC) and other is voltage source converter (VSC). The operation of the EV battery charger is managed in such a way that it is either supplied by PV power or by a grid. Vehicle to the grid (V2G) operation is implemented for improving the stability of the grid during peak load hours and vehicle to home (V2H) is also enabled during islanding mode of operation. For regulating the DC-link voltage from the bidirectional battery converter, a PI control mechanism was provided to this system. The bidirectional DC-DC converter works in buck mode during the charging time of the EV battery and works in boost mode during the discharging time. The charging system operates as an active power filter using voltage source converter (VSC) and the total harmonic distortion (THD) of the grid current lies within the IEEE 519 standard. The various modes of operations are simulated and tested by using MATLAB/Simulink.*

I. INTRODUCTION

Nowadays global warming problems and gasoline prices are boosting day by day. An electric vehicle attracts more attention because of its clean and environmental friendly features. This paper is a solution to meet the basic transportation needs in a greener way. The electric vehicles readied with an energy storage device can be connected to the grid when they are not in use so that a high scale of energy for grid power can be supplied. The integration of energy storage along with distributed energy sources improves the power quality of the grid also. An electric vehicle offer low carbon emission, compression of greenhouse gases and is eco-friendly in nature. The main challenges for an electric vehicle charging mechanism is the lifetime of the battery and charging time. The anxiety among people dealing with the technology of EV is the limited driving range, long charging time and economical aspects. Long charging time would affect the performance of fast charging strategies and related new devices are

developed to improve the charging time. Before moving towards EV technology the infrastructure should be arranged for reliable operation of EVs which includes charging station and EV service station [1]. The charging station plays a key role in EV technology and it should be easily accessible. The solar PV array based charging station location should be in a solar irradiance available area. The charging time of EV should be reduced and precise battery management solutions should be executed for the long driving range [2], [7]. Solar energy conversion system is a renewable energy source that is available in generous and free of cost worldwide. Solar PV is used to transform solar energy into electrical energy. Solar PV cells have nonlinear characteristics and their efficiency is low. The DC power output of the solar PV cell varies with solar irradiation and ambient temperature. A solar PV array-based charging station is presented in this paper to prevent the overloading of the grid and also to minimize the operational cost of the charging station [3]. In this system, the boost converter is abolished and the solar PV

array is connected directly to the EV battery through a bidirectional converter. The voltage regulation for battery charging is done by the bidirectional converter connected to the EV battery. Therefore, this bidirectional multipurpose EV charger is a retrofit solution to the prevailing single-phase bi-directional charger with a modification in the control algorithm [4], [6]. The proposed charging system has the following unique features,

1-Solar PV array-based multi-purpose EV charger provide Vehicle to Grid (V2G), Vehicle to Home (V2H), and Grid to Vehicle (G2V) operation [5].

2-The proposed system will act as an active power filter for reducing the harmonics in the grid current.

3- The THD lies within the limits of the IEEE 519 standard during the   power exchanging.

II.   SYSTEM CONFIGURATION

The described system topology is shown in Fig. 1. It consists of a single-phase bi-directional dc-dc converter that connects the EV battery directly on to the DC bus. A single phase VSC is provided for grid interconnection. Solar PV array-based EV charger is used for the multi-functionalities like EV charging from PV and grid, V2H operation and V2G operations. In the irradiance time of PV, the EV charging will occur and in the absence of PV irradiance, it can charge the EV from the grid. In the peak hour, it will discharge from the battery to the utility grid and also for home purposes. The EV battery is connected to the output of the bidirectional DC-DC converter (BDDC). This DC-DC converter in this charger accomplishes various tasks. While charging the EV battery, the DC-DC converter works in buck mode and operates in boost mode while discharging the EV battery. The proposed charger is connected to the grid through the coupling inductor (Lb). A coupling inductor is needed to eliminate the harmonics and to smoothen the grid current. This is the basic principle of the proposed system.

Fig. 1: Circuit diagram of the solar PV array based multipurpose EV charger

III.   CONTROL MECHANISM

Two main control mechanism are mentioned here. This includes bidirectional DC-DC converter control and grid control mechanism. The need for this control mechanism is,

1) to balance the energy flow in the system

2) production of reference grid current for active power flow

3) charging/discharging current control of EV battery by controlling the bi-directional DC-DC converter

The energy balance in the system and harnessing of solar PV array power are attained by governing the DC bus voltage. However, the active power control to the grid is attained by the grid current control [8].

i. Bidirectional DC-DC Converter Control

The purpose of the bidirectional dc-dc converter control is to regulate the DC bus voltage using voltage control as outer loop and current control as inner loop. The control mechanism is demonstrated in Fig. 2. The MPPT (Maximum Power Point Tracking) algorithm follows the reference DC bus voltage (Vmpp reference) during solar to EV charging. In the absence of solar PV irradiance, the DC link voltage is regulated at 360V by the bidirectional converter control. The DC bus voltage regulation is done by a proportional-integral (PI) controller. The error voltage of the DC link voltage on comparing with actual DC link

voltage is connected to a PI controller. The output of the voltage loop PI controller is then compared with the battery current. The error signal obtained is then connected to the current loop PI controller and then the switching pulses of the bidirectional dc-dc converter is generated by using a PWM generator. When the solar irradiance is low the reference of voltage loop is given as 360 V and when

during sufficient solar irradiance, Vmpp (voltage corresponding to maximum power) is given as reference. During V2G operation, Ibref is provided with the required current to be injected to the grid. During G2V operation, the reference voltage required for battery charging is provided as reference.
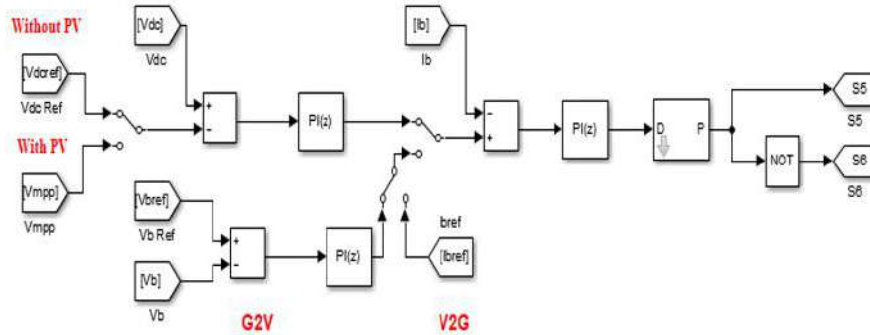
Fig. 2: Bidirectional DC-DC control of the system

ii.   VSC Control

The VSC control as shown in Fig. 3 is used to control the grid current for controlling the power flow. The output of the outer voltage loop PI controller gives the magnitude of the reference grid current (Igref) and using a hysteresis control, the grid current (Ig) is controlled. The proposed system will act as an active power filter with the THD

value of grid current less than 5%. S1, S2, S3, S4 indicates the switching pulses to the voltage source converter. The vehicle to grid control is done by using a PLL controller. It is a voltage driven oscillator that constantly adjusts to match the frequency of an input signal. The PLL controller also helps to generate, stabilize and modulate the signal from noise.
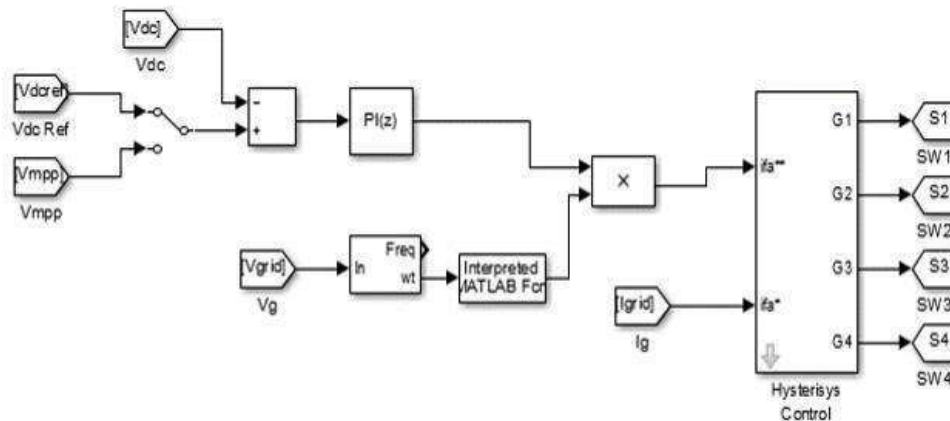
Fig. 3: VSC control of the system

iii.   Operational Strategy based on SOC of Li-ion Battery

The energy management strategy of the proposed charger is shown   in the Fig. 4. This strategy is based on the SoC of battery under different operating conditions. Here the measuring of SOC is set in between the lower limit of 0.2

and upper limit of 0.9, and   the various modes of operation of the system are defined. When solar is not available and SoC of Li battery is less than lower limit of 0.2, load shedding is done.
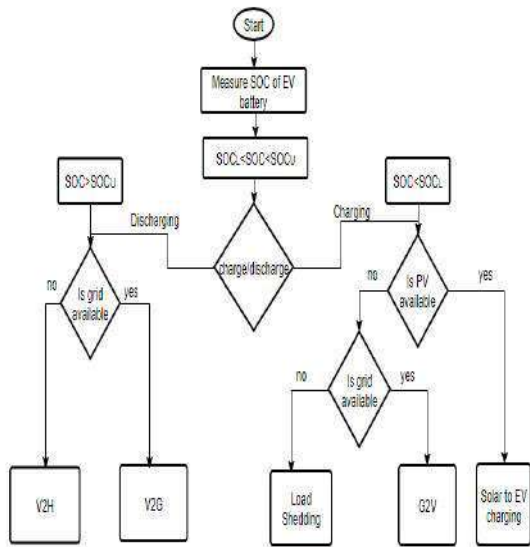
Fig. 4: Operational strategy

IV.   SIMULATION STUDIES AND RESULTS

Simulation of the proposed charger is done in MATLAB/Simulink. The system is tested for solar to EV charging, grid to EV battery charging and EV battery to home operation. The parameters used for simulation are shown in Table.1.

Table.1: Simulation Parameters

Components	Values
Switching frequency	50 kHz
EV battery	240 V, 10 Ah
Cdc	1100 µF
C1, C2	1000 µF
Lb	8 µH
Lc	5 µH
PV array Vm, Im	396 V, 21 A

A. Solar PV Array to EV Battery Charging Mode Operation

The EV battery is charged from solar panel and the resultant waveforms obtained are shown in Fig. 5. From this waveform we can analyze that, at the charging time the battery voltage increases, SoC of battery increases and battery current is negative. The EV battery is charged in constant current/constant voltage (CC/CV) mode.
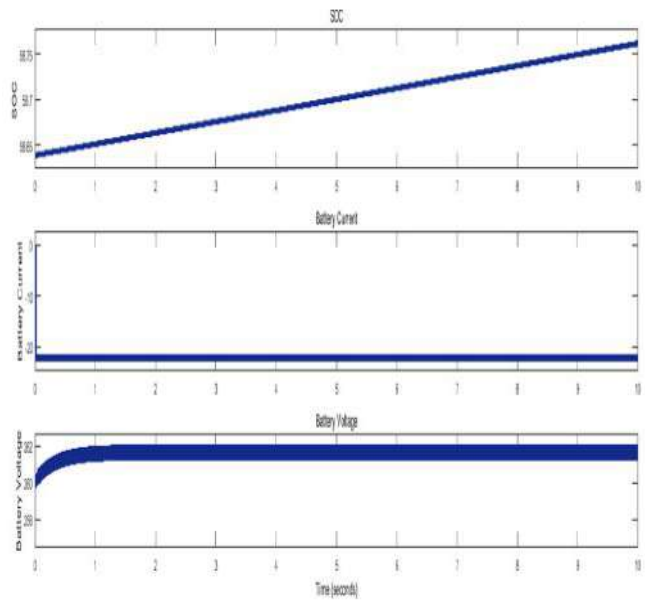
Fig. 5: Solar PV array to EV battery charging mode operation

B. Grid to EV Battery Charging Mode Operation

The grid to vehicle charging is illustrated in Fig. 6. During the vehicle charging, the battery voltage is increasing, SoC of battery is increasing and the battery current is negative.
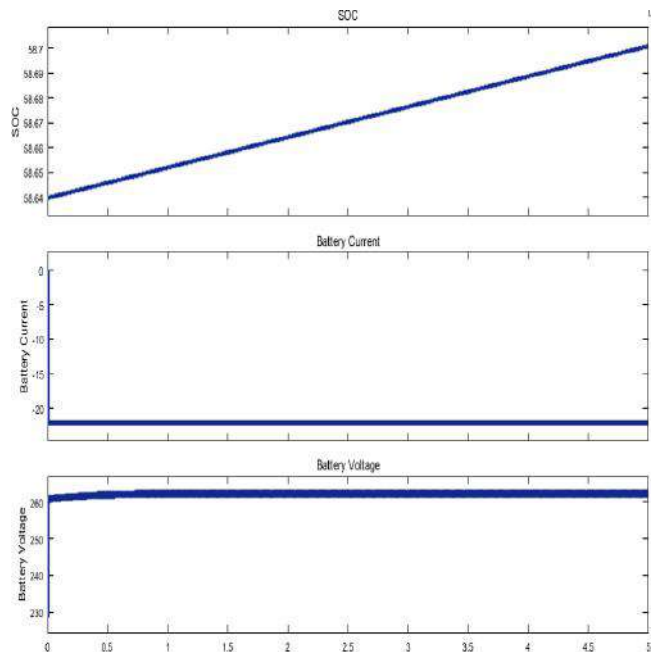
Fig. 6: Grid to vehicle (G2V) charging operation

C. EV Battery to Home Load Discharging Operation

The vehicle to home (V2H) operation is shown in Fig. 7. The load may be linear or non-linear. Here a linear load is used.
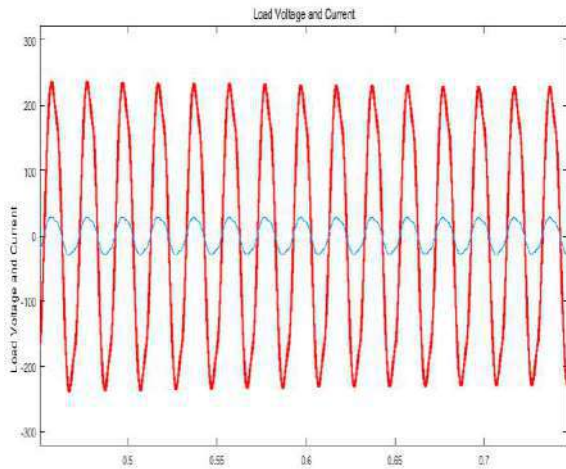
Fig. 7: Load voltage waveform of V2H operation

D. EV Battery to Grid Discharging Operation

In Fig. 8. shows the discharging mode of V2G operation. Here the battery voltage is decreasing, SoC of battery is decreasing and battery current is positive indicating discharging operation. Here it is showed that the EV charger is also controlled to operate as an active power filter for achieving the unity power factor (UPF) operation. The THD measurement waveform for grid current is shown in Fig. 10.
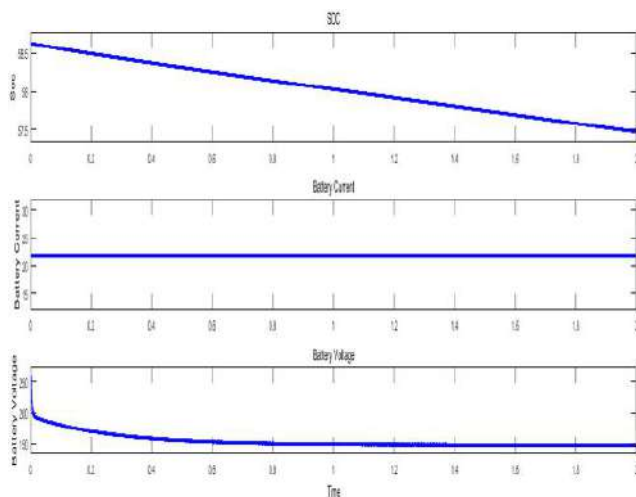
Fig. 8: Vehicle to grid (V2G) discharging operation
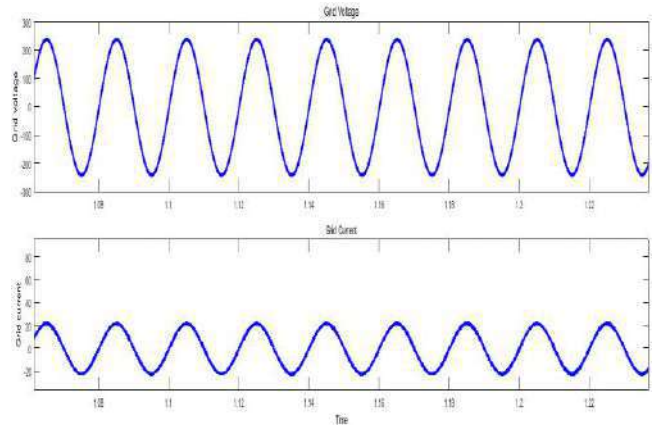
Fig. 9: Grid voltage and grid current waveform
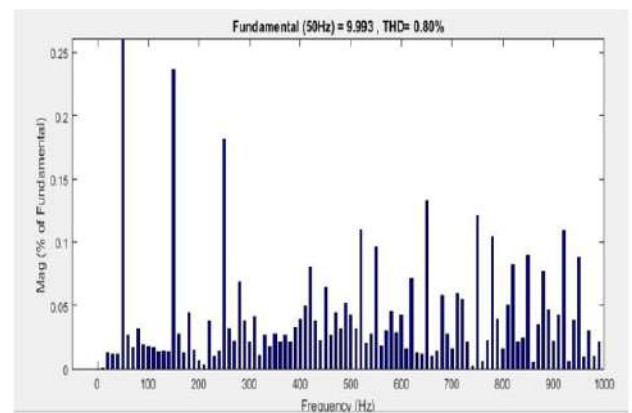
Fig. 10: THD measurement of grid current

V.   CONCLUSION

In this paper, a solar PV array based multipurpose EV charger is presented. The mentioned system consists of an integrated charger with solar PV array, linear load and grid which has been implemented using IGBT switches and they are provided with suitable controlling methods. The solar PV charging is directly done here without using a boost converter that will reduce the circuit complexity. By using this proposed topology we can do both charging and discharging. So this charging system meets the requirements of household loads, EV and the utility. From these test results, it is observed that this charger is performing its specified task of EV charging, supplying local home loads and maintaining the power quality at the grid side. The charger is also controlled to operate as an active power filter for achieving the unity power factor (UPF) operation and total harmonic distortion (THD) of the grid current is within 5%.

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Analysis of the Agroecological Zone Method in Predicting the Impact of Climate Change on Agriculture

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Abstract—Agriculture is an activity dependent on environmental conditions and with the predicted climate changes, serious influences on crops are likely to occur, and prediction studies are important in order to minimize the impacts on agricultural production. The present work is the result of consultations to scientific works published on the proposed topic. It was found that extreme heat increases and greater risks of drought are expected in Brazil and that the Agroecological Zone Method is one of the most used for modeling in which it is desired to verify the impact of the water deficit on plant production, being of easy application, understanding and your results are close to reality. In this situation, depletion in plant production is considered only as a function of the reduction of water available to the plant, which is interesting for verifying the influence of future climate change scenarios on plant production. However, it has the disadvantage of not considering the attack of pests and diseases, which are influenced by climate changes. The importance of reinforcing resilience in agroecosystems is also highlighted, not only with plant improvement through the development of cultivars adapted to future climate scenarios, but also with management alternatives. It is concluded that the Agroecological Zone Method is a reliable alternative to verify the effect of future droughts on agricultural production, despite its limitations and that it is essential to plan and combine strategies for adapting to climate change.

I. INTRODUCTION

Agriculture is an activity that is extremely dependent on climatic elements, such as temperature, rainfall, humidity and solar radiation, and any interference with one or more of these factors can influence plant development [1].

On the other hand, water is essential for agricultural production, as it is necessary for the process of cell growth and expansion; however, 90% of the water required by terrestrial plants is not used in any biochemical route,

being lost through transpiration [2] and it is through this transpiration process that the absorption of essential nutrients for the plant's development and translocation takes place. of solutes [3].

In this context, once the future scenario of climate change is confirmed, with an increase in the Earth's surface temperature and changes in rainfall patterns, the agricultural sector will certainly be affected. This, in view of the dependence of agriculture on the climate, and changes in this component will directly affect, among

others, the physiology of plants. In the case of Brazil, future projections indicate significant impacts on the extreme precipitation regime, with floods and floods; in addition to increases in extremes of heat and greater risks of drought in the country [4] [5]. Thus, agriculture may suffer from more frequent and severe abiotic stresses, such as drought and high temperatures, and biotic stresses, such as greater occurrence of pests and diseases [6]

There are regions of the country where the productivity of some agricultural crops is still below its potential, precisely because of stresses, considered limiting [6]. To minimize these impacts, research in the area of plant genetic improvement has been carried out in order to adapt agricultural production to climate change, through technologies that generate plants that are more tolerant to stresses such as water deficit, high temperatures and changes in the incidence and severity of illnesses. In this context, it is important to highlight that the cultivation of local varieties by farmers is essential, as in addition to avoiding a major crop problem, it also works as a germplasm bank, which can be used by breeders for the development of cultivars resistant to environmental conditions different, especially to climate change [7]. Thus, the loss of genetic resources and local knowledge can compromise the ability of farmers and breeders to obtain plants that will be resistant to future environmental shocks, as in the case of climate change [8].

Therefore, efforts to minimize the consequences of global warming, as well as actions and policies to adapt and reduce vulnerabilities at a local and regional scale, are essential to reduce the risks to social and environmental security. Cuadra et al. [9] mention that, from a strategic point of view, it will be extremely important to foresee how agroecosystems will meet the increased global demand for food and energy in a sustainable way and in a context in which agricultural productivity may present stagnation or associated reductions to climate change [10] [11]. Therefore, understanding how the plant responds to climatic conditions, directly influencing crop yield, is of paramount importance, as well as understanding how far it is possible to predict the resilience of agrobiodiversity to these changes.

Thus, the objective of this work is to evaluate the Agroecological Zone Method as a way to predict the impacts of climate change on agricultural crops.

II.   METHOD

The present bibliographical review was carried out by consulting scientific works and books published in areas related to the proposed theme in several databases: Scielo,

Science Direct, Scopus, Web of Science, EMBRAPA, Capes Periodicals, FAO, among others.

The following keywords were used for the survey: agrobiodiversity, agroecological zone method, effect of meteorological events, climate and plant interaction, requirement of cultivated plants and plant resilience.

Based on the works found, this review article was constructed.

III.   RESULTS AND DISCUSSION

3.1 Resilience in Agroecosystems

Resilience is the intrinsic capacity of a system to maintain its integrity over time, especially in relation to external pressures [12]. The main characteristic of a resilient system is its flexibility and ability to perceive and eventually create options to face adverse situations. The diversity of alternatives that the farmer perceives, or is able to create, is a central element in building the resilience of the agroecosystem [13].

For a better understanding of the mechanism of resilience of agroecosystems, it is essential to study the impacts of climate change on agriculture, in order to minimize production and quality losses, helping to choose strategies to overcome the problems. Among the main difficulties encountered in this type of study, there is the continuing uncertainty about the exact magnitude of climate change that will occur in the next 25 to 50 years [14].

According to Pinho et al. [15], climate changes are due to the increase in the global average temperature expected for the next decades until the end of the century, which, in turn, is related to the increase in the concentration of greenhouse gases (GHG), leading to a reduction the resilience of ecosystems in all biomes, incurring in loss of biodiversity and ecosystem services and increased exposure and socio-environmental vulnerabilities. Initially, in Brazil, the Caatinga biome is the most resilient to global temperature increase, and the Amazon, Atlantic Forest and Cerrado are the most susceptible to loss of resilience. For the Caatinga, the aridization process is enhanced [16] and spatially advances to other possible areas occupied by the Atlantic Forest, especially in the coastal region [17].

To ensure greater resilience and adaptability to climate risks, it will be important to quantify the risk that agroecosystems will be subject to in different ecoregions in Brazil. This task is extremely complex given the continental dimension of the country, the diversity of crops, production systems and availability of natural resources. Objectively measuring ecological resilience is not a trivial task [18], especially at large spatial scales [19]

and it is in this context that the tools used come into play. To assess the responses of agricultural productivity to climatic conditions, empirical (statistical) models and models based on biophysical processes that simulate agricultural productivity and its interactions with the environment and management practices are used [20] [21].

The possibility of adapting agriculture varies depending on the characteristics of each system and the different foreseen future scenarios. There are few analyzes in this regard in Brazil [22]. Andrioli and Sentelhas [23] determined the sensitivity of maize genotypes (*Zea mays*) to water deficit using an Agroecological Zone Model. The model's performance was acceptable for the evaluation of the real yield, whose estimated mean errors for each genotype ranged from -5.7 to +5.8%, and whose overall mean absolute error was 960 kg ha^{-1} (10%).

Barbieri et al. [24] carried out the zoning of sugarcane expansion areas, validating the model with irrigated sugarcane data. The model was effective in estimating the productivity of irrigated sugarcane, in both year and year and a half crops, with the possibility of being used for forecasts throughout the harvest. Monteiro [25] used the same model, associating the penalty of productivity with water deficit, to develop a procedure for obtaining classes of production environments for sugarcane cultivation, in 178 locations in the state of São Paulo. As a result, it obtained satisfactory performance, enabling, together with the use of a geographic information system, to obtain the climatic classes of the production environments, which can support the planning of plants regarding varietal and operational management of sugarcane fields.

Despite great advances in recent decades, development, parameterization and validation on a regional, national and global scale are still insufficient. Initiatives such as The Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intercomparison, Improvement and Adaptation of Agricultural Crops Simulation Models for Climate Change Application (AgMIP-BR) project, coordinated by Embrapa, have sought to accelerate advances in parameterization and validation of these models [9].

There are other practices that reinforce the resilience of agroecosystems, such as: management alternatives, through the recommendation of more favorable times for the implantation of various agricultural crops [26] [27]; genetic improvement of plants, as it has a fundamental role in the development of cultivars adapted to the projected conditions of climate change [10]; animal production, adapted to heat and humidity, in conventional or integrated production systems, contributes to the reduction of thermal stress; intensive and integrated agricultural, livestock and

forestry production systems (crop-livestock-forest integration – CLFI) allows for the intensification of land use for productivity gains in food and energy [28]; ecological systems, which make intelligent use of the natural functionalities offered by ecosystems [29], with the objective of designing multifunctional agroecosystems; fish farming, through the adaptation of aquaculture through integration with plant production for small producers [30], also called aquaponics [31].

It is important to emphasize that the diversity of alternatives to strengthen the resilience of agroecosystems is possible, through access to knowledge in various areas, including technical, ecological, cultural, the construction of concrete solutions in the environment, constructed and/or permitted biological diversity, characterized as a centerpiece in the resilience of an agroecosystem.

3.2 Plant behavior against water deficit

The water deficit in plants is due to a higher transpiration rate than water absorption, which can happen by different mechanisms, such as drought, salinity and low temperatures [32]. Thus, there is a stress on the plant that causes changes in its behavior, and the irreversibility of the situation will depend on the species, genotype, duration of stress, plant development stage and the nature of this stress [33].

Basically, water stress resistance mechanisms involve limiting growth in order to minimize water loss; morphological adaptations; physiological adaptations; and metabolic alterations [34]. However, the most accentuated response of plants to water deficit is the decrease in leaf area production, stomata closure, acceleration of senescence and leaf abscission [35] [36]. At the cellular level, when the plant is subjected to water deficit, the changes involve the concentration of solutes inside the cells, changes in the volume and shape of the plasma membrane, loss of turgor and protein denaturation [32]. Taiz and Zeiger [37] claim that as the stomata close during the initial stages of water stress, the efficiency of water use can increase, that is, more CO_2 can be absorbed per unit of transpired water, because stomatal closure it more inhibits transpiration which decreases the intercellular concentrations of CO_2. As stress becomes more severe, however, dehydration of mesophyll cells inhibits photosynthesis, mesophyll metabolism is impaired, and water use efficiency generally decreases.

According to Larcher [38], a plant organism goes through a succession of characteristic phases when subjected to stress: the alarm phase, the resistance and exhaustion phase. In the first phase, there is a loss of stability in the structures and reactions responsible for

maintaining vital functions, and the plant can react and recover from this stress. In the second phase, of resistance, which is increased under continuous stress, a rusticity process begins and, depending on the duration, the plant can adapt through osmotic adjustment. Finally, in the exhaustion phase, which occurs when stress is too long or its intensity increases rapidly, the plant is susceptible to infections that occur as a consequence of the decrease of the host's defenses and leading to premature collapse.

The frequency and intensity of the water deficit are the main factors limiting agricultural production, accounting for 60 to 70% of the final variability of production [39]. This highlights the importance of knowing the local climatic conditions and the genotype to be used, in order to develop management strategies that make it possible to reduce the effects caused by water deficit [3]. In this context, the assessment of the degree of tolerance and susceptibility of genotypes is an important point to consider in studies involving the tolerance of plants to water deficit [40].

The impacts of climate change can constitute a serious threat to agriculture, as it puts the preservation of current agricultural systems at risk, as well as becoming an opportunity for the development of other systems [14]. In this context, Smit and Singles [41] and Bray [32] state that adequate knowledge of how vegetables respond to water stress is one of the main requirements for choosing both the best variety and the best management practices, aiming, above all, improve the exploitation of natural resources.

Thus, changes in the rainfall regime, which trigger droughts, may negatively influence agricultural regions, and it is important to foresee future scenarios in order to develop measures that help in the resilience of crops.

3.3 Use of the Agroecological Zone Method

Simulation models have been widely applied in agronomy as a research tool, enabling the understanding of plant responses to different environments and, consequently, predicting crop productivity [42]. Through these models, it is possible to simulate different management conditions over several years and locations, using historical or synthetic climate data [43] [44].

The application of mathematical-physiological models has been increasingly used in agriculture, with regard to the provision of tools for decision-making support systems, aiming at real simulations of future processes to be able to face events [25] [45]. According to Streck and Alberto [46], mathematical models are a simplification of reality that allow describing the complicated interactions that exist in agroecosystems and, in this way, indicate the possible impact of changes in meteorological elements and

climate on agroecosystems. Thus, the FAO Agroecological Zone Model (AZM) is one of the most used in research aimed at estimating the agricultural productivity of crops[47] [23], having, however, wide application in agroclimatic zoning studies and in determining the most appropriate times for planting and sowing [25].

This model makes a correlation between the relative fall in productivity and the water deficit in each phenological phase, through a crop response coefficient and, although generic, it can be applied in crop forecasting systems as it is a simple model and presents very satisfactory results [42]. Thus, with the application of this method, the potential and attainable productivity of agricultural crops is estimated, through the input of meteorological variables, determining that the depletion of productivity occurs as a function of the relative water deficit, through a coefficient of response to the water deficit. Such data on the response coefficient to water deficit exist in the literature and are derived from a linear regression between the evapotranspiration deficit (relation between the actual and maximum evapotranspiration of the crop) and the relative loss of productivity (relation between the attainable and potential productivity) [3]. As for the reference evapotranspiration, it can be estimated by methodologies such as Thornthwaite & Mather [48] and the maximum crop evapotranspiration through methods such as the Penman-Moneith [49] or the Class A tank [50], for example, using the crop coefficient (Kc) data obtained in the literature. Reichardt [51] defines the maximum evapotranspiration (ETm) as the maximum water loss that a given crop suffers in a development stage, when there is no soil water restriction and also states that the real evapotranspiration (ETr) is the one that fact occurs. Above all, it emphasizes that if there is water available in the soil and the water flow in the plant meets the atmospheric demand, the ETr will be equal to the ETm.

The AZM model comprises two stages: the first deals with the estimation of potential productivity (Yp) and the second with the penalty for this by the water deficit, thus obtaining the attainable/estimated productivity (Ye), according to the following formula:

$$\text{Ye} = Yp\left[1 - ky\left(1 - \frac{ET}{ETC}\right)\right]$$

Where,

Ye= estimated productivity (kg.ha^{-1})

Yp= potential crop productivity (kg.ha^{-1})

Ky= water penalty coefficient

ET= real evapotranspiration (mm.d^{-1})

ETc= crop evapotranspiration (mm.d^{-1})

$$ETc = ETo . Kc$$

Where,

ETc= crop evapotranspiration (mm.d^{-1})

ETo= reference evapotranspiration (mm.d^{-1})

Kc= crop coefficient

The potential productivity is obtained by a highly productive variety, well adapted to the growing environment, without water, nutritional, phytosanitary stress and salinity problems, the following characteristics being fundamental for its calculation: duration of the growth cycle; leaf area index (LAI) associated with maximum growth rate; harvest index; culture adaptability group and; sensitivity of the duration of the crop growth cycle to the thermal sum of degree days. Subsequently, this potential productivity is penalized with the application of the productivity sensitivity coefficient to the water deficit, since this factor is one of the factors that most affect crop productivity, it is essential to include this variable in the productivity estimation models. Thus, the elements rain and evapotranspiration are associated with productivity values, for the different phenological stages of the crop [42].

In this model, the potential yield drop is directly related to the relative water deficit of the crop, which considers the reference and maximum evapotranspiration, taking into account a crop response coefficient to the water deficit (ky) in each phenological phase of the crop cycle. Thus, the attainable productivity of the crop is estimated [54]. Regarding the meteorological data used in this methodology, the following are required: average air temperature; precipitation (mm), extraterrestrial solar radiation, photoperiod and insolation [3].

Although it requires information on climate and culture, the Agroecological Zone Method is easy to apply in operational terms, in addition to being easy to understand and the results closer to reality [53]. According to Thompson [54], precipitation is the meteorological element most used in the development of models that estimate crop productivity. However, the AZM model has some limitations, as it does not consider the occurrence of pests and diseases and soil fertility [53]. The biological system is complex and the lack of knowledge regarding some processes results in an imperfect or incomplete modeling. This is also due to the great capacity of plants to adapt to different edaphoclimatic conditions [55].

The improvement in the productivity of a crop may be related to greater tolerance to environmental stresses and thus result in an increase in productive stability. Simulation models of soil-plant-atmosphere systems are an appropriate tool for studies involving applications under conditions of great environmental variability, as it is possible to determine the risks that permeate agricultural production due to the main components of production [56] [57]. Some studies indicate that the development of agricultural zoning is a tool that aims to minimize the most recurrent risks that the crop may be subjected to from planting to harvest [58].

Thus, crop forecasting systems using agrometeorological models are present in works of great national relevance, in the case of large crops such as soybean [47] [59], corn [23] and sugar cane [60] [24] [61]. According to Santos and Oliveira [62], the agroclimatic productivity method [63] proved to be efficient in estimating corn productivity, since it elucidates parameters that can influence the reduction of the producer's yield.

In this way, the AZM is an auxiliary tool for experiments with studies on the impacts of climate change on agricultural crops, which constitute a simplification of the reality of agroecosystems [46]. Climate modeling analyzes for Brazil, covering the 1970 to 2050 baseline scenario, considering the cumulative effects of climatic and non-climatic vectors on species loss, indicate that land use changes have a preponderant historical role in biome changes Amazon, Cerrado, Caatinga, Atlantic Forest and marine environments [64]. And, it is also highlighted that climate change started to have an increasing participation in the loss of biodiversity from 1970, resulting, in the year 2050, in significant risks to the provision of ecosystem services [65].

As already mentioned, climate change projections for Brazil point to significant impacts in changing the extreme precipitation regime in the form of floods and floods, in addition to greater risks of drought and increased aridity [4] [5]. In this context, it is essential to recognize the temperature, precipitation and humidity thresholds by which ecosystems will incur in inflection points in order to anticipate and manage emerging risks [66]. Recent scientific evidence demonstrates that current climate conditions and projected changes impose relevant environmental, economic and social burdens, especially on tropical countries in the Global South, such as Brazil, which have suffered non-linear and heterogeneous economic impacts and risks [67]. However, economic losses and socio-environmental costs could be minimized through the implementation of adaptation strategies [68].

IV.   CONCLUSION

Cultivated plants, in general, are quite sensitive to water deficit, which is considered the main factor in modeling, thus, through modeling it is possible to predict

the impact of water deficit on crop yields. Although the AZM model is one of the most applied simulation models, it has flaws because it does not consider soil fertility and diseases, and in this context, when climate changes occur, major changes can occur in relation to phytopathology, such as redistribution and the emergence of new ones. of pests.

Furthermore, it is emphasized that the preservation of ecosystems is essential to ensure life on Earth, and it is essential to plan management strategies for a planned long-term adaptation to maintain genetic diversity.

Thus, adapting to climate change and minimizing its effects requires the adoption of the "precautionary principle" and the maintenance of agrobiodiversity, it being essential to strengthen the resilience of ecosystems so that they contribute to facing the future climate crisis.

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Prospection of antioxidant action of phytochemicals of *Mimosa tenuiflora* (Jurema-Preta)

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Abstract— Objective: The objective this work was to observe phytochemical studies and the antioxidant action of extracts and fractions of different parts of Mimosa tenuiflora (Willd) Poir. Methodology: Search in the database: PubMed, SciELO, Medline via BVS, Lilacs via BVS, Science direct and Cochrane, through the scientific descriptors: "Mimosa tenuiflora and antioxidant"; "Mimosa tenuiflora and phytochemicals"; "Mimosa tenuiflora", has published from january 1990 to june 2021. The inclusion criteria used were: 1) phytochemical studies of Mimosa tenuiflora; 2) antioxidant studies of Mimosa tenuiflora in vivo and in vitro models; 3) available in full texts. The exclusion criteria were articles that were not related and relevant to the theme, duplicated articles and those unavailable for full reading. Results: 24 studies identified the phytochemicals of M. tenuiflora, only 5 of these studies showed antioxidant activity in vitro. The compounds present in the extracts and fractions of different parts of the plant were phenolic compounds, flavonoids, flavonols, xanthones, flavones, polyphenols and tannins. Conclusion: The studies showed wide phytochemical variety present in extracts and fractions of different parts of the plant and few studies showing antioxidant activity of phytoconstituents of M. tenuiflora. The phenolic, flavonoids and polyphenols compounds were the major compounds in the studies involving analysis of the antioxidant activity of M. tenuiflora.

I. INTRODUCTION

The *Mimosa tenuiflora (Willd.) Poir.*, popularly known as "jurema-preta", is a scrubby plant of the Fabaceae-Minosaceae family, native from regions of the Brazilian semi-arid, especially in the caatinga (Albuquerque et al., 2018). In folk medicine, the bark of the stem and root of *M. tenuiflora* are used in the treatment of several diseases, such as inflammation (Martínez-Higuera et al., 2021), wounds and in indigenous and Afro-Brazilian rituals (Grünewald & Azeredo, 2018a, 2018b; Kaasik et al., 2021).

The plants are made up of chemical compounds, known as secondary metabolites, which are formed from products derived from photosynthesis and synthesized by four biosynthesis pathways, the acetate malonate, mevalonic acid, methylerythritol phosphate and shikimic acid pathways (Ahanger et al., 2020; Twilley et al., 2020). The most prevalent phytochemicals in plants are the phenolic compounds (Bresciani et al., 2017; Pasquariello et al., 2020), Many of these fitoconstituents interact with molecules of human organism producing pharmacological action (Li et al., 2020; Wan et al., 2021; Zia et al., 2021)

Studies indicate that phenolic compounds, particularly the flavonoids, are responsible for the antioxidant activity present in the extracts of these plants (Li et al., 2014; Lyu et al., 2020; Sagandykova et al., 2021). It should be emphasized that due to its chemical structure and reducing property, these phytochemicals have the power to eliminate free radicals, inhibit enzymes, in addition to forming molecular complexes and inactivating reactive metal ions, also denominated free radicals (Tahjib-Ul-Arif et al., 2021; Wu et al., 2020).

Free radicals are atoms or molecules with unpaired electrons in the valence layer, extremely reactive, endogenously stemmed from the oxide-reduction reactions of oxygen or nitrogen aerobic metabolism, and or through exogenous sources such as ionizing radiation, X-ray range, ultraviolet light, air pollutants (Liu et al., 2020; Rai et al., 2021). These xenobiotics when not nullified by the antioxidant system, cause acute and cumulative damages, characterized by oxidative stress (Guerra et al., 2021). The oxidation of important biomolecules such as membrane and lipids circulators, proteins and genomic material occur several mechanisms leading to varied dysfunctions e neurodegenerative dissease (Jiang et al., 2016). compounds in *M tenuiflora* extracts proved to be safe and effective in modulating oxidative effects on cell proliferation (Vieira et al., 2021).

The understanding of the phytoconstituents antioxidant profile has been showing therapeutic alternatives in the prevention of degenerative diseases and as adjuvants in curative therapy. The objective of this work was to observe phytochemical studies and the antioxidant action of extracts and fractions of different parts of *Mimosa tenuiflora (Willd) Poir*.

II.   METODOLOGY

This is a systematic review to check the phytochemicals identified in *Mimosa tenuiflora* (*Willd.*) *Poir*. which have antioxidant activity. The systematic review was based on instructions in the Preferred Reporting Items for Systematic Reviews (PRISMA)

method (Moher et al., 2009). The date of search for the studies was until June 2021. The selection of the studies was made in the following databases: PubMed, SciELO, Medline via VHL, Lilacs via VHL, Science direct, Cochrane, involving the scientific descriptors: "*Mimosa tenuiflora* and antioxidant"; "*Mimosa tenuiflora* and phytochemicals"; "*Mimosa tenuiflora*".

2.1 ELIGIBILITY CRITERIA

The eligibility criteria were considered: 1) phytochemical studies of *Mimosa tenuiflora* 2) antioxidant studies of *Mimosa tenuiflora* in clinical trials, in vivo and in vitro models; 3) available in full texts.

2.2 EXCLUSION CRITERIA

After reading the titles and abstracts, articles unrelated to the topic were excluded. In a second moment were removed the duplicated and unavailable full-text articles.

2.3 STUDY SELECTION

The individual selection of articles was carried out by two independent evaluators and the divergences resolved after the reflection on the scientific notes pointed out in the proposal of studies for consensus. In the full reading of the articles, the year of publication, the phytochemical analysis and the methodology used to identify the antioxidant activity were considered. Data were grouped in a Microsoft Excel spreadsheet, version 2016.

III.   RESULT

The search for understanding the phytochemicals of *Mimosa tenuiflora* with antioxidant properties was systematized in inclusion/exclusion criteria as sequentially shown in the flowchart of PRISMA model (**Figure 1**).
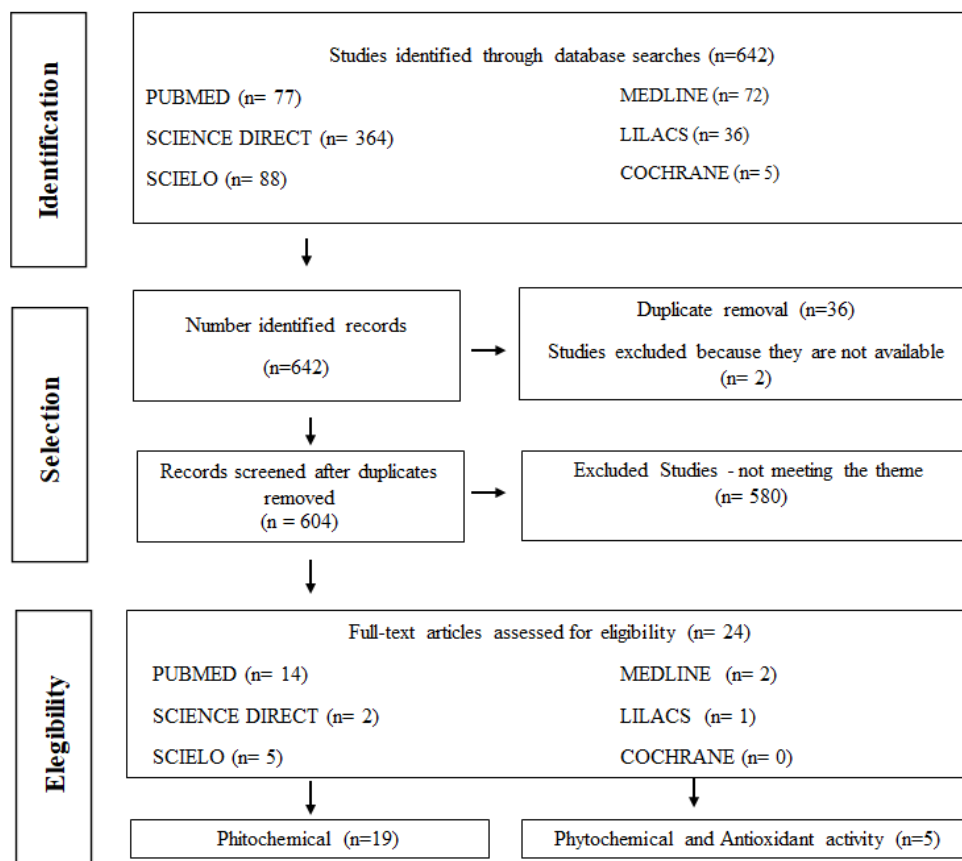
Fig.1: Schematic representation of the identification, selection and eligibility of articles in the systematic review on the antioxidant action of phytoconstituents of Mimosa tenuiflora.

When analyzing the studies, only 5 (20.8%) investigated the antioxidant action of phytochemicals (**Figure 2**). The phytochemicals involved in the studies were identified and isolated from various parts of the plant in the form of extracts and fractions. In most of the studies, the barks, leaves and flowers of *M. tenuiflora* were used. The less involved parts in the studies were the root, shoots, heartwood, branches, twigs and seeds (**Figure 3**).

In relation to the qualitative and quantitative studies analyzed, the phytochemistry of *M. tenuiflora* indicated the presence of different groups of secondary metabolites, according to the parts used, such as phenolic acids (Silva, I et al., 2020a; Silva, S. et al., 2020; Vargas-Segura et al., 2020), flavonoids (Bezerra et al., 2011; Cruz et al., 2016; Santisteban et al., 2019; Silva, I. et al., 2020; Silva, S. et al., 2020; Vargas-Segura et al., 2020), flavanones (Bautista et al., 2015; Bezerra et al., 2011), leucoanthocyanidins, catechins (Bezerra et al., 2011), flavonols (Bezerra et al., 2011; Cruz et al., 2016; Silva, S. et al., 2020), flavones (Bezerra et al., 2011; Silva, S. et al., 2020). Some of these studies pointed out the presence of tannins compounds (Almeida et al., 2005; Amariz et al., 2020; Silva, S. et al., 2020) such as condensed tannins (Amariz et al., 2020;

Azevêdo et al., 2015; Bezerra et al., 2011; Hernandez et al., 2021; Rivera-Arce et al., 2007), water-soluble tannins (Bezerra et al., 2011), triterpene tannins (Almeida et al., 2005) and quinones (Almeida et al., 2005), alkaloids (Almeida et al., 2005; Bezerra et al., 2011) tryptaminic (Simão et al., 2020) such as *N,N*-dimethyltryptamine (DMT) (Amariz et al., 2020; Gaujac et al., 2012; Meckes-Lozoya et al., 1990; Nicasio Mdel et al., 2005; Vepsäläinen et al., 2005), 5-hydroxytryptamine (Meckes-Lozoya et al., 1990) and harmala alkaloids (Simão et al., 2020). Furfural, phenols (Araújo et al., 2018; de Souza Araújo et al., 2018), phenoxychromones (Bautista et al., 2015; León et al., 2004), triterpenoid saponins (Anton et al., 1993), steroids (Amariz et al., 2020; Anton et al., 1993; Bezerra et al., 2011) and sterols (Vargas-Segura et al., 2020) were also found.

■ Phytochemistry ■ Phytochemistry and Antioxidant
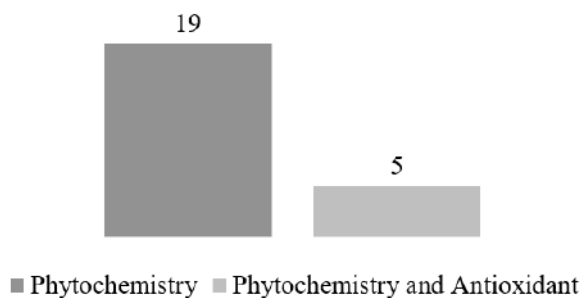
Fig.2: Phytochemical and/or antioxidant action of phytoconstituents of Mimosa tenuiflora (Willd.) Poir.

■ Extracts ■ Fractions
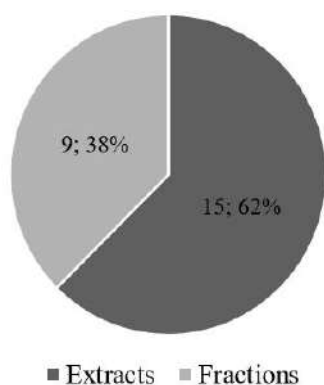
Fig.3: Parts of the Mimosa tenuiflora. plant. used in the studies.

The most common phytochemical compounds in the leaves of jurema and flowers were tannins, flavonoids (Bezerra et al., 2011; Cruz et al., 2016; Santisteban et al., 2019), flavanones (Bautista et al., 2015), phenoxychromones (Bautista et al., 2015; León et al., 2004) and DMT (Nicasio Mdel et al., 2005). In the barks they identified the presence of sterols and sugars, flavonoids, cumarins, flavonols, leucoanthocyanidins, catechins, flavonols, xanthones, saponins, tannis, flavones, phenolics, poliphenols, alkaloids, *N,N*-dimethyltryptamine (DMT) and 5-hydroxytryptamine and saponinis (Amariz et al., 2020; Anton et al., 1993; Azevedo et al., 2016; Azevêdo et al., 2015; Bezerra et al., 2011; Cruz et al., 2016; Hernandez et al., 2021; Jiang et al., 1991; Rivera-Arce et al., 2007; Silva, S. et al., 2020; Vargas-Segura et al., 2020).

The studies involved in the review evaluated extracts and fractions of *M. tenuiflora*. Thus, of the 24 studies, 15 articles used extracts and 9 used fractions (**Figure 4**). Regarding to the types of extracts, the most widely used in the studies were the ethanolic (Amariz et al., 2020; Bezerra et al., 2011; Rivera-Arce et al., 2007; Simão et al., 2020; Vepsäläinen et al., 2005) and methanolic extracts (Jiang et

al., 1991; Simão et al., 2020; Vepsäläinen et al., 2005). In addition to these, some studies used other solvents for the extracts preparation, such as ethanol-water (Silva, I. et al., 2020; Vargas-Segura et al., 2020), formaldehyde/HCl (Azevêdo et al., 2015), chloroform and ethyl acetate and metanol (Anton et al., 1993).
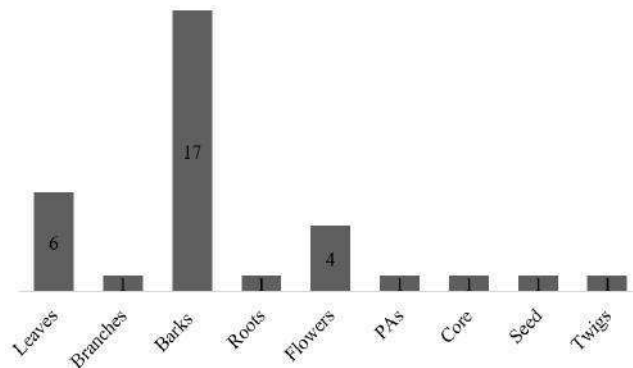
Fig.4: Studies envolved extracts and fractions of Mimosa tenuiflora (Willd.) Poir

When analyzing the phytochemicals present in each extract, saponins (Bezerra et al., 2011; Rivera-Arce et al., 2007), tannins (Amariz et al., 2020; Bezerra et al., 2011; Rivera-Arce et al., 2007; Silva, S. et al., 2020) flavones, DMT and hydrocarbons (Amariz et al., 2020), flavonoids (Amariz et al., 2020; Bezerra et al., 2011; I. Silva et al., 2020; Silva, S. et al., 2020) e phenolics (Silva, I et al., 2020; Silva, S. et al., 2020) in the ethanolic extracts are observed. In the methanolic extracts, saponins (Jiang et al., 1991), DMT(Amariz et al., 2020; Vepsäläinen et al., 2005), tryptamimic alkaloids, harmala alkaloids, phenolic compounds were identified (Simão et al., 2020).

In the ethanol-water extract they found the presence of sterols, flavonoids, coumarins, sugars, phenolic acid (Vargas-Segura et al., 2020), polifenóis (León et al., 2004). In the formaldehyde/HCl extracts was determined the presence of condensed tannins (Amariz et al., 2020; Azevêdo et al., 2015). Finally, in the chloroform, ethyl acetate and methanol extract were identified saponins and steroids (Anton et al., 1993).

The fractions used were the hexane, acetone, methanol, ethanol, dichloromethane, hydroalcoholic, ethyl acetate, n-hexane, formaldehyde/HCl and chloroform fractions. In the hexane-ethyl acetate fraction, they found phenoxychromones (León et al., 2004). In the hexane, acetone and ethanol fraction, they identified phenoxychromones and flavanones. The hexane, acetone and methanol fraction found DMT and 5-hydroxytryptamine (Meckes-Lozoya et al., 1990). The ethanol, hexane, dichloromethane, ethyl acetate and butanol fraction found the flavonoids and flavonols (Cruz

et al., 2016). In the ethyl acetate fraction they found flavonoids (Araújo et al., 2018; Santisteban et al., 2019), furfural and phenols (Araújo et al., 2018). In the methanol resuspended fractions and in the n-hexane fractions, the DMT (Gaujac et al., 2012; Nicasio Mdel et al., 2005) was identified.

The five studies that evaluated the phytochemistry and antioxidant activity of phytochemicals correlated this activity with the presence of phenolic compounds, flavonoids, flavones, flavonols, xantones, tannins and the polyphenols. These studies evaluated the antioxidant activity of jurema-preta extracts by using the reduction methods of the phosphomolybdenum complex, reduction of the 2,2-diphenyl-1-picrylhydrazil (DPPH) radical and the discoloration test of the 2,2'-radical cation. azine-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) (**Table 1**). The ethanolic extract presented phenolic compounds such as flavones and flavonoids. It has a strong antioxidant potential by the DPPH methods (in a dose of 17.21 µg/mL) and ABTS (3.57 µg/mL) (Silva, S. et al., 2020).

Table 1: Antioxidant activity of Mimosa tenuiflora (Willd.) Poir.

Parts of plants	Extracts ou fraction	Methods	Phytochemical	Ref.
Bark	Ethanolic extracts	DPPH and ABTS	Pyrogalic tannins, flavones, flavonois, xanthones and flavonoids	(Silva, S. et al., 2020)
Bark	Ethanolic extracts	DPPH and phosphomolybdenum	Phenolic and flavonoid	(Silva, I. et al., 2020)
Leaves, twigs, barks and roots	Ethanolic extracts	DPPH, TLC, ABTS	Phenolic compounds	(Magalhães et al., 2018)
Bark	Ethanol-water extracts	DPPH and total polyphenol	Polyphenols	(Rodríguez-León et al., 2019)
Bark	Aqueous extract	DPPH	Polyphenols and condensed tannins	Hernandez et al., 2021

DPPH: 2,2-diphenyl-1-picrylhydrazil. ABTS: 2,2'-radical cation. azine-bis (3-ethylbenzothiazoline-6-sulfonic acid. TLC: Thin layer chromatography.

In another study, the ethanol extract of M tenuiflora in the flavonoid presence test presented 5.49 µg.ml-1 and in the total phenolics test, using the Folin-Ciocalteau method, it presented 50.58 µg.ml-1. It has significant antioxidant capacities by the two methods, phosphomolybdenum (41.77%) and DPPH (86.08%) (Silva, I. et al., 2020).

The ethanolic extracts of leaves, branches and roots were fractionated by using the hexane, dichloromethane, ethyl acetate, hydroalcoholic, distilled water solvents. Of these fractions, ethyl acetate was the one with good antioxidant activity in both methods, with the lowest values of the concentration at which the drug produces, 50% of its maximum effect (EC50) against DPPH (EC50 = 141.20 ± 0, 02 µg/mL) and ABTS (EC50 = 273.00 ± 0.08 µg/mL) and in the phytochemical triage showed the highest total phenolic content (92.72%) correlated with the antioxidant activity by the DPPH method and ABTS method) (Magalhães et al., 2018).

The ethanol/water extract from the bark of the jurema preta had a high total polyphenol content (425 mg/g). For the DPPH assay, it was observed that for 12.5 mg/L of extract, I obtained 50% of the inhibitory concentration (IC50), similar to the values respectively reported for vitamin C and catechins 46 and 58% (Vepsäläinen et al., 2005). The aqueous extract of the bark of stem showed high antioxidant activity, with an IC_{50} of 10 mg/L, compared with the Trolox, which had an IC50 of 3.5 mg/L (Hernandez et al., 2021).

IV. DISCUSSION

The *Mimosa tenuiflora* (*Willd.*) *Poir.* is a plant widely used by the population of the caatinga for curative purposes and in drinks during religious rites (Grünewald & Azeredo, 2018a; Kaasik et al., 2021). The systematic review showed that there are few studies that evaluated the antioxidant action of *M. tenuiflora*. In the face of variations in the phytochemical composition of different

parts of plants, vegetables from different regions and of different extraction and isolation techniques used in the studies, a source of investigation emerges directed towards to the antioxidant activity.

The most common phytoconstituents found in the extracts and fractions of the studies selected in the review are phenolic compounds, flavonoids, tannins, saponins and alkaloids. Gurung (Gurung, 2020), performed the phytochemical analysis with the ethanolic extract of the root, stem and leaves of *M. rubicaulis* and also noted the presence of flavonoid compounds, phenol and terpenoids. According Silva et al (Silva, S. et al., 2020) , the presence of tannins and flavonoids in the ethanolic extract is due to the polarity of these compounds, for they are more soluble in polar solvents, the ethanol solvent can cross cell membranes and extract intracellular substances with similar polarity.

In the methanolic extract of the stem was found saponins, tannins and flavonoids. Another study using the aqueous, ethanolic and methanolic extract of leaves, flowers and roots of *M. pudica*, was detected the presence of phenolic and flavonoids compounds (Ahmed et al., 2019). Nascimento et al (Nascimento et al., 2016), using the hydroethanol, hexane and chloroform extract, ethyl acetate and hydromethanol from jurema-preta bark revealed the presence of flavonoids, tannins, xanthones, triterpenes, steroids and phenols, with the highest content of total phenolics found in the ethyl acetate extract and the highest percentage of inhibition of the free radical DPPH 2.2-diphenyl-1-picrylhydrazil was found in hydroethanol extract, ethyl acetate and in the hydromethanol fractions.

Several tudies show the antioxidant action in vivo that portray the antioxidant effects and mechanisms of polyphenol compounds (Cory et al., 2018; Pandey & Rizvi, 2009). On the other hand, Ferreira et al (2016), pointed out that "phenolic compounds are found in several structural forms and act as reducing agents, free radical scavengers, metal chelations or oxygen deactivators". Thus, it is understood that the presence of phenolic compounds, such as flavonoids and tannins in the extracts indicates that these metabolites can contribute to the antioxidant activity of the compounds of *Mimosa tenuiflora* (Willd) Poir. The pharmacological activities observed may have started by synergistic or antagonistic action of chemical compounds present in medicinal plants. thus, it is necessary to isolate and identify the chemical constituents and pharmacological prospection to the dose response definition. Furthermore, there are few in vivo studies to understand the antioxidant mechanisms (Patro et al., 2016).

V. CONCLUSION

The studies showed a wide variety of phytochemicals present in extracts and fractions in different parts of *M. tenuiflora*. However, there are few studies showing antioxidant activity of the phytoconstituents of this species. The phenolic, flavonoids and polyphenols compounds were the major ones in the studies involving the analysis of antioxidant activity of *M. tenuiflora*. However, bio-guided studies, with the isolation and identification of phytochemicals and subsequent evaluation of the antioxidant activities of these isolated or associated chemical species, might contribute to the preventive or curative therapeutic action of the phytoconstituents of *Mimosa tenuiflora* (*Willd.*) *Poir.* for pharmacological purposes.

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If it stops, it stopped: Ethical implications and conduct in the Do Not Resuscitate Order in Intensive Care Unit

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Abstract— Objective: To map the production of knowledge and make considerations about the main updates and recommendations available in the literature for the management and conducts in front of a patient in Cardiopulmonary Arrest with a Do Not Resuscitate Order (NOR) in an Intensive Care Unit. Method: narrative literature review. The source of information consisted of relevant publications in the literature, carried out from June to July 2021, based on the narrative synthesis of evidence on the updates contained in the main guidelines and official recommendations published by bodies linked to the Brazilian and international health area .Results: the results pointed to the difficulty of doctors and health professionals in talking about the subject, however, it was found that they believe in the patient's autonomy as a fundamental factor in the decision process, as well as the participation of family members and staff multidisciplinary. Conclusion: the consent to implement the ONR must be a joint decision, in which the objective must always offer the best for the patient and their families, supporting such decision in ethical precepts. Respect for the dignity and autonomy of the patient is the main factor that must be considered in decision making, not only for the implementation of the ONR, but for any procedure that may be performed on the patient.

I. INTRODUCTION

Cardiopulmonary resuscitation (CPR) is not indicated for all patients who present Cardiopulmonary Arrest (CPA), and may be refused by patients and their legal guardians and not instituted by health professionals in specific situations in the health care context. The Do Not Resuscitate Order (ONR) consists of the authorization of the patient or spouse, representative or family members not to adopt CPR measures in case of CPA in the terminal phase of an incurable disease or in circumstances that make recovery irreversible. The decision not to resuscitate is adopted by the medical professional after analyzing the risks and benefits, and discussing with the multidisciplinary team the uselessness of such maneuvers[1].

ONR consists of the careful decision not to perform CPR maneuvers in patients in the terminal stage of life, with irreversible loss of consciousness or those who may have untreated CPA[2]. It is a conduct aimed at not using Advanced Life Support (ALS) to maintain vital signs in cases where efforts to prolong life are not clinically and ethically justified[3].

The ONR has been part of the Medical Ethics Code of the American Association (AMA) since 1992. In Europe, between 50 and 60% of patients who died in a non-sudden manner in hospitals in countries such as the Netherlands, Switzerland, Denmark and Sweden declared an individual decision and autonomous from non-resuscitation. However, the global panorama regarding the conduct of professionals is not uniform, due to marked differences in

cultural factors and the lack of consensus in global guidelines[2].

In the 70s, the first guidelines and policies that recommended not adopting CPR measures in this context emerged in the world. However, the ethical complexity involved in the application of such measures meant that acceptance was not universal and immediate. In the United States of America (USA), Australia and some countries in Europe, aiming to meet one of the main paradigms of bioethics, with the maintenance of the autonomy of the patient and their families, the prior elaboration of the ONR was allowed, to prevent the submission of these individuals to advanced resuscitation measures that prolong vital functions in an unjustified way[1].

In Brazil, according to Resolution n. 1,805/2006 of the Federal Council of Medicine (CFM), in the terminal phase of illnesses, the physician is allowed to limit procedures and treatments that prolong life, guaranteeing relief from symptoms that lead to suffering, which guarantees comprehensive care, respecting the will and autonomy of the patient and/or their legal representative. It is reiterated that according to article 41, sole paragraph of the Code of Medical Ethics, non-resuscitation is justified in cases of incurable and terminal illness, however the physician must offer palliative care, taking into account the wishes of the patient and/or their representative cool[4].

In the Brazilian scenario, the ethical discussion has covered the last two decades, being driven by CFM actions that motivated the debate about the terminality of life. These initiatives are evidenced mainly by the publication of CFM resolutions n. 1,805/2006 and 1,995/2012, which deal, respectively, with the therapeutic limitation of care for terminally ill patients and the advance directives of will (known in Brazil as living will). It should be noted that in public health, the refusal of treatment is an integral part of the Charter of Health Users' Rights, issued by the Ministry of Health (MS). In this context, the ONR is presented as a complement to the living will for a specific situation in which the patient expresses his desire for not resuscitation in case of CPA[2].

In view of this reality, the care provided to critical patients in the context of intensive care emerges. According to the Brazilian Ministry of Health, Intensive Care Units (ICUs) are hospital units for the care of critically ill or at-risk patients, who have uninterrupted medical and nursing care, with specific equipment and specialized human resources, in addition to access to technologies for diagnosis and therapy. Death is a constant presence in this hospital sector and professionals are in routine contact with the dying process, and sometimes the technical resources, knowledge and competence of

intensive care providers are limited, given the advance of the disease, especially when the cure it is not possible, with the diagnosis of out of therapeutic possibilities of cure[5].

In Brazil, ONR is not a practice specifically recognized in the scope of Medical Ethics, however, the limitation of procedures is supported by federal ethical and legal provisions, among which CFM Resolution n. 1805/2006 of the CFM and the Health Users' Rights Charter of the Ministry of Health as already mentioned. However, even though it is not officially recognized, this approach is routinely adopted in clinical practice[1].

In this scenario, terminal patients, those considered out of therapeutic or cure possibilities are or should be the protagonists. Terminal patient is defined as one who, at a certain point in the evolution of their disease, is no longer salvageable, even if they have all the therapeutic resources available, therefore, they are in the process of unavoidable death. It appears that in front of these patients, professionals in a desperate attempt to reject the imminent death, so terrifying and uncomfortable, focus on machines and procedures, offering robotic and depersonalized care, fighting a fight against death. Thus, they propose an excessive, abusive and disproportionate therapeutic care, known as dysthanasia[6].

The discussion around a "good death" in the ICU is recurrent and (re)emerging, and the topic has become an ethical dilemma. For intensivists, the "comfort" to the patient is provided by the introduction of an advanced airway (orotracheal intubation, for example), the institution of mechanical ventilation and the use of sedative drugs. This condition is opposed to what is prioritized in processes involving assistance in Palliative Care, in which the focus is on maintaining the patient's autonomy, pain and symptom control, preferably without invasive interventions. The discourse on the concept of producing a "good death" focuses on the awareness of the maintenance of individual identity and acceptance of the death process. However, the implementation of this palliative model in the ICU is complex in practice; because it is multifaceted, loaded with myths and ethical and legal conflicts. When a death occurs in the ICU, it is usually marked by the sick person's vulnerability and extreme physical dependence. Such picture results from the severity of their clinical condition, and sometimes as a result of the induction of coma, by the action of drugs to relieve symptoms and the discomfort produced by the conducts performed in intensive care[5].

In the routine of ICUs, there is a difference between death and CPA. The terms are distinguished by the decision (or not) of resuscitation. When a patient receives

a diagnosis in which there are no therapeutic possibilities for a cure, the team assesses that the priority has changed, and no longer resides in investing in the use of resources to maintain their life. The assistant medical team communicates that "if the patient stops, it stopped-SPP". The medical record contains guidance on the conduct of comfort, which means not performing any procedure with the goal of cure. In the case of CPA, the order is not to perform CPR maneuvers, and thus the death is defined with the ONR registered in the medical record and communicated to the entire multidisciplinary team[5].

It should be noted that there are no specific ethical standards on ONR in force in Brazil, however the procedure is evident in hospitals, as evidenced by the records in medical records described in the literature. In this way, it seeks to elucidate the ethical and moral principles and dilemmas, both of health professionals themselves and of patients who are faced with a watershed, life and death. In this context, the objective of this study was to map the production of knowledge and to make considerations about the main updates and recommendations available in the literature for the management and conducts in front of a patient in Cardiopulmonary Arrest (CPA) with a Do Not Resuscitate Order (ONR) in a Emergency Unit. Intensive Care (ICU).

II. METHOD

Narrative literature review. The source of information was composed of relevant publications in the literature, carried out from June to June 2021, from the narrative synthesis of evidence on the main updates for the management and conducts in front of patients in Cardiopulmonary Arrest (CPA) with a No Order Resuscitate (ONR) in ICU. Opinions, works, articles, dissertations, theses, event proceedings, editorials, conventions and legislation were included as bibliographic sources. The texts found were read, organized and synthesized, and the synthesis presented below.

III. RESULTS AND DISCUSSION

Intensivists work with highly serious patients, so they are in constant contact with death. However, in this sector, the dying process is usually called in different ways, namely: death and CPA. This differentiation brings with it also different forms of action, as well as the expression or not of feelings. Death is understood as an expected death, when all professionals wait for the sick person to die in a few hours or in a few days. The team does nothing to revert the patient's condition.

Professionals do not express so much suffering when death actually takes place. While in CPA, intensivists perform all possible measures so that the patient survives with minimal or no sequelae, using all available resources. When there is a return to spontaneous circulation and survival, there is great satisfaction from the team. On the contrary, when death occurs, professionals tend to express the feeling of failure, failure and impotence, considering that it is an unexpected death[5].

In an attempt to deny the existence of human finitude and driven by the moral principle of preserving life, the health professional decides to use a therapeutic arsenal to prolong the time of death, configuring dysthanasia. Dysthanasia is, therefore, a term that can be synonymous with obstinacy or therapeutic futility, where technology is used to painfully and uselessly prolong the process of death. It is dedicated to prolonging the maximum amount of lifespan, fighting death as the greatest and last enemy[6].

The non-resuscitation of patients in the terminal phase of progressive disease is a humanistic act that aims to meet the bioethical principle of non-maleficence, with the essential purpose of minimizing human suffering and avoiding the practice of dysthanasia. It is considered that the moment is opportune for debate, and for ethical, clinical and legal guidelines on the order not to resuscitate in Brazil to be elaborated, filling the existing normative gap in the country[2].

The ICU is considered a restricted and closed unit, both in its physical space, with closed windows and doors, central air conditioning, artificial lights, which keep the external environment outside, as well as the super-specialization characteristic of its care team, which deals with high-tech equipment aimed at the care of critically ill patients. Due to these characteristics, the intensive care team tends to be considered "better" than that of other sectors of the hospital, both by the intensivists themselves and by professionals from other sectors. The service routine is marked by an organization of the team, aiming to maintain as much control as possible over the patient's clinical conditions and vital functions, which is kept under constant monitoring by electronic equipment and by the nursing staff. It is a space for maintaining life in order to avoid death whenever possible[5].

In this context, how is the No Resuscitation Order operated? An issue that raises many debates both in the medical and legal areas is the possibility of the patient to decide autonomously about their resuscitation or not, in case of CPA, since the Federal Constitution ensures the right to life and the protection of human dignity[7].

In the United Kingdom, the document "End-of-life treatment and care: good practice in decision-making", carried out by the British Medical Association, the Resuscitation Council and the Royal College of Nursing, identifies three situations in which CPR should be refused: when clinical evaluation concludes that CPR will not be successful in restoring cardiopulmonary function, circulation, and neurological function; when, after detailed discussion with the patient (or family members/legal representative), an agreement is reached that the benefits of CPR are outweighed by the costs and risks of carrying it out; and when the patient has an advance directive of will or makes an informed decision to refuse CPR[8].

In Portugal, on April 13, 2012, the National Executive Council of the Medical Association approved a document on the ONR, whose proposal has been the subject of in-depth discussions since 2007, following a meeting between the medical teams of the Intensive Care Units and the Ethics Committee and Resuscitation Committee of Hospital Fernando da Fonseca. The document was intended to be a source of guidance for recommended procedures in defining ONR and not a set of imposed standards. It proposes the ONR for various clinical conditions, namely: patient with chronic renal failure on hemodialysis and with an incurable chronic disease with expected survival of less than three months, or metastatic neoplasm (depending on the type of neoplasm and prognosis) and patient with advanced and irreversible oncological disease that, due to its evolution, has led to a progressive degradation of physical status and/or activity in recent times. This document also adds that, if possible, use should be made of assessments of the patient's performance status based on predictive scales, such as the Palliative Performance Scale (PPS), which allows the formulation of a prognosis and a time estimate of survival of a patient in Palliative Care[8].

It should be noted that the philosophy of Palliative Care is to integrate death in the progression of life and opposes the firm therapeutic obstinacy and the idolatrous cult with the biological dimensions. It does not intend at any time to abbreviate or postpone death, it seeks relief from pain and other symptoms, integrating the social and psychological aspects of comprehensive care[9].

In this context, to end this important dynamic that involves death and dying, given the need to provide autonomy to patients and their families in the face of a diagnosis of short-term impossibility, advance directives of will emerge and, in this perspective, the possibility of registering the will vital.

The living will originated in the United States of America (USA), precisely in 1969, when LuisKutner proposed the adoption of the living will, known in Brazil as the living will, a document that would serve to protect the individual right of the human person and allow death. In other words, the living will proposed by Kutner was based on the assumption that the patient has the right to refuse to undergo medical treatment whose objective is, strictly, to prolong his life, when his clinical condition is irreversible or in vegetative state with no possibility of recovering their faculties, currently known as persistent vegetative state[9].

In countries with a legal tradition similar to Brazil, such as Spain, DAV can be public or private. The first modality admits two forms of registration: a) in a registry office, by means of a public deed, without the presence of witnesses; b) in front of an employee working for the Administration, designated by the Health Council. In the second, the document must be signed by three capable witnesses, and of these, two cannot have a family relationship or a pre-established legal relationship with the grantor. It is noteworthy that the justification for the second possibility is to avoid having to resort to third parties, such as witnesses or notaries, for an act that falls within the sphere of personal autonomy and intimacy of people[9].

The current state of knowledge has allowed the development of a range of technical, technological and therapeutic possibilities that can be used in the most varied clinical situations. However, since the 1970s, CPR has not been considered an eligible therapy for all critically ill patients. Due to the irreversibility of the clinical prognosis in certain clinical situations, limits are imposed on the health care team in the fight for a cure. From this postulate, ONR emerges, the first measure capable of refusing a specific therapeutic intervention. The ONR is a matter of marked importance, which assumes clear and significant importance in promoting respect for the dignity of human beings in such a delicate phase of life, such as the terminal phase. Their discussion is understandably uncomfortable, given their duality between being able to assume death in case of CPA and the responsibility to prevent taking a futile attitude, that is, carrying out a harmful intervention, contrary to the person's interest[8].

It is described that physicians feel insecure about adopting ONR, although there is a consensus that the decision to implement such conduct in medical practice is essential. The insecurity comes from the lack of a guideline, as the legal aspects intimidate many professionals who fear lawsuits for omission of help. In view of this fact, the need for a clear guiding directive is

evident, in which respect for the patient's autonomy should be in the foreground. CFM Resolution n. 1995/2012, addressed the need for the existence of a regulation of advance directives of the patient's will in the context of Brazilian medical ethics. It also considers the relevance of medical behavior in the face of critical situations experienced by terminal patients. The CFM Resolution n. 1805/2006, gives the physician the power to decide whether resuscitation procedures are necessary or not when the patient is in a serious condition[3,9].

The Federal Council of Medicine (CFM) published Resolution No. 1995/2012, which establishes guidelines for any patient, as long as they are of legal age and fully conscious, to define with their physician what therapeutic limits they wish to receive during terminally ill and unable to decide on their care. Under this resolution, the physician must, when informing the patient of this possibility, always observe the dictates of the Code of Medical Ethics, and that such provisions of the patient will prevail over any other non-medical opinion, including the wishes of family members. In addition, the physician must record in the medical record such advance directives of will[7].

The advance directives of will can be defined as written instructions in which the person, freely and properly clarified, exposes their wishes and positions, in order to guide future decisions regarding their health. They are carried out from the moment there is medical proof that the patient is unable to make decisions, and can be written by all adult individuals, regardless of their current state of health. Within this scenario, there are two types of advance directives, namely: the lasting mandate and the living will. The lasting term corresponds to the appointment, by the person, of someone he trusts to make decisions about his health care, in case he becomes incapable. The living will is a legal document, in which the patient defines the type of treatment and medical procedure he wishes to undergo when the reversal of his clinical condition is no longer possible and he is not able to make decisions[10].

In general terms, this document is a form of manifestation of previous wishes, in case someone is diagnosed with terminal illnesses that make it impossible to make a conscious decision. The living will may deal with the refusal and/or acceptance of treatments that artificially prolong life, provision for organ donation and the appointment of a representative. However, the patient cannot refuse palliative care, as they are considered essential for maintaining the ethical and constitutional principles of human dignity[7].

Making decisions based on the best evidence for good health practices, which enable the best results for patients when they are unable to effectively communicate their wishes is a daily occurrence in the daily lives of many professionals, especially physicians. The importance of informed decision-making shared by the health professional who attends the patient is essential for the quality of care and, above all, for good results. Literature shows that patient participation in treatment leads to better results, which is in line with the understanding that for the maintenance of the health of a sick person, the basis of care is a good and comfortable relationship between the professional and the patient[11].

In 1991, the US Congress passed the federal "Patient Self-Determination Act", a law that recognized the patient's right to self-determination. By the mid-1990s, all US states had expressly recognized the legality of such a document. In the meantime, there were two types of advance will directives: living will and durable power of attorney for healthcare (DPAHC). While the living will consisted of the document by which the individual manifested the refusal of treatments in the face of a terminal diagnosis or proof of Persistent Vegetative Status, the DPAHC, translated as a lasting mandate, consisted in the appointment of people to make decisions regarding treatments for health for which this individual would want to submit to the condition in which he was no longer able to respond consciously, due to permanent or temporary incapacity[12].

In Latin America, Puerto Rico was the first country to legislate on DAV and, more recently, Argentina and Uruguay have also done so. Although Brazil has not yet legislated on this topic, on August 31, 2012, the Federal Council of Medicine (CFM) approved Resolution CFM n. 1995, recognizing the patient's right to express his will on medical treatments and appoint a representative for such purpose, as well as the physician's duty to comply with the patient's wishes or their legal representative. This resolution corroborated to heat up the debate, especially on the need for legislative regulation of advance directives of will. This is because, as a professional body, the resolution has normative force only among physicians, not having the legal force to regulate essential aspects of the subject among other professional categories and other segments of society, such as formalization, content, capacity of grantors, the validity period and the creation of a national registry[12].

In Brazil, ONR are not supported by legislation, which obliges health professionals to apply CPR in all cases, except when death is unquestionable. This creates space for debate on the eminent and unquestionable need to build, based on scientific evidence and consensus in the

literature, standardized behaviors that support the work of professionals, taking into account the moral and ethical aspects of each situation and always bearing in mind the well-being of the people involved. Physicians are not required to perform CPR maneuvers on patients with clear signs of death (cadaverous stiffness, decapitation, decomposition, or cadaveric livor), even when requested by family members. Other criteria for not starting CPR maneuvers are prior court order not to resuscitate; absence of physiological benefit due to deterioration of vital functions despite the best available treatment and neonates whose pregnancy, low birth weight or congenital anomalies are associated with early death[9].

Finally, the class character of the CFM resolution does not detract from its merit, on the contrary, it turns the eyes of society in general to the debate on this extremely important issue, given that many Brazilian citizens have already sought out the notary offices, seeking to register its advance directives, showing that the theme has social importance to justify the debate[12,13].

IV.   CONCLUSION

The results pointed to the difficulty of doctors and health professionals in talking about the subject, however, it was found that they believe in the patient's autonomy as a fundamental factor in the decision process, as well as the participation of family members and a multidisciplinary team. It was possible to observe reports that professionals do not agree with disproportionate procedures when dealing with patients with terminal illnesses and have a clear notion about the importance of palliative care in clinical practice.

The physician has a duty to always respect the opinion of the patient and their families, and this is strongly recommended and accepted in the guidelines and ethical principles. When a doctor or hospital goes to court, it is because the case needs special attention. The same happens when a family member takes action against a doctor's decision.

The decision to implement ONR should be something that starts to be part of the medical routine, but before that there needs to be legislation in force for this purpose, so that, in this way, the medical team can make the necessary decisions with legal support, without the fear of losing your record due to unnecessary processes.

The decision-making process related to the end of life involves a series of cultural issues that make the debate on the subject difficult, such as the process of denying death and the desire to fight for life, at any cost.

In the Brazilian scenario, there is still no tradition that values patient autonomy, as happens in other countries, and, therefore, the final decision often ends up being taken by the medical team and multidisciplinary team, which most often seek to assist to ethical principles to ensure greater well-being and quality of life for patients and their families, as well as the end of life with minimal discomfort, pain and suffering.

The end of life tends to be a conflicting, controversial and complex period, in which the central figure, the individual in the process of death, and others involved experience intense feelings and emotions, which should be debated based on ethical principles shared between the patient, family members and health professionals.

The unquestionable advances in the process of managing the well-being of terminal patients achieved in recent years have made it possible to prolong the lives of many people. However, it brought a dilemma, it is complex to increase longevity without extending the suffering. The euphoria that arises with the longer life expectancy conflicts with concomitant problems that present themselves over the years, especially in the health area. In this scenario, the dignity and autonomy of the human person in the terminal stage emerge as guiding and guiding elements, fundamental in decision-making that involves this stage of life. In short, the discussion about ONR raises different issues, not only of a clinical, legal and economic nature, but also of an ethical nature, which we believe are far from consensus.

Despite being over 40 years old, the ONR is still unclear, which is why it is inferred that there is still a long way to go, both in terms of educating the population and, above all, health professionals, as well as in terms of standardization this decision-making in legal terms, so that its discussion and application becomes transversal and independent of the figure of the doctor or the institution.

Above all, the need to promote a multidisciplinary debate about the issues that permeate the end of life is highlighted, given the current and growing technical and technological capacity of science to prolong life. We believe that it is increasingly important for palliative medicine to grow, so that the end of life is increasingly provided with greater comfort and quality, but above all, with greater dignity and autonomy.

The consent for the implementation of the ONR must be a joint decision, in which, the objective, must always offer the best for the patient and their families, supporting such decision in ethical precepts. Respect for the dignity and autonomy of the patient is the main factor that must be considered in decision making, not only for the implementation of the ONR, but for any procedure that may be performed on the patient.

Finally, we recommend that the inclusion of debates on the end of life should be carried out in such a way that it starts to generate interest on the part of health professionals. We consider it important that the terminality of life theme is better addressed during graduation, not only in the theoretical context, but mainly in practice, which may be the object of other studies.

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Histological description of fresh, cooked and frozen cassava flesh

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Abstract— The aim of this study was to describe the histological feature of cassava flesh at harvest, after cooking and after freezing. A light optical microscopy was used to analyze the relevant aspects of cassava flesh at these statuses. The non-uniform aspect of cooked cassava is associated with the partial dissolution of the middle lamella and the large amount of non-collapsed cells, while the formation of numerous spaces between cells determines the spongy aspect of cassava after freezing. These data increase the knowledge about cassava post harvest and its processing.

I. INTRODUCTION

In many countries of Africa, Latin America and the Caribbean, cassava (*Manihot esculenta* Crantz) storage roots are mainly consumed just boiled [1]. Sweet cassava is normally cultivated for this propose and the consumer acceptability is based on the final texture (mealiness) and a low time of cooking [2].

In order to guarantee a high quality or large shelf life of boiled or processed cassava - peeled, frozen and precooked, different approaches are necessary. [3]; [4] and [5] suggested the after cooking quality is related to de tissue condition, what is dependent of storage and time conditions, age of the plant as well as cell and tissue composition. However, [6] suggested the interaction between the components of the tubers and the structural make-up of the tuber tissues [7] play a more important role than the physicochemical and functional properties

Thus, studies regarding the comparison of cassava texture at harvest, after cooking and after freezing increase

our knowledge about cassava texture and can bring light for different processing process. The current study aimed to describe the histological status of cassava flesh at harvest, after cooking and after freezing.

II. METHODOLOGY

Seven months old cassava storage root of IAC 576-70 genotype were harvested manually at the experimental field of the College – (Further information will be provide after review process). The IAC 576-70 genotype is a sweet cassava largely cultivated and eaten in Brazil [7].

At harvest time, six roots from different plants were harvested and their middle parts were used for sample preparation and posterior microscopy observation. The roots were washed, peeled and sliced into small pieces of 0.05 m. samples were classified into three categories namely raw, cooked and frozen.

Samples were classified into raw, cooked and frozen cassava. Raw cassava comprised of the flesh of freshly harvested roots. For cooked cassava, the 0.05 m pieces were cooked in water at 85 ℃ for 30 minutes according to [8] and afterwards, sample was cooled at room temperature. Frozen cassava was obtained by packaging part of the 0.05 m cassava pieces in a plastic bag in a freezer at -20℃ for 24 hours.

After having the raw, cooked and frozen samples, they were prepared for the histological analysis. Sample preparation for histological analysis was previously fixed in a medium constituted by 50 % ethanol: 10 % formalin: 5 % acetic acid for 48 hours and stored in 70 % ethanol until used [9]. After at least 2 weeks they were dehydrated with gradual alcohol concentrations according to [9] and embedded in historesin [10] (Leica® Germany) .

The resulting blocks were sectioned at 8 μm thickness with a microtome (Leica RM 2025; Leica®, Germany). The sections were stained with 0.05 % toluidine blue at pH of 4.7 according to [11] and mounted on slides with Entellan (Merck Millipore®, Germany). The relevant aspects from the various sections were observed under a light microscope (Zeiss®, Inc., NY, USA) and the images were taken by a digital camera (Olympus®, Japan), connected to a microscope (Zeiss®, Inc., Thornwood, NY, USA).

III.   RESULTS AND DISCUSSION

Fresh cassava flesh is mainly constituted by parenchyma cells with primary cell wall with different thickness. Lignified cells were represented by the vessel elements, dispersed among the modified xylem and ranged inside the axial and radial ray (Figure 1). Cassava flesh is a modified secondary xylem adapted to store carbohydrates as starch grains. This tissue comes from the activity of the vascular cambium during secondary growth or the growth in thickness of the roots. Cassava flesh is composed of parenchyma cells, few vessel elements and fiber, all these cells differ quantitatively depending on the stage of development of the root [7].

As shown in Figure 1, the fiber content of cassava flesh is composed of cell wall substances and cannot be considered as a fiber in the anatomical sense. According to [12], the fiber present in cassava is mainly composed of cellulose, hemicellulose and pectin, and their amount vary according to the morphological part of the flesh, the age and the environmental conditions. [7] have shown that the fiber cells only exist in the region of the central cord, and fiber cells and vessel elements are the only cells with secondary walls – have lignin in their composition, representing only 5-10 % of cassava flesh.

After the cooking process, the flesh presented a non-uniform aspect (Figure 2), with intercellular spaces. The increase of intercellular spaces is attributed to the gelatinization of pectin [13], which is a component of the middle lamella and parenchyma cell wall [12]. Few parenchymatous cells collapsed and no starch granules were observed inside the parenchyma cells (Figure 2C). The absence of starch granules inside the parenchymatous cell shows the effect of temperature in the starch, and that the cell wall is not a physical barrier for the starch gelatinization.
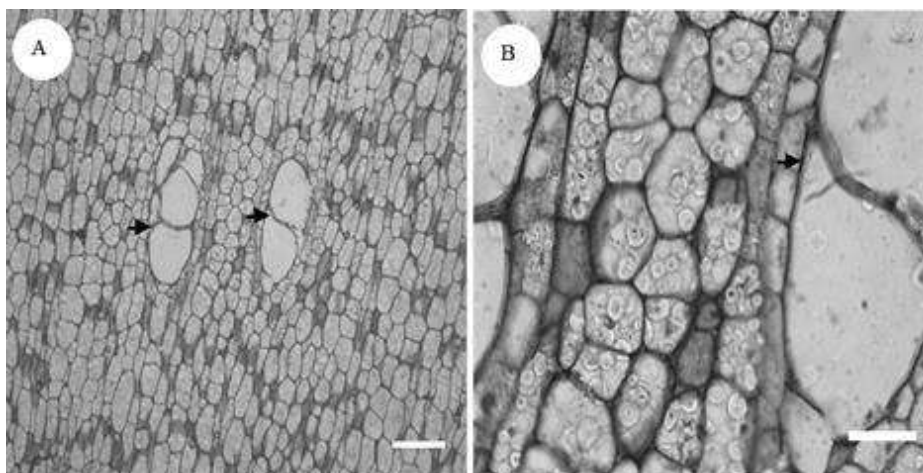
Fig.1: Cross sections of fresh cassava flash. A. Secondary xylem with parenchyma cells and vessel elements, scale bar = 150 mμ and B. Detail of A., showing starch granules, the presence of primary cell wall thicknesses and the presence of lignin only in the vessel element cell wall (arrow), scale bar = 50 mμ.
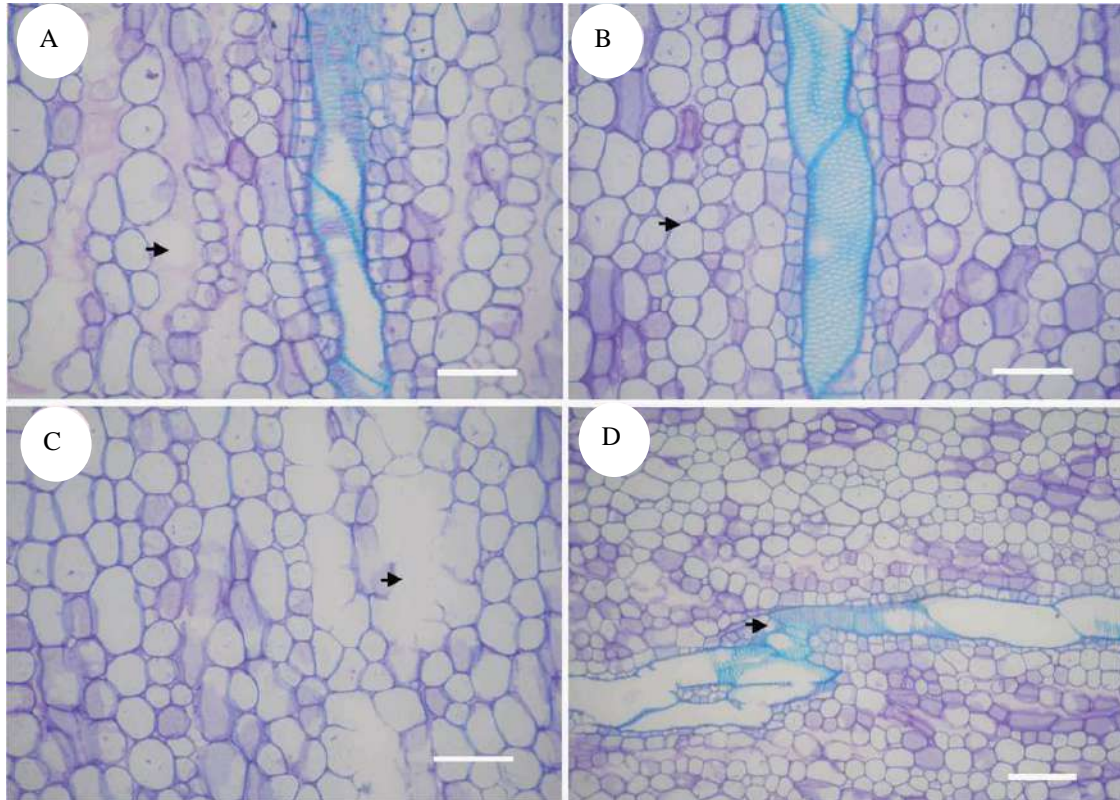
Fig.2: Cross sections of cassava flash after cooking. A and B longitudinal section (A. arrow showing flesh with non-collapsed area; B. arrow showing spaces caused by the dissolution of the middle lamella); C. Transversal section (arrow showing collapsed cells); D. Radial section (arrow showing vessel elements). Scale bar = 100 mμ.

The chemical composition of pectin present in the middle lamella and cell wall is different [5]. The pectin of the middle lamella confers cell adhesion; it acts as cementing agent giving shape, firmness and strength to the cells. This property of pectin may be correlated to the non-uniform texture of the flesh after cooking. [4] has shown that the mealiness of cooked potato (*Solanum tuberosum* L.) is determined by the chemical composition of the cell wall. The results obtained in our study support the observation of [4], since cooked cassava flesh has presented a complete starch gelatinization, while major parenchyma cell wall remained intact.

After the freezing process, cassava flesh presented a spongy aspect. The microscopy observation showed the presence of many opening spaces between the cells (Figure 3) and the presence of plasmolyzed cells. The spongy aspect of the flesh after freezing may be explained by the dehydration process caused by the formation of ice crystals in the intercellular region [14]. According to [15], during freezing the formation of ice occurs firstly inside the intercellular region because of the lower concentration of dissolved solutes. The presence of ice in this region induces a vapor pressure gradient between the inside and the outside of the cell, inducing some water flow inside the cells, promoting the increase of the ice crystals and consequently the separation of the cell walls.

A similar phenomenon was observed in green bean by [3]. He observed that the damage rate of parenchyma tissue decreased with the increase of freezing rates. The increase of the size of crystals induces a pressure on the cell wall and membranes and subsequently breaks them. The decrease of the available water inside the cell because of ice formation induces an increase in the concentration of solute inside the cell, decreasing the freezing point and subsequently the formation of crystals within the cell [3]. The increase of the solute concentration inside the cell as well as the spaces formed among the parenchyma cells because of ice may certainly contribute to the decrease in cooking time as previously observed by [16].
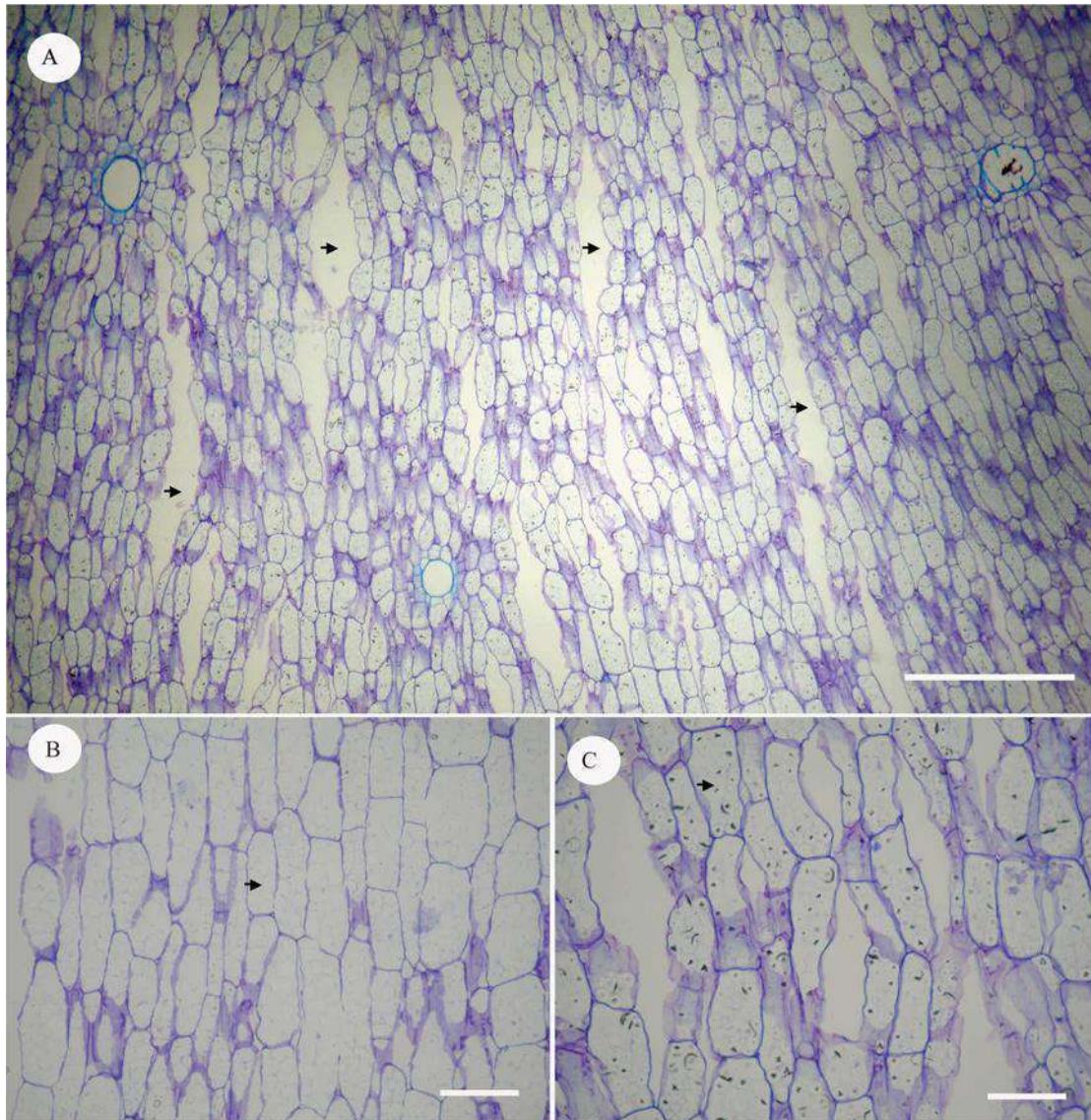
Fig.3: Cross sections of cassava flash after freezing. A. Reserve tissue with numerous gaps between cells (black arrows), scale bar = 500 mµ; B. Intact parenchyma cells (black arrow); C. Plasmolysed cells filled with starch grains (black arrow), scale bar = 100 mµ

IV. CONCLUSIONS

The non-uniform aspect of cooked cassava is associated with the partial dissolution of the middle lamella and the large amount of non-collapsed cells, while the formation of numerous spaces between cells determines the spongy aspect of cassava after freezing.

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Rural Credit in Family Agriculture: An analysis of the distribution of PRONAF resources in Pará from 2016 to 2020

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Abstract— Over time, family farmers have been on the sidelines of public policies that have fostered their development since the colonial period. However, after the promulgation of the Federal Constitution of 1988, added to various social movements that claimed policies that really assist this people, in 1995, the National Family Farming Program (PRONAF) was created, with the objective of enhancing the development of farmers, with an increase in income, quality of life, number of jobs, in addition to the permanence of man in the countryside. Thus, this study aimed to analyze the distribution of PRONAF resources in the state of Pará in the period from 2016 to 2020. Taking into account that in Pará rural establishments are predominantly family farming, corresponding to more than 85%. Therefore, this study found that the state of Pará had a share of more than 21.9% of the resources distributed in the Northern Region in 2020, obtaining expressive growths in the period studied in the costing modality, with emphasis on the livestock activity this year, It is noteworthy that over the period studied there was an increase of 183% in the total value of PRONAF resources financed in the state of Pará, and that in 2020 the state received R$ 490,666,354.83 totaling 12,674 contracts. Furthermore, it is worth noting that the southeast region of Pará was the region that had the greatest increase in receipts of resources from PRONAF in the period studied, 184% between the years 2016 to 2020. That the work of rural extension needs to be implemented more and more in the state, in order to help in the projects and that more resources can be available to small farmers who need it so much.

I. INTRODUCTION

Agriculture has been practiced since the beginnings of society, at first it was used on a subsistence basis, however over the years, in addition to producing for their own consumption, man started to allocate the surplus production by bartering, and finally, the commercialization of food. Throughout history, agriculture has gone through several phases of transformations and modernizations that mainly benefited the large and more capitalized landowners.

In Brazil, agricultural modernization caused the same reflex, since only employers' agriculture benefited the most from these advances. From a governmental point of view, the State has always implemented public policies that benefit the largest farmers more, leaving small farmers or family members on the sidelines of these policies.

Although large producers have their importance, family farming has a very important role in Brazilian society. In addition to the economic, environmental, social and cultural benefits, it is responsible for a large part of the food that arrives on Brazilians' tables; in addition to helping to mitigate the rural exodus, diversifying its products, employing most of the jobs in rural areas, among many other factors.

Only after the Federal Constitution in 1988 with the legal reorganization of the state, added to the demands of rural movements that the Government implemented the first public policy in the context of family farming, the National Family Farming Program (PRONAF) created in 1995 with the objective of promoting the development of family farming through the granting of rural credit, in order to guarantee the permanence of man in the field, as well as the possibility of growth and perpetuity of the activity.

Therefore, this work aims to analyze the distribution of PRONAF resources in the state of Pará in the period from 2016 to 2020. And as specific objectives: to analyze the distribution of the number of contracts and financial amounts allocated in the costing, investment, commercialization and industrialization; in addition to verifying the greatest incidence of subprograms in the modalities present in the program.

A.   Portraits of family farming in Brazil

Among the Brazilian economic activities, agribusiness has been renowned. In this scope, family farming is responsible for guaranteeing a good part of the food that is on the table of Brazilians, in addition to guaranteeing employment in rural areas, being crucial to alleviate the exodus in the countryside [1]. There are records that the production of food and domestication of animals took place between 5,000 BC to 10,000 BC, where plants began to be cultivated and animals managed for their own subsistence, as well as bartering. From that point on, agriculture and at the same time animal husbandry evolved and spread around the world [2][3].

In Brazil, although agricultural production had been practiced for a long time by the Indians, it only gained more notoriety and greater dimensions after the discovery of the country in 1500, when it began to be developed by Portuguese colonizers [4]

The forms of production in Brazil Colony were export-oriented and experienced various economic cycles such as: mining, rubber, sugar and coffee. Soon, there were large properties of land destined for the production of monocultures that were under the yoke of Portugal

In this juncture, subsistence agriculture was formed, as large producers grew and benefited, on the other hand, throughout history small subsistence farmers and low production capacity were left out in the open [5].

The same author discusses that Brazilian agriculture has gone through several periods of transformation, including the Post-War period in which the policy of "modernization" of Brazilian agriculture was adopted, with significant changes occurring in the agricultural dynamics. However, it also brought negative environmental and social externalities in the last decades of the 20th century. After the mid-1950s, several debates began to be discussed and raised in defense of family farming that over the centuries was left abandoned and unattended by the State.

Castro, Resende and Pires[1] corroborate some aspects stating that farmers received little support from the State to develop their activities.

Family farming was forgotten by all entities of the federation during the process of modernization of Brazilian agriculture, which began after World War II. It was only after the promulgation of the Federal Constitution of 1988, with the legal reorganization and the endorsement of organizations and social movements that the discourse of the need for public policies in the area of family farming, especially rural credit, became solid [6]. The National Program for Strengthening Family Farming (PRONAF) created in 1995 was the first public policy focused on family farming [6] [7] [1].

There is a great deal of discussion about the concept of family farming, for Corrêa, Maneschy and Sobrinho[8] family farming is characterized by agricultural establishments, so that the production system is carried out by the family, being developed mainly as a source of subsistence with the objective of meeting food needs.

Usually, family farmers have a low level of education, production is diversified, with a view to increasing income by taking advantage of environmental opportunities and the availability of local labor [1].

This subsistence activity is responsible for a large part of the food that is produced to feed the population [9]. In large part, there is a diversification of cultivated foods, little technology is used, production is low-income, and one of the most notable characteristics is that the management of the activity is family-run, as well as the

workforce [7]. Troian and Machado[10] brought together some distinct definitions about the expression "family farming" that can be seen in Table 1 below.

Table 1: Different definitions for the expression family farming

Definitions for the expression family farming	Author
Characterized as one in which the family performs productive work while owning the means of production. It has a productive structure that involves family-production-work and all the strategies defined by the family tend to ensure its immediate survival and guarantee the reproduction of subsequent generations.	Wanderley (1996)
Production unit with extremely different, varied and similar conditions. Non-homogeneous social group, which has eccentric adaptive competence.	Lamarche (1997)
It does not fit into a single model and involves cultural aspects in the way of life and how it is associated with economic activities. They associate family relationships with productive activities and have a vocation to adapt to peculiar regional situations, incorporating and adapting their mode of production to local characteristics.	Carneiro (1997)
Those who practice activities in the rural environment basically meeting the following conditions: the activities in the productive space to be practiced predominantly by the producer and family; that is, family labor is greater than contracted work, and the extension of the productive space is within an area specifically determined for each region of the country.	Guanziroli e Cardim (2000)
The forms of productive organization adopted go beyond production/economic profitability, taking into account the needs and objectives of the family.	Carmo (2000)
Units made up of domestic groups that carry out their work under a family economy, united by parental and consanguineous ties.	Schneider (2006)
Farmers who practice activities in rural areas, meeting, simultaneously, the following requirements: "I – does not hold, under any title, an area larger than 4 (four) fiscal modules; II – predominantly use labor from the family itself in the economic activities of its establishment or enterprise; III – has a minimum percentage of family income originating from economic activities of its establishment or enterprise, as defined by the Executive (Wording given by Law No. 12,512, of 2011); IV – run your establishment or business with your family".	Brasil (2006, art. 3)
Influential conduct of the family in the organizational structure of social reproduction, through the development of family and individual strategies that influence the transfer of material and cultural heritage. Family farming mode in which property and work are linked to the family.	Savoldi e Cunha (2010)

From the table, it is clear that the concept of family farming has matured, due to the large volume of studies and research related to the subject. Among the definitions listed in Table 1. It is worth highlighting the creation of Law 11.326, of July 24, 2006, which defines the guidelines for the formulation of public policies for this segment, in addition to identifying this public by defining the criteria. The law establishes that the property is classified as family farming when activities are carried out in rural areas, has an area of up to four fiscal modules, labor from the family itself, income linked to the establishment itself and that the management of the property or enterprise is carried out by the own family. The following are included as beneficiaries of family farming according to the criteria defined in the law: foresters, aquaculturists, extractivists,

fishermen, indigenous peoples, remnant communities of rural quilombos and traditional communities [11].

The Ministry of Agriculture, Livestock and Supply (MAPA) adds that family farming is formed by small rural farmers, traditional peoples and communities, land reform settlers, foresters, aquaculture, extractivists and fishermen. The main products produced by this sector are: corn, cassava root, dairy cattle, beef cattle, sheep, goats, vegetables, beans, sugarcane, rice, swine, poultry, coffee, wheat, castor, fruit and vegetables. Of the 5 million rural properties in the country according to the 2017 Agricultural Census, around 77% of agricultural establishments were classified as family farming, occupying an area of 80.9 million hectares which

corresponded to 23% of total rural establishments Brazilians. Furthermore, the sector employed more than 10 million people in September 2017, which corresponded to 67% of those employed in agriculture [9].

B.   Family farming in the state of Pará

The state of Pará, located in the Amazon biome, is the second largest in terms of territory and one of the richest states in the great North Region, with an area of 1,245,870,707 km² and an estimated population of 8,690,745 people, distributed in 144 municipalities [12]. The State is divided into six geographic Mesoregions, which are a set of municipalities in a geographic area that have similarities in common in economic and social areas and belong to the same Federation Unit, defined by the dimensions: social process, being determinant, the aspect natural, as a condition, and geographic and communication elements, as a spatial factor of articulation [13].

Thus, the following geographic Mesoregions make up Pará: Baixo Amazonas with 15 municipalities; Marajó with 16; Metropolitan of Belém with 11; Northeast Pará with 49; Southwest of Pará with 14; and Southeast Pará with 39. In these Mesoregions of Pará there are 22 geographic microregions. Of these Mesoregions, the ones with the greatest predominance of family farming are the Northeast and Southeast with more than 60% of rural family farming establishments, whereas in the Northeast region of Pará it held more than 40% and the Southeast of Pará with 21%.

According to the 2017 Agricultural Census, Pará had 281.7 thousand rural establishments, of which more than 85% were family farm establishments. Rural establishments had an area of more than 28.4 million hectares in Pará, and family farming in relation to this area represented 30%. This sector employed almost 80% of all personnel who were employed in the field, which was over 979 thousand workers [14]. These data show the importance of this activity in economic, social and environmental aspects.

The Pará economy is based on industry sectors; agriculture and livestock; and trade and services [15]. According to the Agricultural Defense Agency of the State of Pará (ADEPARÁ) agriculture, in addition to being responsible for most of the food that arrives on the table of Brazilians daily, in Pará the agricultural production chain is responsible for almost 40% of the state's economy. In 2017, the state occupied the first position in the production of cassava, açaí, cocoa, citrus and oil palm crops, standing out in these productions in the country [16].

This predominance of family farming in the state of Pará is repeated in many municipalities in the Amazon, although in recent years family farming has been losing ground to monoculture, especially in Southeast Pará, where the agricultural frontier area in which soybean is located is located. main crop, so that it had an increase of 684% in planted area, going from 71 thousand hectares in 2008 to 557 thousand hectares in 2018 [17]. Despite this, there are many municipalities that still have a very strong agricultural and/or extractive tradition. Family farming represents the essence of society, supplying the market and having a direct influence on organized social movements [8].

C.   PRONAF's public policy as a financial support for family farming in Brazil

Public policies are the product of government, their construction is carried out by various social actors that make up a complex social game. The process of formulating, implementing and evaluating policies is carried out in a completely political environment. This construction is conceived through the interaction between the State and society, resulting in actions that will impact and benefit the collective interests and needs of various individuals and segments of society [18].

For a long time, family farming was on the sidelines of society, lacking public policies to promote and include in political agendas, considering that throughout the Brazilian historical process, public policies were exclusively aimed at employer agriculture, benefiting the most capitalized [19]. After the promulgation of the Federal Constitution of 1988, with the legal reorganization of the Brazilian State, debates around public policies that benefit the rural environment, especially in family farming, became more discussed, gaining great notoriety in the agendas of policies that came to benefit this segment [20].

Troian and Machado[10] highlight that, throughout history, public rural credit policies have been unable to meet the needs of family farmers. However, with the consolidation of the 1988 Constitution, several social movements endorsed the speech and demanded that the Federal Government elaborate specific policies for family farming, with the aim of promoting rural development [20].

In this scenario, several organizations and social movements were created, such as: the Single Workers Center (CUT) in 1983; National Department of Rural Workers (DNTR) in 1988; Landless Workers Movement (MST) in 1984; Movement of People Affected by Dams (MAB) in 1991 and National Council of Rubber Tappers (CNS) in 1985.

In the following years, such organizations elucidated their creations even more the precariousness of Brazilian family agriculture and the need for policies on the part of the State that would benefit them, highlighting agrarian

reform and rural credit [21]. As a result of these claims, in 1994 the government of Itamar Franco created the Program for the Valorization of Small Rural Production (PROVAP), which was subsidized with resources from the National Development Bank (BNDES). This program was the kickoff for the PRONAF public policy that was to be created two years later. In 1995, during the government of Fernando Henrique Cardoso, PROVAP was remodeled, increasing its coverage area [22]. PRONAF was established in 1995 by resolution No. 2191 of August 24, 1995, through the Central Bank of Brazil, offering financial support to farmers [23][24].

In 1996, PRONAF was implemented by Presidential Decree No. 1,946. In 1996, the creation of this public policy had the objective of promoting rural development through the granting of credit, being considered as one of the main public policies in rural areas based on financial volume and the number of benefited farmers [25] [6]. Until the early 1990s there was no public policy at the national level that specifically benefited family farming, therefore, PRONAF was implemented with the premise of including and meeting the needs of this social segment [26][27][28].

According to Sena and Barbosa[29], the main objective of the program is to provide resources for financing production, acquisition of equipment and infrastructure in family farming establishments, as well as providing an increase in the farmer's income, therefore the permanence of the man in the countryside avoiding the rural exodus [30]. Diniz Filho and Zafalon[31] strengthen this statement, saying that PRONAF was established in the 1990s to support family farmers. On the other hand, Pêssoa[32] highlights that PRONAF aims to socially strengthen the category of family farming, with the objective of enhancing development in the rural environment, with actions aimed at increasing production, improving the lives of farmers, maintaining jobs and insertion in the market.

Among other features, the program aims to alleviate the adversities faced by rural farmers in remaining in the countryside, so the possibility of getting a credit allows the farmer to have capital to increase productive capacity, purchase equipment, inputs, improve infrastructure.

The credits granted by the program can be used for funding, marketing, investment, industrialization or integration of quotas by beneficiaries in agricultural production cooperatives. The criteria regarding credit limits, terms and interest will depend on the purpose. The program has low interest rates ranging from 3% to 4.6% per year and advantageous terms and payment conditions [1][24][30]. In addition to enabling a variety of credit lines as summarized in Table 2.

Table 2: PRONAF credit lines

Credit line	Farmer group
Pronaf Costing	It is intended for financing agricultural activities and processing or industrialization and marketing of own production or that of third parties classified under Pronaf.
The Pronaf Plus Food/Investment	Aimed at financing the implementation, expansion or modernization of production and service infrastructure, agricultural or non-agricultural, in rural establishments or in nearby rural community areas.
Pronaf Agroindustry	Line for financing investments, including in infrastructure, aimed at the processing, processing and marketing of agricultural and non-agricultural production, forestry and extractivism products, or handcrafted products and the exploitation of rural tourism.
Pronaf Agroecology	Line for financing investments in agroecological or organic production systems, including costs related to the implementation and maintenance of the enterprise.
Pronaf Eco	Line for financing investments in techniques that minimize the impact of rural activities on the environment, as well as allow farmers to better interact with the biome in which their property is located.
Pronaf Forest	Financing of investments in projects for agroforestry systems; ecologically sustainable extractive exploration, forest management plan, restoration and maintenance of permanent preservation areas and legal reserve and recovery of degraded areas.
Pronaf Semi-Arid	Line for financing investments in projects for coexistence with the semi-arid region, focused on the sustainability of agro-ecosystems, prioritizing water infrastructure and the implementation, expansion, recovery or modernization of other infrastructures, including those related to agricultural and non-agricultural production and services projects, according to the reality of

	farming families in the semiarid region.
Pronaf Woman	Line for financing investment of women farmer credit proposals.
Pronaf Young	Investment financing of credit proposals from young male and female farmers.
Pronaf Costing and Marketing of Agribusiness Relatives	Aimed at farmers and their cooperatives or associations to finance the cost of processing and industrialization of their own and/or third-party production.
Pronaf Quota-Part	Investment financing for the payment of quotas for family farmers affiliated to production cooperatives or for investment in working capital, costing or investment
Rural Microcredit	Aimed at low-income farmers, it allows for the financing of agricultural and non-agricultural activities, and the credits can cover any demand that may generate income for the assisted family. Credits for family farmers in Group B and female farmers belonging to family production units in Groups A or A/C

The main sources of resources for PRONAF, in addition to the BNDES, come from the Worker's Support Fund (FAT), which is currently the main source of resources with around 80% of the total since 1999. Other important sources are the Constitutional Funds of the Northeast (FNE), Midwest (FCO) and North (FNO) [22]. The main financial institutions responsible for providing PRONAF credits have been Banco do Brasil (BB), Banco do Nordeste (BNB) and Banco da Amazônia (BASA). For the farmer to have access to the program, he must meet the criteria and have a Declaration of Aptitude to PRONAF (DAP), which is one of the requirements that qualifies the farmer to have access to the program [29] [23].

Although PRONAF has been an advance for family farming in Brazil, however there are several studies that demonstrate that most financial resources have always been concentrated in a more elite group of family farmers, especially those located in the southern region of the country [6][10][23][25][33][34][35][36][37][38].

II. METHODOLOGY

The research was developed through a bibliographic study, using a quantitative approach. According to Gil [39], a bibliographic study is based on various scientific materials such as books, articles, dissertations and theses. For Lakatos and Marconi [40] "it is a general overview of the main works already carried out". Considering that one of the most relevant data sources that supported the research was the data collected on the IBGE website, specifically, from the 2017 Agricultural Census, with the state of Pará as the object in question. rural credit for family farming in the state through PRONAF [39][40].

In order to obtain more information on the volume and values handled by Pronaf, secondary data from the Central Bank of Brazil collected from the Rural Credit Data

Matrix in the field of contracts were used, so that they were analyzed in the aspects of the Major Regions, the state of Pará, and the different modalities and subprograms of PRONAF.

The data obtained in the aforementioned references were used in Microsoft Excel 2016 in order to carry out a statistical analysis of the percentages of historical evolution of financial resources allocated to PRONAF, allocated in the state of Pará during the period studied. As well as, in the manipulation of data, construction of tables, tables and graphs of the Mesoregions and the main cities where the resources were destined.

All the literature used as the basis for writing this article was gathered from articles, government documents, dissertations, monographs and journals available on the web. First, a general survey was carried out on the fundamental data related to Pronaf, so that, from that moment on, the theoretical basis on the subject could be carried out, so that the analysis of the program's specificities could be carried out.

III. RESULTS AND DISCUSSION

Through the 2017 Agricultural Census data, it can be noted that the state of Pará is predominantly formed by family farming, taking into account the number of rural establishments, reaching more than 85%[14]. In the state of Pará there were a total of 281,699 rural establishments according to the 2017 Agricultural Census, which corresponded to an area of 28,419,453 hectares. About 51% of Pará's land use was destined to pastures with more than 14.5 thousand hectares, another 37% were composed of forests with more than 10.5 thousand hectares and about 6% were destined to crops with more than 1 .6 thousand hectares[14]. It is observed that in land use the most predominant activity is livestock, a situation that has been

modified in recent years due to the entry of precision agriculture throughout the territory of Pará, in the last 10 years.

Of the area set aside for crops, around 47% (780,929 hectares) are permanent crops. On the other hand, temporary farming represented 53% with 889,790 hectares

and another very small percentage was destined to the cultivation of flowers, greenhouses and greenhouses. In Graph 1 below, the temporary crops that have the largest share in the state's total production in 2017 are shown in family farming, as shown above.

Graph 1 – Temporary crops produced by family farming with the highest share in 2017.
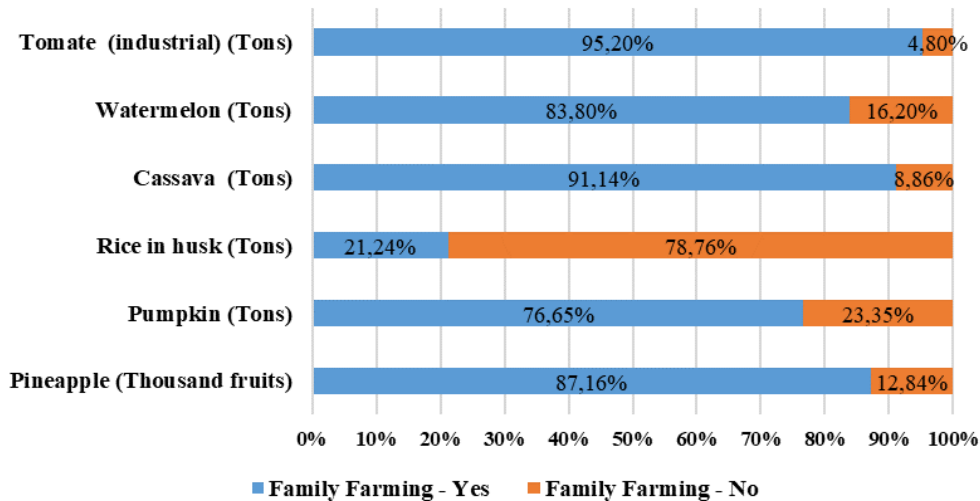
Source: Created by authors.

Note that of the temporary crops represented in the graph above, family farming is responsible for more than 75% of the state's production, with the exception of rice, which only represented 21.24%. However, crops such as cassava had a production of more than 1,041 tons, of which family farming was responsible for more than 949 tons.

Graph 2 presents a representation of the financial movement of PRONAF resources that occurred in the specified period. It could be noted that from 2016 to 2017 the Brazilian regions continued to grow, and as shown in this research by other studies, the South region in the period studied predominates as one of the regions that received the most financial resources in the 25 years of the program. The South region obtained an average of 55.22% of the amounts financed from 2016 to 2020. While the Southeast, Northeast, Midwest and North regions obtained an average of 16.32%; 14.59%; 7.09% and 6.78%, respectively. This inequality in distribution was identified in the studies by Schultz and Ahlert [23]; Troian and Machado[10]; Cruz et al.[42].

However, it is notorious to know that in the aforementioned southern region, there is greater

organization among the communities of family farmers, in association, unions, cooperatives, agrovilas, has political representation, great availability of technical assistance and ease in marketing and marketing its products[38].

It was observed that the South region presented a significant annual growth, while the other regions remained almost stagnant in relation to the distributed percentage of financed amounts. These facts reinforce the discourse of the concentration of financed amounts in the South region, which in 2020 alone was responsible for more than R$ 17.9 million of the R$ 31.1 million of amounts financed in the country. In the North region, Pará was the second state that received the most funding from PRONAF, only behind the state of Rondônia. The distributions of the number of contracts in the Brazilian regions are shown in Graph 3.

Graph 2 below depicts the movement of PRONAF resources distributed in the Major Brazilian Regions in the period from 2016 to 2020.
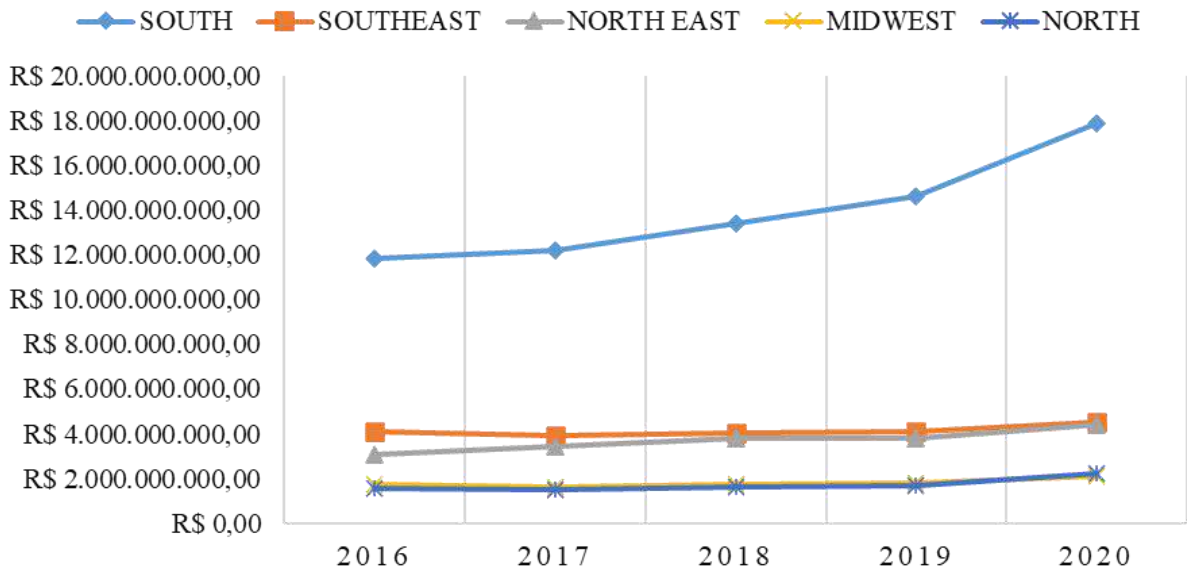
Source: Created by authors.

Graph 3 – Number of contracts distributed in the Major Brazilian Regions from 2016 to 2020.
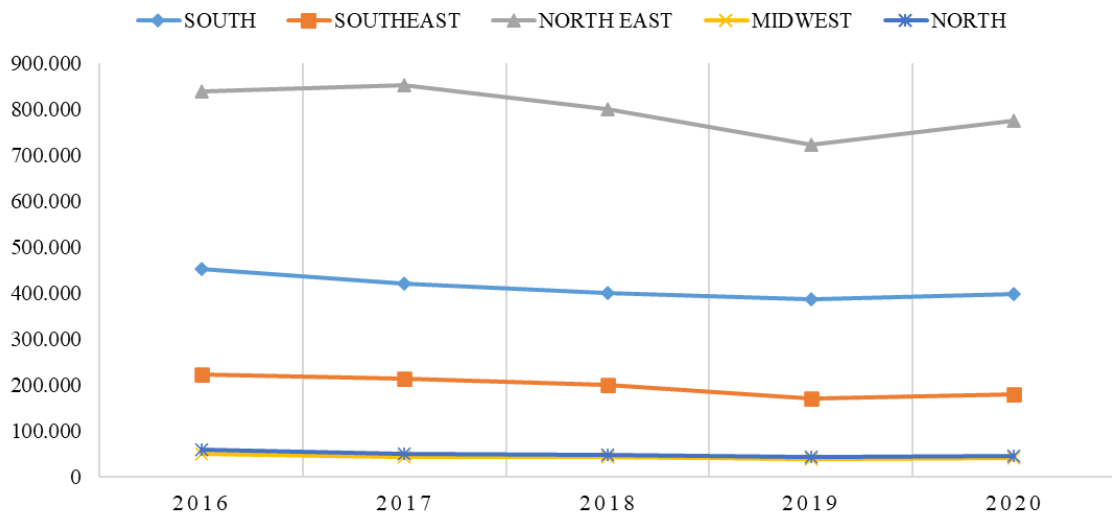
Source: Created by authors.

There was a drop in almost every year in the Brazilian regions, with a slight increase from the year 2020.

According to the study carried out by Grisa, Wesz Junior and Buchweitz[25], the South Region in 1998 accounted for 60% of contracts and the Northeast Region for 25%. In 2012, this reality began to change, with the South region accounting for 32.75% of contracts and the Northeast region for 45.48% of total contracts, while the

North and Center-West regions had small shares, never exceeding 6 % of the total. Over the years of PRONAF's public policy, the Midwest and North regions had the lowest growth in rural credit. Therefore, the regional distributions of resources are out of balance, which runs from 1999 to 2017 [10].

Although the southern region concentrates the largest amount of financing as seen in Graph 2, however, it is the Northeast region that holds the largest number of contracts. One of the reasons is that this region accounts for almost half of the number of rural establishments in Brazil, accounting for about 54% of contracts in 2020, followed by the South region with approximately 28% and the Southeast with 12%.

The regions that presented the lowest number of contracts were the Midwest and North regions, around 3% each of the distribution of contracts in the country. Both in the number of contracts and the amount financed in the

North region (which has 7 states), Pará has been in second place over the years, only behind the state of Rondônia and ahead of the state of Acre.

Through data from the Census of Agriculture, it is possible to verify that in 2017 only 6% (17,661) of rural establishments had access to some type of financing, of which 37% were financed by the government, while the other 63% occurred in the private sector.

Of the financing provided by the government, a percentage of 1.75% (4,940) of rural establishments received financing through PRONAF [14]. It is noticed that more than 75% of the financing made by the government consisted of the studied program. Graph 4 depicts the distribution of PRONAF resources from 2016 to 2020 in the state of Pará in the financed modalities.

Graph 4 – Analysis of the distribution of PRONAF resources in the state of Pará from 2016 to 2020.
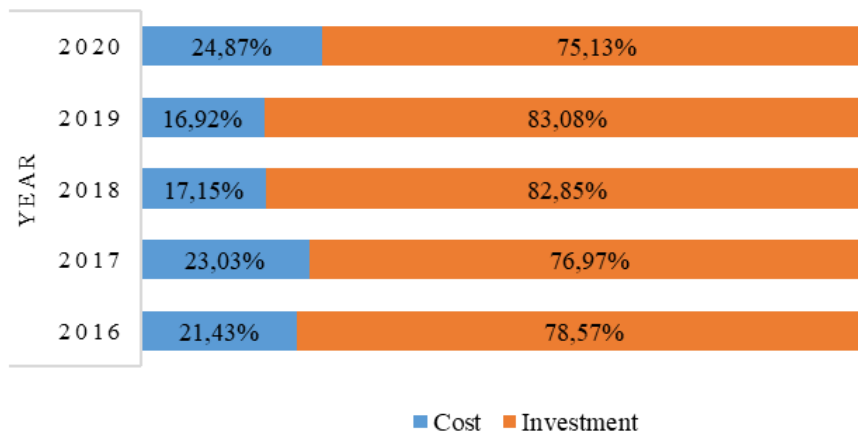
Source: Created by authors.

According to data provided by the Central Bank of Brazil (BCB)[41], in relation to the distribution of PRONAF financial resources, the state of Pará corresponds to 17.19% of the resources destined for the Northern region in 2017. Furthermore, it was verified that the modalities existing PRONAF: costing, investment, commercialization and industrialization, in the state there was only registration of contracts in the costing and investment modalities, as exemplified in Graph 4. It was noted that over the analyzed period, more than 75% of the resources were destined to the investment purpose.

It is important to highlight that in 2016, of the 57.18 million reais allocated to Pará, of this amount were allocated to the costing and agribusiness (investment) subprogram, corresponding to 99.98% and 0.02%, respectively. In the costing subprogram, 1,172 contracts were financed for the agricultural activity, totaling R$ 31,927,409.33. While in this same subprogram 1,132 contracts were allocated, resulting in R$ 25,249,970.46 directed to the livestock activity. The average values of the contracts corresponded to R$ 27,242.00 and R$22,306.00, respectively. For the agro-industry (investment)

subprogram there was only 1 contract for livestock in the amount of R$ 7,473.13.

The investment modality in 2016 had a total allocation of R$ 209,673,575.51 in the state of Pará. In this modality, the subprograms achieved consisted of: costing; microcredit; agribusiness (investment); woman; Forest; agrarian reform (microcredit); Eco (renewable energy and sustainability); it's young. In the year 2020, there is a marked growth in the livestock activity in number of contracts and financial values compared to 2016, as shown in Table 3.

Table 3: Distribution of PRONAF resources by activity, costing area, number of contracts and average value of contracts in the costing modality in 2016 and 2020.

Year	Activity	Area of Cost	Quantitative Cost	Cost Value	Average value of contracts
2016	Agricultural	R$ 11.397,56	1.172	R$ 31.927.409,33	R$ 27.241,82
	Livestock	R$ 1.242,33	1.132	R$ 25.249.970,46	R$ 22.305,63
	Total	R$ **12.639,89**	**2.304**	R$ **57.177.379,79**	**R$ 24.816,57**
2020	Agricultural	R$ 6.877,35	524	R$ 24.895.473,77	R$ 47.510,45
	Livestock	R$ 160.789,90	2.528	R$ 97.138.057,87	R$ 38.424,86
	Total	R$ **167.667,25**	**3.052**	R$ **122.033.531,64**	**R$ 39.984,77**

Source: Created by authors.

In the financial aspect, the total cost of the program more than doubled from 2016 to 2020, in addition to more than doubling the number of contracts for the livestock activity, consequently, there was a decrease in the number of contracts in the agricultural activity. One of the reasons that consequently led to this increase in livestock activity was the high demand from foreign trade in exports, since the increase in the dollar valued the price of beef in the country, so with the heated market this encouraged family farmers to seek resources to pay for cattle production in the state.

Graph 5 - Distribution of PRONAF resources in Pará by Mesoregions from 2016 to 2020.
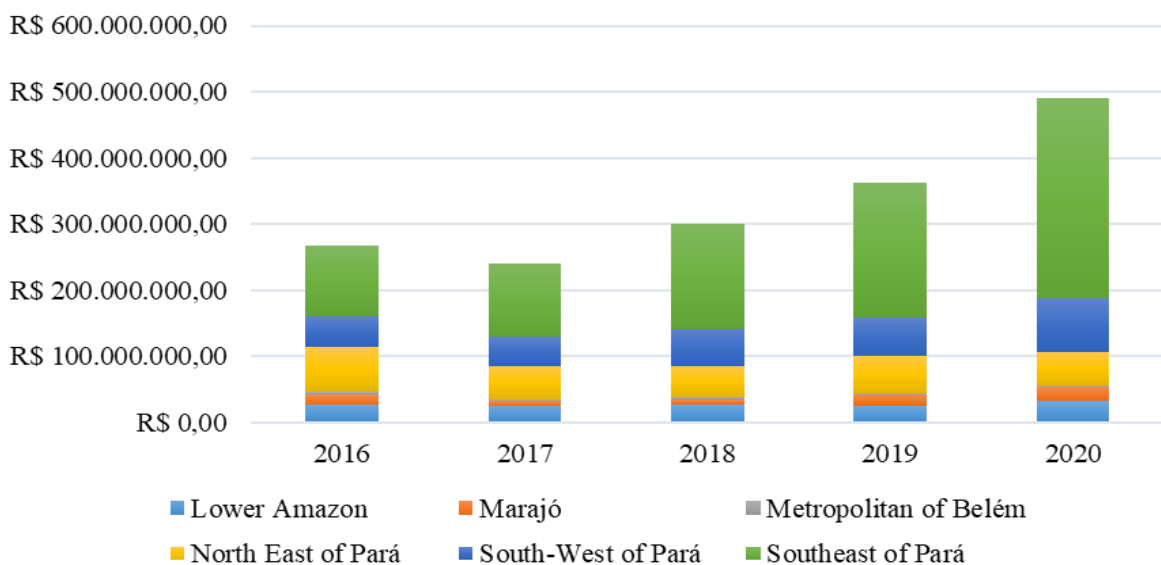
Source: Created by authors.

In graph 5, we see the evolution of the distribution of PRONAF resources in the period studied, making it evident that the Southeast Mesoregion of the state of Pará PA, is the one that had the greatest increase in the distribution of this resource, and that in this region there is the largest number of settlements of rural workers in the state. Noting that in 2017 all mesoregions had a reduction in the distribution of these resources, one of the causes to be considered was the period of political transition that the country faced.

Table 4 - Ranking of the 10 municipalities in Pará that received the most resources from PRONAF in 2020.

Position	Cities	Mesoregion	2020
1º	Eldorado do Carajás	Southeast	R$ 29.939.856,42
2º	Itupiranga	Southeast	R$ 29.061.256,27
3º	Floresta do Araguaia	Southeast	R$ 28.069.184,43
4º	Marabá	Southeast	R$ 23.522.388,11
5º	Pacajá	South-west	R$ 20.151.716,71
6º	Novo Repartimento	Southeast	R$ 19.730.474,41
7º	Rurópolis	South-west	R$ 15.815.658,54
8º	Piçarra	Southeast	R$ 15.678.828,81
9º	Conceição do Araguaia	Southeast	R$ 14.820.351,67
10º	Água Azul do Norte	Southeast	R$ 14.456.553,02

Source: Created by authors.

Another important factor analyzed in this study, as shown in Table 4, which shows the 10 municipalities that most received PRONAF resources in the state of Pará in the period studied, 8 municipalities are the ones with the largest number of settlements and encampments in the state, with emphasis on the 26 de Março settlement, located in the municipality of Marabá - PA, which is one of the largest settlements of landless workers in Latin America, with the largest number of settled families, the only one in Brazil that has implemented a Federal Institute within the settlement, exclusively for attend to the children of settlers, campers, maroons and riverside dwellers [27].

One factor that has made it difficult for small farmers to have access to PRONAF is the lack of dissemination in the mass media where information reaches the small rural producer, and the shortage of rural extenders to provide technical guidance on the required documentation and in carrying out the DAP as already mentioned in this work. This scenario shows that over the years it has not changed, requiring changes in public policies in order to solve the problem, so it is certain that with greater resources for the small producer, there will be a significant increase in production from agriculture family in Brazil[23][29].

IV.　　CONCLUSION

PRONAF recognized as the first public policy aimed at family farming was the result of several studies over its 25 years. Despite being praised, it has received several criticisms over the years. This work achieved the objectives which were proposed.

We observed throughout this study that, for the family farmer to have access to this resource, it is necessary for him to have technical assistance from rural extension professionals, who will help him in the construction of the entire process for the realization of the financing. For this, technical support is needed from the municipal secretariats of agriculture and also from rural extension professionals in the state, such as rural extensionists from the state secretariat of agriculture.

The state of Pará has stood out as one of the states in the northern region that receives the most funds from PRONAF. However, given the large number of family farmers in the state, it is observed that the number of contracts carried out in the state is negligible, corresponding to less than a tenth of the number of family farming establishments in the state, and that family farmers would be producing a lot more, if development lines such as PRONAF benefited a much larger number of small producers.

As it is known, that the products of family farming are what feed the Brazilian people, a public policy like this must be increasingly strengthened and publicized, available to everyone, only in this way will we really be a true country called the breadbasket of the world. Since the government would be strengthening the production of its market and internal consumption, since precision agriculture has really stood out on the planet

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Sustainable Rural Development: Productive Experiences of Quilombola Costneira/Tronco Community, Municipality of Paquetá - Piauí

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Abstract— Over many years, quilombola communities have been the target of social inequalities, victims of the exclusion process. However, they are symbols of struggles and persistence, which carry with them knowledge reproduced by their ascendants, which ensure the subsistence of their members without degrading sustainability. Thus, they are defined as ethnic-racial groups according to criteria of self-attribution, with their own historical trajectory, endowed with specific territorial relations, with presumption of related black ancestry. Thus, analyzing sustainable rural development from the productive experiences of the Custaneira/Tronco Community, located in the municipality of Paquetá, in the state of Piauí, made it possible to understand its particularities, consequently, also present ways followed by the community, aiming at greater awareness of socio-environmental causes.

I. INTRODUCTION

Due to the conflicts and struggles of the blacks for their freedom, the quilombola communities are present throughout the national territory. Currently there are about 170 communities in the State of Piauí [1]. The study was contemplated in the Quilombola Community Custaneira/Tronco, located in the microregion of Picos, which is in the process of legalizing the titration of its territory by official bodies, although the recognition of its identity as quilombolas is already explicit and concrete, both in the understanding of its members, as public institutions, like the National Institute of Historical and Artistic Heritage (IPHAN), responsible for protecting and promoting cultural goods.

Research has revealed that the local social changes are directly linked to the transformations regarding man's dependence on natural and cultural resources. Consequently, although they express vulnerability of socioeconomic character, the quilombola community has manifested its strength and considerable adaptive ability in the face of social and environmental changes [2].

Thus, the feeling of belonging, territoriality, respect for nature, the cooperative spirit and richness of traditional knowledge provide the empowerment and spatial organization of this community [3]. In view of this, the traditional experiences of quilombola families carry a unique value that declare a representative meaning by demonstrating forms of persistances attributed to a sustainable productive model, which also expresses a symbolic meaning, contributing to the strengthening of local culture [4]. Beforehand, when considering the observations made in the Quilombola Costneira/Tronco Community, from a sustainable and socioeconomic point of view, it allows us to understand the degree of sustainability of the mechanisms adopted by the community and to know the unfolding of this situation.

Thus, the origins exposed to historical, environmental and cultural conditions determine the identity of the community and constitute the conjunction of its productive development. Because of this, this study presents an expressive scientific contribution not in the sense of presenting model proposals, but of emphasizing the competence and strength of the internal potential of its environment, seeking a more targeted look at the measures of productive organizations currently exhibited, which still show little expression, but nevertheless can be used as a strong provider at the local level.

However, the territory's economy is composed of agricultural activity, focused on family agriculture. Thus, the object of this study is based on the important role of analyzing sustainable rural development from the productive experiences of the Quilombola Custaneira/Tronco Community, in obtaining prerogatives for the preservation of local sustainability, above all, to maintain its social, cultural, historical and its identity conventions. In addition, natural and cultural resources form the foundation for the support of this community. However, they have suffered threats due to external factors such as drought and drought, which can limit and harm the maintenance of productive and economic activities, implying community income.

Therefore, this scenario emphasizes the usefulness of this study when perceiving the situations of economic instability experienced by these quilombola families, and concerns about the future life expectations and circumstances of this population. In this way, the apprehension of the productive space created particularly by members of the community, mediating relationships of trust and collaboration, allowed us to investigate cooperation with local development. Finally, in this perspective, the present study brings a brief discussion about the processes arising in the area, which, despite the daily difficulties, are in constant search for well-being and implementation of new information and assistance.

II. THEORETICAL REFERENCE

2.1 The Sustainable Rural Development and Family Farming

The predominant development model that was established in the 1950s is related to the idea of economic growth, and was characterized by technological domination and transformation of the environment. [5], such a process did not consider the social needs, or at least the competence to restore ecosystems, thus proposing a unique paradigm for an immense diversity, without taking into account the singularities of each region.

Thus, the concept of sustainable development, occurred only from the Brundtland report in 1987, providing subsidies for a new thinking around sustainable development and, diffuses with the notion that, to be sustainable it is necessary that development adapts to economic growth, wealth distribution and environmental conservation [6]. Soon, it came to be seen as a challenge, at the same time, an appeal for interventions that would ensure an effective balance between the economic and social dimensions allied with the rational management of natural resources against a capitalist model [7].

Based on the axis of this current discussion that seeks to deepen the dilemma, production, consumption and exploitation of natural resources, it can be seen that the expression "sustainable rural development" in Brazil is increasingly evident, especially, from the 1970s, when there were various behavioral changes and demarcations of the limits of economic rationality and the challenges of environmental degradation, however, important regional development policies have emerged by the government to reduce inequalities. Practically the same year there was also the Stockholm Conference, causing greater awareness and awareness of the socio-environmental and sustainable causes [5].

Thus, the approach of "sustainability" in rural development brought with it new expectations for the field and the notion of interdependence among the most varied segments of the development process. Therefore, due to the magnitude of the problems caused to sustainable development, occurred in the last decades of the twentieth century, the concern to put on the agenda the discussion on this theme and, consequently, the risks the life of the planet.

In this context, rural development is directly linked to social and economic development, so, although its projects have economic bases, they are usually judged not only by these merits, but also by the social impacts caused [8]. Because of this, the study includes rural development as a process resulting from actions established to provoke changes, both socioeconomic and environmental, improving family income, especially the quality of life and well-being of rural populations [9].

However, [10] rural development is geared towards poverty reduction, broadly shared growth, food security and sustainable management of natural resources. After all, the core of these demands is projected in the conditions necessary to achieve this development.

Having said that, the emergence of family farming for rural development comes with the adoption of a new paradigm that supersedes the previous thinking that treated it only with a factor of delay and misery and passes, then,

to be recognized as a bearer of unemployment solutions, in addition to, meet the basic needs of human beings, and give continuity to future generations. As a result, small farmers have been valued for stimulating rural life and maintaining the rural population [11].

Still on this thought [12], this image of a small-scale enterprise that makes use of relatively outdated mechanisms needs to be improved, considering the idea of deconstructing it, I try to look at the models of advanced capitalist countries. It is concluded that family agriculture incorporated into the market has the capacity for innovation and technical evolution, bringing within the field a diversification of activities and contributions in the environmental preservation process, where it can no longer be confused as peasants.

The concept of family farming was applied through Law 11,326 [13], by the Brazilian state and integrates several categories, among them, quilombola communities. In this sense, the same is defined as productive units where work and management are interconnected, and management is controlled by the head of household. It is understood that in these units, the diversification and durability of natural resources are essential for their progress, since the family and the land are inseparable in this process [14].

Since then, these categories have become more visible, one of the positive points was access to a range of federal public policies, including the National Program to Strengthen Family Agriculture (PRONAF), considered, then, one of the most important in the federal sphere and aimed at family farmers to boost sustainable rural development [15].

To this end, the link between sustainable rural development and family farming lies in the use and preservation of natural resources, which are considered the most appropriate because they apply more environmentally-friendly production practices, with the variation of crops and the lower use of chemical material, enabling the growth of sustainable agriculture.

Finally, the use of natural resources, the direction of investments, the orientation of technological development and institutional changes are harmonized and reinforce the present and future potential, in order to meet human needs and aspirations [16]. However, it is important to link these issues to the progressive recognition of sustainable agriculture as a guide to programs, actions of governments and societal behaviors, with the theme being promoted in different arenas of government and civil society discussions [17].

2.2 Quilombola Community: A Historical Perspective

When discussing issues related to traditional communities, and the developments of social historiography, we refer to a historical past, constituted by a slavish and cruel regime, occurred worldwide. Thus, the black social movements took over the concept, in their material and symbolic expectations, for the organization of a political and cultural struggle, which would result in the inclusion of Article 68 of the Transitional Constitutional Provisions Act, existing in the Federal Constitution of 1988, in which it says: "To the remnants of the quilombola communities that are occupying their lands is recognized the definitive property, and the State must issue the respective titles".

In summary, the Federal Constitution granted an area to these traditional communities, allowing them greater freedom [18], but it was only from the 2000s that managers understood the urgency of minimizing inequalities in order to consciously achieve the promotion of social justice in those communities which, in fact, have always existed on the margins of society [19]. Then, in 2003, the Special Secretariat for Policies to Promote Racial Equality (SEPPIR) was born through the recognition of the struggles of black movements, linked to the Ministry of Human Rights with the aim of minimizing these inequalities and conceiving these communities remnants of quilombos as traditional populations with their respective rights.

Thus, with the 1988 Constitution, these communities came to be considered as "groups that developed, over time, practices of resistance in the maintenance and reproduction of their characteristic ways of life in a given place" [20]. In this perspective, these communities began to be inserted in Brazilian public obligations through public policies, as well as in academic debates.

After all, these groups are characterized in a culturally differentiated way, which recognize themselves as such, have their own forms of social and economic organization, occupy and use territories and natural resources as a condition for their cultural, social, religious and ancestral reproduction, using knowledge and innovations, which are generated and transmitted by tradition [21].

With similar elements [22], describes quilombo as, a rural black community inhabited by descendants of enslaved Africans, with kinship ties, who live on agriculture, on land donated, purchased or secularly occupied by their ancestors, who maintain their cultural traditions and experience them in the present as their stories and their code of ethics, propagated orally from generation to generation. In this follow-up, it can also be said that they are seen as ethnic-racial groups according to

criteria of self-acceptance and with resistance to the historical oppression suffered [23].

The National Institute of Colonization and Agrarian Reform (INCRA), charged with recognizing and formally consenting to the titration of quilombola territories, estimates that there are around three thousand communities in Brazil. Specifically in the state of Piauí at the moment registered a total of 88 certified communities [1].

It is essential to recognize that the areas occupied by the quilombolas are perceptibly marked by social and cultural vulnerabilities, especially economic.

In the cultural scenario, the subsistence of the communities is demarcated by their territories that live through traditional productive activities such as farming, livestock, fishing, growing small vegetable gardens, among others. However, the experiences derived from patrimonial knowledge, are generally favorable for the maintenance, centered on the exploitation of natural resources, with little technology, precarious articulation with the market, intense use of family labor and basically sustainable [24]. In this way, the economic life of the quilombolas is predominantly rural, containing skills that reproduce various activities in the family unit of production without the use of instruments [25].

Therefore, fostering discussions between scientific knowledge and the empirical knowledge of quilombola communities is a way of exposing the rich knowledge present in its environment to thus understand its role in the cultural and social construction of Brazil, in addition to seeking greater awareness of socio-environmental and socioeconomic causes through research.

III.   METHODOLOGY

This research was carried out in the Quilombola Custaneira/Tronco Community (figure 01), located in the Northeastern Semiarid, within the limits of the municipality of Paquetá - PI. Located in the micro-region of Picos, semiarid Piauiense. Distance about 309 km from Teresina - PI, and 26 km from Picos - PI. Due to the geographical proximity and socio-cultural, commercial, family, political and administrative relations established throughout its history, the community receives influences from the municipalities of Picos, Santa Cruz and Oeiras. In this Mesoregion there are voluminous concentrations of afrodescendant population. At the moment the community aggregates 167 people, 48 families and is in the process of legalizing the titration of its territory by official bodies [26].

Fig.1: Custaneira/ Tronco Community, located in the City of Paquetá - PI.

Source: Reproduction/Internet (2020)

The methodological path followed was, first, a bibliographic/documentary search from the available records and resulting from previous research with access to the documentary field and database of official agencies, among them, Fundação Cultural Palmares and IPHAN. This being a research that unceasingly seeks knowledge, mainly theories that direct the paths to scientific work [27].

This study was conducted based on exploratory and descriptive research [28]. It should be noted that the work was developed and supported in the experiences experienced in the community, during the work in the field, especially through the conviviality with it, where there was the concern to describe thoroughly from the observation, of the records and the interpretation that, happened in a natural and effective way.

Thus, descriptive research has as main objective to describe characteristics of a population or phenomenon [29]. As for exploratory research, it can provide a broad view about a fact, allowing a deepening on the subject addressed, especially in the scientific field.

Finally, the typology of procedures of this study has a qualitative approach, which have the ability to report a problem, analyze the interactivity of certain variables, consequently, understand the dynamics of social relations [30].

IV.   RESULTS AND DISCUSSIONS

The history of the Quilombola Custaneira/Tronco Community, belonging to the municipality of Paquetá - PI, began with the arrival of blacks in the territory, however, it was only known as black community. Soon, from the first national meeting of quilombola communities in Brasilia in 1996, with the participation of leaders, this context began to be repackaged, bringing to this people, through its history and culture, the task of being legally recognised as an organised quilombola community. Finally, only in 2012 they obtained the certificate, giving them full rights to their

declared identity and assured by the Palmares Cultural Foundation.

Regarding the appropriation of land, it is worth mentioning that the Costneira/Tronco Community itself, purchased by their families from former landowners, has about 440 hectares, Families use approximately 35 hectares for planting and subsistence of these families.

However, the quilombola community under study has as its main means of subsistence family farming, through the cultivation of manioc, corn, beans and rice, sometimes beating carnauba, or receiving government social resources as a family grant, and distribution of basic baskets. However, in the summer or in times of drought men go out in search of various jobs in other states, in order to ensure the survival of their families [31].

Fig.2: Manioc plantation.

Source: Personnel file (2021)

As for the economic activities more developed by the community is to livestock, put in the following figure (03), with the rearing of chickens, goats, pork and cattle, consecutively, the handicraft. Also noteworthy is the commercialization of organic sesame for companies in other cities, the sale of chestnuts, sweets and cakes, in addition to the sale of medicinal plants taken from the forests of the territory, for the manufacture of medicines and baths, sold to society at free trade fairs, exhibitions and even in the community.

Fig.3: Goat Rearing.

Source: Personnel file (2021)

One of the most striking difficulties that the community faces is the scarcity of rainfall, which directly

interferes with its production and quality of life. Seen from this, the community was benefited with the design of cisterns, as shown in the figure (04), that captures the water in the rainy season, which together with the help of the well contributes to the planting and use of the community.

Fig.4: Cistern for rainwater collection and use.

Source: Personnel file (2021)

Another benefit that favors the community economy through the partnership of municipal management with the state is the inclusion of these small farmers in the Food Acquisition Program (PAA)where part of the school meal budget is earmarked for the purchase of food from these family farmers and distributed to municipal and state schools, strengthening local trade, at the same time, promoting and privileging them. In short, the municipality has worked in social, cultural, economic and sustainable support, since, to ensure production in the community it is necessary to take care of the local territory, because both are interconnected.

Fig.5: Vegetable and fruit plantation.

Source: Personnel file (2021)

As shown in figure 05, the quilombola families make conscious use of the territory, seeking the balance between sustainable and economic development, since, everything that the community has comes from the forests. In short, there is no use of natural resources without the necessary use, constantly maintaining the vitality of these resources, an example is the removal of firewood without degrading the environment.

In recent times the community has carried out together with the quilombola youth a work of awareness, in the

sense of preserving and improving what the earth can offer, transforming this into their present and future livelihood, so that there is no need to work in other lands, or even in other states, but that they understand that with the continuous care the community can guarantee sustenance.

Certainly, because it is an organized and active community in its decision-making processes, recently was entered in the Rural Environmental Registry (CAR), a kind of electronic record of environmental information of rural properties, aiming the monitoring and control of the situations of the areas of permanent preservation.

Therefore, it was also possible to highlight the important role of the association in strengthening family ties in order to unify the quilombola struggle in guaranteeing their rights. Finally, it is observed that the residents of the Quilombola Custaneira/Tronco Community live with natural restrictions typical of the semiarid regions of Brazil, with high temperatures and scarce rainfall. In this way, they seek in the potentialities of the region the resources for the maintenance of life in the locality.

V.　CONCLUSION

Therefore, this research sought to bring questions inherent to the productive experiences of the community studied, socioeconomic factors and the housing mode of these families in the direction of sustainable development. Therefore, to show the importance of this theme not only in the environmental context, but in the action of knowing and valuing other cultures, attitudes and values.

Thus, it expects this study to stimulate the construction of other works and encourage the sustainable preservation of the environment and its cultures. To this end, the reflections made through observation in living with the community sought to ensure the veracity of the facts, above all, enable information that subsidize decision-making in planning and sustainable management local, generating mutual benefits to the community, from the strengthening of the productive forces.

In this way, given all the requirements, after the study is carried out, it is necessary to make clear that the results will be returned to the community, reinforcing its knowledge, practices and life history. It is understood that all these developments obtained with the performance of the study will also contribute to motivate economic growth allied to the preservation of natural resources.

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Decentralized Domestic Effluent Treatment System to Attend a Single-Family Residence

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Abstract— In Brazil, in semi-urban and rural regions, the absence of basic sanitation becomes more evident, above all, the lack of sanitary sewage, caused by the high cost of implementation and maintenance of centralized systems with collection networks and sewage treatment plants. Given this reality, decentralized systems have been widely used in semi-urban and rural housing centers, providing treatment with efficiency and low cost, besides having an important role in expanding the care of sewage services, especially in areas devoid of sewage collection networks. This research proposes the integration of theoretical models based on the contributions of researchers to the subject, with the equations established by the technical standards ABNT (NBR 7229/1993) and a (NBR 13969/1997) related to effluent treatment, using the theory present in the literature to size an individual system of treatment of domestic effluents, which meets a single-family residence, seeking to generate knowledge for practical application in localities devoid of sewage collection network. For this, it was designed to form an integrated form, a treatment system containing three reservoirs, with the septic touch initiating the purification process, directed to the liquid part for biological treatment in the anaerobic filter, with anaerobic microorganisms stabilizing the organic matter before final disposal of the effluent in the sink. In general, decentralized systems are considered by several researchers as an efficient solution in the treatment of domestic sewage. NBR 13969/1997 defines the likely ranges of removal of pollutants, according to the type of treatment, where the combined septic tank system and anaerobic filter achieved good results in the removal of (BOD), (DQO), (SNF) and sedimentable solids, increasing treatment efficiency and meeting the parameters for effluent disposal in the environment as permitted by CONAMA Resolution No. 430/2011. Regarding the cost of implementation, the budget was obtained by budget spreadsheets, using the unit prices of the National System of Research of Costs and Indexes of Civil Construction, reference, Recife, July 2021. With the treatment system designed in an integrated way, standing out for the lower cost and smaller built area, reducing the costs of implantation by 28% compared to the system with the separate projected reservoirs.

I. INTRODUCTION

Basic sanitation promotes sanitation and social inclusion, where the human right to water and sanitation declared at the United Nations General Assembly on July 28, 2010, recognizes the right to drinking water and sanitation as an essential right for the full enjoyment of life and all human rights, through Resolution A/RES/64/292 (UN, 2010).

Sanitation did not keep pace with population growth, causing a deficit in the collection and treatment of domestic wastewater, especially in peripheral and rural regions without a collection network and sewage treatment plant. The low population density in these regions becomes financially unfeasible to build collection networks, causing governments to prioritize the implementation of centralized treatment systems in locations with higher concentrations of inhabitants.

According to the publication of the National Water Agency (ANA), in Brazil, 43% of the population has sewage collected and treated, in addition to 12% using septic tank, that is, 55% have treatment considered adequate; 18% have their sewage collected and untreated, which can be considered as a precarious care; and 27% do not have collection or treatment (ATLAS ESGOTOS, 2020).

Currently, reservoirs, lakes and rivers are being overwhelmed by freshwater demand due to rapid industrialization and population explosion. To solve this problem, several decentralized wastewater treatment systems have been built worldwide to reuse wastewater recycling for non-potable uses, such as fire protection, toilet discharge and garden irrigation (BAJPAI; KATOCH; CHATURVEDI, 2019).

The policies and actions of the government of urban and regional development, housing, combating and eradicating poverty, environmental protection, health promotion and other relevant social interest, aimed at improving the quality of life, should consider the essential articulations to promote basic sanitation, including about its financing, according to Federal Law 11.445/2007 (BRASIL, 2007).

The need to advance in the fields of sanitation and water management has resulted in recent reforms of legal frameworks and a significant increase in resources for sanitation. In the academic field, this framework inspires the challenge of better understanding the trajectories of these policies, which motivates this effort to know the historical formative processes and structural factors (MURTHA; HELLER, 2015).

Faced with this reality, decentralized systems are presented as an adequate social technology to serve single-family homes in isolated locations with low cost, shorter execution time and efficiency in the removal of pollutants, acting effectively in the protection of public health and contributing to the preservation of the environment. Social technologies in sanitation are understood as techniques and methodologies developed through interaction with communities and have been shown to be key to the development of sanitation effectively, easily operating and maintaining, in addition to promoting the social inclusion of minority groups through the participation of the population in lectures, training and training on the theme (HORA; RODRIGUES; SACHO, 2019).

The Brazilian Association of Technical Standards, through NBR 7229/1993, design, construction, and operation of septic tank systems, defines the sewage system as being "the set of facilities that brings together collection, treatment and disposal of wastewater". It must be sized and deployed to receive all the evictions.

The mathematics present in the dimensioning of a domestic effluent treatment system, although there is a normative about the minimum volume to be stored in each tank, nothing is about the dimensions about length, width and height. Thus, the purpose of the practice is to discuss the possible changes in these dimensions of the tanks that store and treat effluents (REHFELDT; ERTHAL, 2015).

In this scenario, given the concepts and information contextualized about the treatment of domestic effluents, in isolated regions devoid of a collection network and centralized sewage treatment plant, this research intends to dimension a decentralized system, which is effective in removing pollutants, starting with a primary treatment in the septic tank, followed by secondary treatment in the anaerobic filter and ending with the destination in the sink.

II. METHODOLOGY
STUDY AREA

The project for individual solution of treatment of domestic sewage was elaborated with the purpose of being implemented in a single-family residence with four residents in SítioTreme, located in the rural area of the municipality of São João, at coordinates 8º50'26.0"S and 36º26'12.3"W, 3 km from Mestre Dominguinhos Highway (BR 423,Km 92), in the state of Pernambuco (Figure 1).

Fig.1: Part of the Map of Countryside–Treme Neighborhood Site.

It can also be replicated in locations with low demographic density devoid of sewage collection networks, such as rural communities and peripheral regions of cities. However, the system is no longer implemented, due to lack of financial incentive to research by the government.

METHODOLOGICAL STEPS

The procedure used in the research is of quantitative approach with descriptive objective, proposing the integration of theoretical models with the equations established by the technical standards NBR 7229/1993 and NBR 13969/1997 related to effluent treatment in Brazil, using the theory present in the literature to size an individual system of treatment of domestic effluents, which meets a single-family residence, seeking to generate knowledge for practice in locations devoid of sewage collection network.

The analyses of the calculations followed the concepts of environmental technology through bibliographic research on the subject contextualized and from data of dimensioning of domestic sewage collected in the technical and scientific literature.

LAYOUT OF A TREATMENT SYSTEM

The project proposes the design of a conventional treatment system model but built in an integrated way sharing the walls of the Septic Tank, Anaerobic Filter and Sinkhole. From fashion to perform a comparison of the cost of deployment of systems with reservoirs built separately and in an integrated way.

The first option is the most widespread, with the reservoirs being constructed separately and interconnected by means of PVC pipes, differentiating from the model under study that predict the execution of the reservoirs in an integrated way, divided into three

tanks in masonry structure at once, with walls of 19.0 cm thickness and internal coating with 1.0 cm of chapisco and 2.0 cm of mortar.

The dimensions of the systems under study follow the recommendations of the technical standards NBR 7229/1993 and NBR 13969/1997, in addition to observing concepts of environmental technologist for the construction, operation and maintenance of sewage treatment system, observing the following specifications:

- 1.50 m of buildings, land boundaries, sinks, infiltration ditches and building water extension.

- 3.0 m of trees and any point of public water supply.

- 15.0 m of groundwater wells and bodies of nature water.

- As for the removal of digested sowe, about 10% of its volume should be left inside the tank.

To use the standard, government data are used to obtain the average number of people per dwelling. Among the data collected, ibge corroborates that in the country, in each household live, on average, 2.9 people per residence, with the Northern Region reaching the highest regional average in Brazil, with 3.3 people per dwelling.

According to the National Household Sample Survey (PNAD, 2017), in Brazil almost 70% of households, it is connected to the general sewage network, with the following percentages of connection by region: 27.4% in the North, 47.2% in the Northeast, 60% in the Midwest, 69% in the South and 89% in the Southeast. Among which, 29.9 million people live in rural areas, of this number only 5.7% of the population has sewage connected to the sewage collection network and 23% use septic tank, with the remainder allocating untreated sewage into the environment.

This information is relevant, considering that the number of people per household is the main parameter for sizing the useful volume in liters of each element that makes up the individual treatment system. As the national average is 2.9 people and the most critical region being 3.3 people per residence, we will adopt the worst citation, rounding to 4.0 people, for calculation.

As the system will meet a medium standard residence with four residents, the daily contribution of sewage was adopted to be 130 liters per inhabitant/day, according to Table 1 of NBR 7229/1993. Evaluating that the period of detention of the evictions, by daily sewage contribution range, according to Table 2 of NBR 7229/1993, was used

one day. While the slable accumulation rate was used to determine the slable accumulation rate, according to the cleaning interval of one year and the weighted ambient temperature range greater than 20° C, as pointed out in Table 3.

Table 1 - Daily contribution of sewage and fresh sludge by type of occupying building

Building	Unit	Contribution of sewage (C) and fresh sludge (Lf)	
Permanent occupants			
Residence			
High standard	person	160	1
Medium standard	person	130	1
Low standard	person	100	1
Hotel (except laundry and kitchen)	person	100	1
Temporary accommodation	person	80	1

Table 2 - Period of detention of evictions, by daily contribution range.

Interval between cleaning (years)	K values per ambient temperature range (t), in ºC		
	T ≤ 10	10 ≤ t ≤ 20	T > 20
1	94	65	57
2	134	105	97
3	174	145	137
4	214	185	177
5	254	225	217

Table 3 - Slable accumulation rate per interval between cleanings and temperature.

Percolation rate min/m	Maximum daily application rate m³/m².d	Percolation rate min/m	Maximum daily application rate m³/m².d
40 or less	0,2	400	0,065
80	0,14	600	0,053
120	0,12	1200	0,037
160	0,1	1400	0,032
200	0,09	2400	0,024

According to NBR 7229/1993, the septic tank system is the set of units for the treatment and disposal of sewage, using septic tank and complementary treatment units and final disposal of effluents and sludge. How much the septic tank is the rectangular cylindrical or prismatic unit of horizontal flow, for sewage treatment by sedimentation, flotation, and digestion processes.

However, to size the anaerobic filter and sink, we will use the technical standard NBR 13969/1997, as it is more specified for the design, construction and operation of complementary treatment units and final disposal of pretreated liquid effluents in the septic tank.

Among the complementary treatments listed, we highlight the parameters related to the anaerobic filter because it is an integral part of this study, with percentage values consisting of 40 to 75% of biochemical oxygen demand, 40 to 70% of chemical oxygen demand, 60 to 90% of non-filterable solids, 70% or more of sedimentable solids and 20 to 50% of phosphate (NBR 13969/1997).

As for the sinkhole, the standard states that it consists of a unit of final disposal of the verticalseptic tank effluent in relation to the infiltration ditch. Due to this characteristic, its use is favorable only in areas where the aquifer is deep, where it can guarantee the minimum distance of 1.50 m between its bottom and aquifer level (NBR 13969/1997).

Because it is a vertical infiltration unit, which crosses a few layers of soil, the site of installation of the sink, needs to undergo a test to estimate the infiltration capacity in the soil and the dimension of the bottom of the pit for testing should be about the same from the bottom of the sink. As far as it is concerned, this quota consists from the minimum distance of the maximum quota of the local aquifer in relation to the output quota of the septic tank pipe (NBR 13969/1997).

SIZING

The dimensioning directly influences the characteristics of the effluent, as well as the desired final efficiency, given this, a system of domestic depletion composed of septic tank, anaerobic filter and sink, sized according to current standards, can achieve an efficiency between 70 and 85% in the removal of biochemical

oxygen demand and 80 to 90% in the removal of suspended solids (DA SILVA; MONTEIRO, 2020).

The treatment begins by the septic tank with the collection of effluents from the bathroom from the toilet and the sink and shower drains through direct piping, in addition to the service area and kitchen through the fat box.

Then, the evictions follow by severity for biological treatment in the anaerobic filter, with anaerobic microorganisms act to stabilize organic matter. Finally, the effluent already treated is directed to the sinkhole by taking the layers of the subsoil.

The research provides for the elaboration of a decentralized treatment system with integrated construction system, sharing the walls of septic table, anaerobic filter and sinkhole, with a reduction in implantation costs above 25%, maintaining the effectiveness of treatment with apart apart reservoirs.

However, the dimensioning proposed in this research will serve for both systems, with the calculations performed separately each element that composes the system, diverging only in the design of the project. With both dimensioned to serve a single-family residence with four residents, enabling its implementation in all regions of Brazil. In addition to pay ing the minimum design dimensions, established by technical standards NBR 7229/1993 and NBR 13969/97.

- Daily Contribution of Sewage

In Brazil, the per capita consumption of a medium standard residence is used as a design parameter to size sewage systems. The amount of sewage generated by a population varies according to the existence or not of public supply, the proximity of water from the home, the climate, the habits of the population (FUNASA, 2017).

In 2017, the per capita use of water by families was 116 liters per inhabitant/day, according to IBGE. In view of this information, we will adopt the daily consumption of 130 liters per inhabitant/day, meeting the national average and the parameter of 130 liters of daily sewage taxpayer for medium standard residence established by the technical standard of NBR 7229/1993.

- Taxpayer rate

N = Total contributors

Q = Number of rooms = 2

P = Number of people per room = 2

$$N = Q * P \qquad (1)$$

- Daily Contribution of Sewage

CT = Total contribution

N = Number of contributors = 4 people

C = Daily contribution = 130.0 liters per capture.

$$CT = N * C \qquad (2)$$

- Fat Box

The fat boxes should allow the retention and subsequent removal of the fat, according to NBR 8160/1999, which determines the inner diameter, the submerged part of the septum, the retention capacity and nominal diameter of the outlet pipe.

When sizing the fat box for the collection of only one kitchen, the standard recommends the use of the small fat box (CGP).

As a rule, these boxes are fundamental for the proper functioning of the system and can be prefabricated of fiber cement or reinforced plastic.

- Septic Tank Sizing Equation

TS = Septic tank

N = Number of contributors = 4 people

C = Contribution of dumps = 130 liters

TDH = Hydraulic holding time = 1 day

K = Slable accumulation rate = 57 liters

Lf = Contribution of fresh slable in days = 1 day

$$TS = 1.000 + N * ((C * TDH) + (K * Lf) \qquad (3)$$

- Equation for Anaerobic Filter Sizing

FA = Anaerobic filter

N = Number of contributors = 4 people

C = Contribution of dumps = 130 liters

TDH = Hydraulic holding time = 1 day

K = Slable accumulation rate = 57 liters

Lf = Contribution of fresh slable in days = 1 day

$$FA = 1,6 * N * C * TDH \qquad (4)$$

- Equation for Sink Sizing

The volume of the sink is determined according to the volume of the septic tank and may have equal or higher dimensions. However, it is necessary to determine the rate of soil pergrowth for the proper functioning of the sink (NBR 13969/97).

The bottom dimension of the test pit must be about the same as the sinkhole. As far as it is concerned, that dimension is determined from the minimum distance of the maximum quota of the local aquifer and the output

quota of the septic tank pipe. When an assay is done on several layers, the result of each cava is obtained by means of the equation where: Ki and Hi are, respectively, the rates and heights of the layers where the tests were carried out (NBR 13969/1997)

$$K = \sum(ki * Hi)/\sum(Hi) \quad (5)$$

Table 4 - Conversion of pergrowth rate into surface application rate.

Daily contribution (L)	Detention time	
	Days	Hours
Up to 1500	1	24
From 1501 to 3000	0,92	22
From 3001 to 4500	0,83	20
From 4501 to 6000	0,75	18
From 6001 to 7500	0,67	16
From 7501 to 9000	0,58	14
More than 9000	0,5	12

S = Sinkhole

C = Length

L = Width

P = Depth

$$S = C * L * P \quad (6)$$

- Pipes and Canecões

The pipes are designed considering the alignment and elevation of the pipes between the tanks, promoting the flow of wastewater during the treatment by gravity, remaining buried desdá exit of the residence until the entry into the septic tank.

Most of the time the pipes used are PVC for building sewage, which must meet the technical specifications placed in the NBR 8160/1999 standard, in addition to the connections necessary to connect, the septic tank with the anaerobic filter and the sink.

- Proposed Model

With the results obtained through the equations established by the technical standards NBR 7229/1993 and NBR 13969/1997, they will define the minimum dimensions for the design of an individual sewage treatment project, designing a model of easy execution and low cost, contextualizing concepts of environmental technology, in addition to socioeconomic and operational aspects.

Socioeconomic aspects include the rapid acceptance by the population, adaptation to the local culture, low installation cost, ease of obtaining materials and skilled workers. It can also generate by-products such as biogas during treatment, or biofertilizers after treatment.

As for the operational part, the individual treatment of domestic sewage offers numerous financial advantages due to the absence of sewage collection network, lifting stations and permanent labor, thus avoiding the collection of monthly fees for maintenance by sanitation companies. Needing only the hiring of the truck clean swosa from time to time, as specified in the project.

The project proposes the construction of a treatment system in masonry at once, with ceramic brick 19 cm thick and internally coated with chapisco and plaster. Dividing into three tanks with distinct functions in the treatment. With the septic tank containing bottom slab, wall coated with mortars and cover slab with sigh for elimination of gases.

The anaerobic filter must contain, in addition to the items already mentioned, a slab with several holes that allows the ascending flow of the sewage seated 50 cm from the bottom slab and the filter bed composed of crushed stone no. 3 or 4. While in the sinkhole the bottom slab is replaced by a layer of crushed stone, allowing the infiltration of the treated effluent underground.

With the system in operation, it is warned to collect samples, after treatment and before percolating underground, for analysis of the main physicochemical parameters such as: biochemical oxygen demand, chemical oxygen demand, non-filterable solids, sedimentable solids and phosphate.

The results obtained in the laboratory should be compared with the parameters found in technical standards such as NBR 7229/1993 and NBR 13969/1997, in addition to the parameters indicated in CONAMA resolution no. 430/11, which refers to this research, related to the decentralized treatment of effluents in Brazil.

BUILDING MATERIALS AND BUDGET

From the dimensioning, the proportions for each treatment unit were reached. Enabling the survey of materials and labor of each element that composes the treatment system in order to pray them, in order to promote the discussion about the economic viability of the proposed systems.

The budget was obtained through budget spreadsheets

with unit prices being obtained through consultation with the National System of Research of Costs and Indices of Civil Construction - SINAPI reference, Recife, July 2021 (SINAPI, 2021). This tool was fundamental for the survey of the costs of the system with the apart reservoirs and for the system with the integrated reservoirs.

III. RESULTS AND DISCUSSION

The results of the alvitrate dimensions are described in subsequent items to contribute by expanding the debate by addressing issues related to the decentralized treatment of domestic sewage in peripheral and rural locations devoid of the collection network.

Promoting the use of an individual system of treatment of domestic effluents, containing septic tank, anaerobic filter, and sinkhole, incorporating efficiency, low cost and ease of execution, contributing decisively to public health and the sustainability of the environment.

The research proposes a treatment system designed to form integrated, containing three reservoirs, dividing the walls of septic marquee, anaerobic filter and sinkhole. Separately, each element that makes up the system, based on technical standards NBR 7229/1993 and NBR 13969/1997.

In addition to CONAMA Resolution No. 430/2011, which provides for effluent release conditions and standards. Aiming to attend a single-family residence, occupied by four residents, weighing the generation of 130 liters of daily sewage taxpayer per person for medium standard residence, considering the minimum dimensions established by technical standards.

SIZING CALCULATIONS

- Calculation of the Taxpayer rate

N = Total contributors

Q = Number of rooms = 02

P = Number of people per room = 02

$$N = Q * P \quad (7)$$

$$N = 2,0 * 2,0$$

$$N = 4,0 \text{ Pessoas}$$

- Daily Contribution of Sewage

CT = Total contribution

N = Number of contributors

C = Daily contribution = 130.0 liters per capture.

$$CT = N * C \quad (8)$$

$$CT = N * C$$

$$CT = 4,0 * 130,0$$

$$\text{Contribuição Total} = 520 \text{ litros por dia}$$

- Fat Box Volume Calculation

Item 5.1.5.13 of NBR 8160/1999

Inner diameter = 0.30 m

Submerged part of the septum = 0.20m

Retention Capacity = 18L

- Septic Tank Sizing

TS = Septic tank

N = Number of contributors = 4 people

C = Contribution of dumps = 130.0 liters

TDH = Hydraulic holding time = 1 days

K = Slable accumulation rate = 57 liters per person per day

Lf = Contribution of fresh slable in days = 1 day

$$\mathbf{TS = 1.000 + N * ((C * TDH) + (K * Lf)} \quad (9)$$

$$TS = 1.000 + 4 * ((130 * 1) + (57 * 1))$$

$$TS = 1.000 + 4 * (130 + 57)$$

$$TS = 1.000 + 748 = 1.748 \text{ litros}$$

- Dimensions adopted for septic tank:

A septic tank was adopted, in masonry structure at once in ceramic bricks, with walls 19 cm thick and internal and external coating of 3.0 cm, as well as bottom slab and cover slab in reinforced concrete, obeying the minimum dimensions established by NBR 7229/1993.

Length......................... 1.0 m

Width.................................... 1.0 m

Height..................................... 2.0 m

$$TS = 1,0 * 1,0 * 2,0 = 2.000 \text{ litros}$$

- Anaerobic Filter Sizing

FA = Anaerobic filter

N = Number of contributors = 4 people

C = Contribution of dumps = 130.0 liters

TDH = Hydraulic holding time = 1 days

K = Slable accumulation rate = 57 liters per person per day

Lf = Contribution of fresh slable in days = 1 day

To discuss the subject matter of this research, it is important to highlight Law No. 11,419/2006, which provides for the computerization of processes, with this rule to the effective introduction of virtual procedure leading into the judiciary. This norm, presented in the jurisdictional activity, a transformation relative to the

understanding before the judiciary of the necessary look at paradigm changes for the benefit of the jurisdiction and, also, of the environment.

$$FA = 1,6 * N * C * TDH \quad (10)$$

$$FA = 1,6 * 4,0 * 130 * 1$$

$$FA = 832 \text{ litros}$$

Dimensions adopted for anaerobic filter:

An anaerobic filter was adopted, in a masonry structure at once in ceramic bricks, with walls of 19 cm thickness and internal and external coating of 3.0 cm, as well as of bottom slab and reinforced concrete cover slab according to the minimum dimensions established by NBR 13969/1997.

Length.......................... 1.0 m

Width................................... 1.0 m

Height...................................... 1.4 m

$$FA = 1,0 * 1,0 * 1,4 = 1.400 \text{ litros}$$

- Sink Scale

Based on the calculations of the capacity of the septic tank, similar dimensions and materials can be adopted, replacing the bottom slab with a layer of crushed stone. However, it is necessary to determine the rate of soil pergrowth for the proper functioning of the sink, according to the NBR 13969/1997 standard.

Length.......................... 1.0 m

Width................................... 1.0 m

Height...................................... 2.0 m

$$S = C * L * P \quad (11)$$

$$S = 1,0 * 1,0 * 2,0 = 2.000 \text{ litros}$$
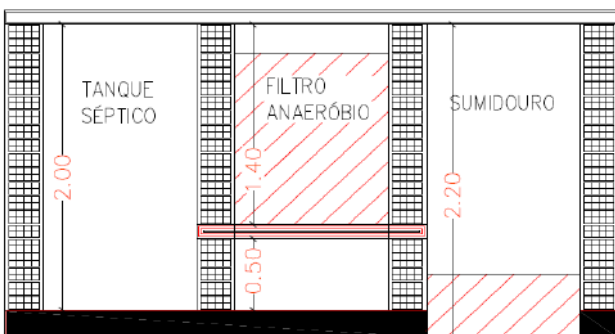
Fig. 3: Cutting of the Domestic Effluent Treatment System

TECHNICAL SPECIFICATIONS

The main parameters and criteria recommended for the implementation of the constituent parts of an engineering project, related to sewage treatment systems, are available in brazilian technical standards (NBR) published by the Brazilian Association of Technical Standards (ABNT) and in the guidelines described in the Funasa Sanitation Manual (FUNASA, 2017).

- Sewage systems

The basic functions of the sewage system are to collect and conduct evictions from the proper use of sanitary appliances to an appropriate destination in accordance with current legislation.

The final disposal of the effluent from the building collector of a sanitary sewage system must be carried out in a particular treatment system when there is no public sewage collection network (NBR 8160/1999).

- Individual Treatment System

Individual systems are designed to safely collect, treat and dispose of domestic effluents generated by a single-family home, composed mostly of: septic tank, anaerobic filter and sink. It must satisfy the characteristics and functionalities established by technical standards NBR 7229/1993 and NBR 13969/1997.

- Construction Lease

The rental of the treatment system must comply with the limits of the land of the residence, in a topographic quota equal to or less than that of the sanitary system, obeying the minimum clearance of 4 m of tanks and 30 m of groundwater or surface water capitation systems. In addition to keep 1.50 m distance between your sinkhole bottom and the aquifer level.

- Earth Drive

The excavation can be carried out manually or mechanically, added to the dimensions of the reservoir with a spacing of 50 cm for each side. This spacing had been used to facilitate the execution of the work and should be regrounded after completion. This backfill must be medically compacted in 20 cm layers using the excavated material itself.

- Bottom Slab

The bottom slab of the system was designed to be executed as baldrame slab, with hollow bottom in the sinkhole and slabs at the bottom, in the septic tank anaerobic filter. Built in reinforced concrete, with wood shape, ribbed steel reinforcement CA-50 10 mm and concrete with compression resistance of 30 MPa.

- False Background of the Anaerobic Filter

The false bottom slab has been designed with 10 cm thickness and holes that allows the upward flow of effluents into the anaerobic filter. Being executed in reinforced concrete, ribbed steel reinforcement CA-50 10

mm and concrete with compressive strength equal to or greater than 30 MPa (NBR 6118/2014).

- Cover Slab

The cover slab was designed with 15 cm thickness, three lids for inspection and sigh pipe in septic tank, anaerobic filter and sink. Being executed in reinforced concrete, with wood shape and shimmage, ribbed steel reinforcement CA-50 10 mm and concrete with compressive strength equal to or greater than 30 MPa (NBR 6118/2014).

- Arrangement of Armor

The arrangement of the reinforcements of the bottom slabs, cover slab and false bottom, was designed to be executed in ribbed steel reinforcement CA-50 10 mm in diameter and 15 cm in spacing.

- Masonry

The masonry designed, provide the construction of walls using massive ceramic bricks with nominal dimensions of 19x9x9 cm seated folded in joints of 1.0 cm of mortar, according to the project. Mortars should be well dosed, in the proportion 1:2:8 (cement, lime and sand) and the bricks have all the flat faces of material (NBR 7170/1983).

- Coating

The coating is composed of the chapisco and the single mass, on the internal and external walls. With the chapisco in the trace of 1:3 (cement and sand), having the purpose of providing greater adhesion between the masonry and the coating. And the unique mass in the traces of 1:2:8 (cement, lime and sand), where the use of hydrated lime, is exencial, because it promotes a greater power of accommodation in the variations of the walls, besides minimizing the risks of cracks.

- Sanitary Facilities

The pipes and canecões will be seated according to alignment and leveling, with full coverage in order to protect the pipe from the requests caused by the transit of people and animals on site. The tubes must be placed with their lower geratriz coinciding with the cradle shaft, so that the bags are in the previously prepared excavations, ensuring a continuous support of the tube body (NBR 7367/1988).

- Cleaning the Work

The work must be delivered without any trace of leftover building materials, nor with waste. The executed pits will need to be completely closed at the end of the execution and the hydrosanitary facilities should be in perfect operation in the delivery of the work.

- Effluent release conditions

The indirect release of effluents into the receiving body shall comply with the provisions of CONAMA Resolution 430/11 that determines the conditions for the release of effluents from any polluting source:

- pH between 5 and 9;

- Temperature: below 40°C;

- Sedimentable materials: up to 1 mL/L in 1-hour inmhoff cone test;

- Biochemical Oxygen-BOD demand 5 days, 20°C: maximum of 120 mg/L;

- Hexane soluble substances (oils and greases): up to 100 mg/L;

- Absence of floating materials: minimum removal efficiency of 20%.

- Maintenance

Maintenance should be carried out by removing 90% of the activated sludge resulting from the sewage treatment process. This stake is responsible for the extermination of biodegradable organic pollutants present in domestic effluents.

In the absence of a collecting net, the use of septic tank presupposes that its effluent was: sent to the drainage network, when available, removed by a cleaning truck or preferably, for reasons of lower cost, infiltrated into the soil through sinks (TOLEDO et al., 2021).

The waste should be removed by a suction hose inserted into the whole of the system prepared to receive the effluents and remove the excess stake, usually the trucks of the clean fossa type.

This material must be removed and transported by specialized companies interested in receiving the proper final destination. The ideal is to leave about 10% of the activated sludge at the bottom of the system, for the continuity of biological treatment of effluents.

SYSTEM EFFICIENCY

The systems under study are heamuch used for their efficiency in removing waste from thewastegiftisstico. Becoming a viable technology, with simplified constructive and operational methods. Differentiating in the layout of the project, with the first being executed separately and occupying a larger deployment area and the second being built in an integrated way, requiring less space on the ground. Due to the lack of government incentive, research cannot execute the proposed system for the analysis of physical-chemical parameters, providing results of efficiency tests in scientific

publications and technical standards.

The results found in publications regarding the efficiency of systems that use the septic tank as primary treatment and the anaerobic filter as secondary treatment are very promising, there was a removal of the main pollutants contained in effluents, in the order of 67% for ST, 100% (SST), 62.9% (BOD), 96.7% (WFD), 70.2% (NT), 46.5% (PT) and 80% (K), and the population levels of E. Coli in the treated effluent were below 1000 NMP 100 mL-1 (PITORO, 2019).

The Brazilian Association of Technical Standards, through NBR 13969/1997, Septic Tanks - Complementary treatment units and final disposal of liquid effluents - Design, construction, and operation, defines the probable ranges of removal of pollutants, according to the type of treatment, considered in conjunction with the septic tank (.

Table 5 - Probable pollutant removal ranges.

Process Parameter	Submerged anaerobic filter	Aerobic filter	Sand filter
DBO	40 to 75	60 to 95	50 to 85
COD	40 to 70	50 to 80	40 to 75
SNF	60 to 90	80 to 95	70 to 95
Sedimentable solids	70 or more	90 or more	100
Ammoniacal nitrogen	–	30 to 80	50 to 80
Nitrate	–	30 to 70	30 to 70
Phosphate	20 to 50	30 to 70	30 to 70
Fecal coliforms	–	–	99 or more

With the anaerobic filter obtaining good results in the removal of pollutants, evidenced in the enalises of parameters such as: the biochemical demand of oxygen, the chemical demand of oxygen, the solids in supenção and the sedimentable solids.

In view of these results, it is observed that the primary treatment used only the septic tank is partially efficient, while the combined system using the septic tank as primary treatment and the anaerobic filter as secondary treatment can increase the treatment efficiency, meeting the parameters for disposal of effluents in the environment allowed by CONAMA Resolution No. 430/2011.

ECONOMIC VIABILITY

To evaluate the costs of implementing the treatment systems exposed in this study, the economic feasibility analysis was performed by surveying the costs, using the values obtained in the SINAPI table, shown in Tables 6, 7, 8 and 9, respectively.

Through the tables presented, it was verified that the total cost of the system designed separately was R$ 15,218.99, with the septic tank costing R$ 4,504.56, the anaerobic filter R$ 4,966.88 and the sink r$ 5,747.55. Meanwhile, the cost for tour of the integrated system was R $ 10,940.02, reducing execution costs by 28% compared to the first, making it more viable due to the lower cost.

Table 6 - Comparative Cost Sheet.

SUMMARY WORKSHEET		
Item	**Discrimination**	**Total Value**
1	System with separate reservoirs	
1.1	Septic Tank	R$4,504.56
1.2	Anaerobic Filter	R$4,966.88
1.3	Sink	R$5,747.55
	Sum 1.1+1.2+1.3	R$15,218.99
2	System with integrated reservoirs	R$10,940.02
3	Deployment cost difference	**R$4,278.97**

Thus, the treatment system designed in an integrated way stands out for the lower cost and smaller built area, with economic viability and implementation, achieving the same efficiency of the separate system in the removal of pollutants..

IV. CONCLUSION

Decentralized sewage treatment systems are considered by several researchers as an efficient solution in the treatment of domestic sewage. Performing the primary treatment by means of the septic tank, the secondary treatment biologically with the use of the anaerobic filter and the final destination of the effluents treated in the sink.

This research proposes the layout of a decentralized domestic sewage treatment system, capable of treating

waste generated by a single-family residence composed of four residents, built in an integrated way, with a minimum capacity of 2,000 liters in the septic tank, 1,400 liters in the anaerobic filter and 2,000 liters in the sink.

For this, the dimensioning and technical specifications of an individual treatment system divided into three reservoirs were presented, following the recommendations of technical standards NBR 7229/1993 and NBR 13969/1997, with the object of developing an efficient project in the removal of pollutants with low cost of implantation and maintenance.

In view of this, the disposal of effluents in the soil, even treated, is not subject to the parameters and release standards set out in CONAMA Resolution 430/11, but may not cause pollution or contamination of surface and groundwater.

The proposed system is, then, a treatment that can be replicated in isolated communities, obeying technical standards in order to meet the main parameters related to sewage treatment in Brazil, mitigating the aggressive effects on the environment and opening opportunities to improve the living and health conditions of the inhabitants of peripheral and rural localities.

About the cost of implementation, the treatment system designed in an integrated way, stands out for the lower cost and smaller built area, reducing the implementation costs by 28% compared to the system with the separate projected reservoirs.

Based on scientific literature and technical analyses, we can affirm that in order to achieve the universalization of basic sanitation in Brazil, it is necessary to make efforts to expand sewage services, especially in peripheral and rural regions without collection networks and sewage treatment plants.

Therefore, the growing need to develop technologies aimed at the decentralized treatment of sewage, opens space for further studies, referring to the patterns of effluent releases in the receiving bodies, aiming to meet the legal requirements and the preservation of the environment.

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Optimization of isolation parameters for starch extraction from *Amaranthus paniculates* (Rajgeera) using response surface methodology

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Abstract— *Amaranthus paniculates is a pseudo-cereal. It is a potential reservoir of starch and the properties of end-use product are dependent on the starch. As the major component in Amaranthus paniculates is starch it is very necessary to standardize the process for starch isolation for the maximum recovery of starch with minimal impurities. The study was aimed to improve the isolation parameters for the starch extraction using response surface methodology (RSM). The NaOH concentration (0.00 - 0.75 %), sieve mesh size (100 - 300) and steeping time (1 - 24 hrs) were taken as independent variables and starch yield (%), protein (%) and fat (%) were taken as optimizing responses. Quadratic model was used to evaluate the results. The process was optimized at 0.375 % of NaOH concentration, sieve of 300 mesh and steeping time of 24 hrs for the desired results i.e starch yield (39.91%), protein (0.87%) and fat (0.53%) with a desirability level of 1.00*

I. INTRODUCTION

India is an agricultural country and plenty of food grains are grown here, Amaranth is one of them. It belongs to family Amaranthaceae and has more than 60 species out of which *Amaranthus paniculates, Amaranthus hypochondria, Amaranthus cruentes,* and *Amaranthus caudatus* are the essential grain species (Brenner et. al., 2000 ; Narender Kumar et. al., 2013). *Amaranthus paniculates* is a tall annual herb and is a flowering plant species. Starch accounts for 50% to 69% depending on the species. Starch is the major component of *Amaranthus paniculates*. The major reserve polysaccharide in plants is starch and plays a crucial role in the food industry especially in the bakery industry (Teli et. al., 1996). Starch is a semi-crystalline, white, tasteless and odorless powder that is composed of several amylose and amylopectin linkages branched complexly. Starch forms the major source of carbohydrates in dietary seeds, cereals, legumes, pseudo-cereal and in the parts of plants like tubers, roots, leaves, stems, etc. (Kumar N et. al., 2013). The amylose and amylopectin content of the starch varies with the source of starch and therefore the chemical composition, properties and the structure of starch vary as well. The shape and size of the starch granules is also different for each variety. The importance of starch as a food ingredient is evident from the fact that it forms 30% of the average diet and on a dry weight basis and more than 25% on an available energy basis (Galliard, 1987). Starch is a highly versatile food ingredient that is used as an additive in the form of an emulsifier, stabilizer and thickener (Rengsutthi, 2011) in various food formulations in daily life. It has extremely small granules and has low amylose content and has 90-95% of amylopectin which provides excellent freeze/thaw stability. Due to the presence of high amount of amylopectin, the higher value of enthalpy change is observed. Amaranth starch has good swelling power because of high amylopectin content. Gelation properties are interrelated to the water absorption capacity, amaranth has a good gel formation capacity because the water absorption capacity of amaranth starch is good (Sindhu et al,2016). Amaranth

also contains squalene which exhibits cholesterol properties (Petras R. Venskutoins and Paulius Kraujales, 2013). it is also found in the study by (Martirosyan D.M., 2013) that *Amaranthus paniculates* is a good source of flavonoid especially rutin. It has various characteristics other than its nutritional value, it is resistance to a wide range of agro-climatic conditions such as drought, hot climate, and pests as well as it adapts readily to new environmental conditions (Yue et. al., 1993). An earlier method was to soak the grains in aqueous solution with $HgCl_2$ to inhibit the enzymatic activities. (Wankhede et. al, 1989) but the drawback is the toxicity of $HgCl_2$. Colour and clarity play a very important role in the application of ingredient in food products. The acceptability of starch may be reduced because of its color (Galvez and Resurreccion, 1993).

Response surface methodology (RSM) software is very important for the optimization. It is very useful in designing, formulating and improving the process parameters. (Bas and Boyac, 2007)

II.   MATERIAL AND METHODS

2.1 Material

The *Amaranthus paniculatus* seeds used in the present study were procured from the National Bureau of Plant Genetic Resources (NBPGR) located in Shimla, India. The grains were sun-dried for 1 day and screened to remove foreign matters. The grains were stored in a sealed container at room temperature for further studies.

2.2 Physical properties

The diameter of the grain is determined by screw gauge.

2.2.1 Thousand kernel weight

Thousand kernel weight is determined by the method given by varnamkhasti *et al., (*2008) it was determined by randomly selecting 1000 grains and weighing the grains on electronic balance.

2.2.2 Porosity

Porosity (ε) is defined as the fraction of space in a bed of grains that is not occupied by the grains.

$\mathcal{E}=(1-\rho b/\rho t)\ 100$

Where,

ρb is bulk density of the grains

ρt is the true density of the grains

2.2.3 Bulk density (ρb) and true density (ρt)

Bulk density (ρb) is the ratio between the mass of a sample of grain and the total volume occupied by it. It was determined by pouring the grains from a certain height into the cylinder of known volume, weight the grains in the cylinder.

Bulk density *(ρb)* = mass / volume

True density (ρt) is the ratio between the mass of the sample grains and the actual volume occupied by it, it was determined by the toluene displacement method (Mohsenin, 1986)

2.2.4 Angle of repose

Angle of repose is the angle with the horizontal at which the material will stand when piled. It was determined by adjusting the funnel on the burette stand at a height of 2 cm from the base, grains were poured in the funnel till the pile of the grains touches the end of the funnel, note the diameter of the pile and put the values in formula to get the value of angle of repose.

$\emptyset = \tan^{-1}(2H/D)$

Where,

H is the height of the funnel from the base

D is the diameter

Value of tan inverse is calculated using tan inverse table.

2.3 Preparation of Flour

The flour was prepared by grinding the grains in Butterfly grand turbo (2015) available in the food processing laboratory of the Food Science and Technology Department, Pondicherry University, India. prepared flour was sieved through sieve no. 100 (Jayant Scientific Ind. Mumbai) and stored in zip lock bags at room temperature for further study of its nutritional composition.

2.4 Proximate Composition

The prepared flour sample was analyzed for its chemical composition i.e. moisture, protein, carbohydrates, fat, fibre and ash by using the methods given by AOAC, 1990. All the analyses were conducted in triplicate, the average value and the standard deviation was taken as the final value.

2.5 Isolation of Starch

Amaranth grains are soaked in an alkali solution of different concentrations (0.00-0.75 %) for 1- 24 hrs at 4°C and stirred twice or thrice in between. The grains were washed with distilled water after steeping and blend in the blender at full speed to make the slurry. The slurry was filtered through different mesh size filter screen (100 - 300). The filtrate was centrifuged at 3000g for 20 min. Discard the supernatant and scrap the top yellow layer containing protein and other impurities. Suspend the starch again in distilled water and centrifuged as described above. This process was repeated 4 times to remove the maximum amount of impurities. The isolated starch was kept in a hot

air oven at 50°C for 10-12 hrs for drying and stored in sealed packs at room temperature.

2.6 Chemical composition of starch

The extracted starch was analyzed for moisture, fat, proteins, ash and fibre content by the standard methods given by AOAC,1990. Method of (Williams et al., 1970) was used to determine the amylose content of the isolated starch, and the absorbance was measured at 625nm using UV Spectrophotometer (UV-1800, Shimadzu, Japan). The amount of amylose present is calculated by using the standard curve blends of amylose.

2.7 Starch yield

Starch yield is the the ratio between, the amount of powder obtained after drying and the total amount of starch slurry

Powder yield (%) = Dried powder/ amount of starch slurry ×100

2.8 Color parameters

Colour parameters of the isolated starch were analyzed by using Color flex spectrophotometer (CX2748) (IR technology service(P) Ltd., Bangalore). the values were determined in L*, a* and b* where lightness and darkness are represented by L*, green and red opposition are represented by a* and yellow and blue opposition is represented by b*.

2.9 Swelling power and Solubility of Starch

Swelling power and solubility were analyzed by the method given by (Adebooye and Singh, 2008) with slight modifications, 500mg of the starch sample was heated with 20 ml of distilled water for 30 min at 80°C. Bring the same to room temperature. Centrifuge the sample at 3000g 20 min. Pour the supernatant into the petri dish, weigh and kept for drying at 100°C and weigh again. The residue was weighed for the estimation of swelling power. The solubility and swelling power were calculated by the following formula:

Solubility = dried supernatant weight/ wet sediment weight× 100

Swelling Power= wet sediment weight/ sample weight-dried supernatant weight

2.10 Bulk Density and Tapped Density

The method given by Jangam et al. (2010) was used to determine the bulk density and tapped density. 1g of the sample was loaded in 10 ml of measuring cylinder and to determine the bulk density, bulk volume was noted. In the same measuring cylinder, the sample was tapped 100 times and to determine the tapped density (weight\volume) of the sample the final volume of the sample was recorded.

2.11 Water and oil absorption capacity

Water and oil absorption capacity was determined by the method given by Ige et al (1984) . 2 g of sample was dissolved in 10 ml of distilled water, allow it to rest for 15 min and then centrifuge it at 3000 rpm for 20 min. Decant the supernatant, tubes were dried at 40°C and weighed after drying. For the oil absorption capacity, take 2 g of sample and add 5 ml of groundnut oil the sample. The solution was stirred for 1 min and then kept for resting for 20 min. After resting the tubes are centrifuge at 3000 rpm for 20 min. The volume of the oil which is not absorbed is noted.

2.12 Water Activity

To determine the water activity of the sample electronic water activity meter was used (Aqua lab Series, Decagon Devices, Inc., Pullman, USA)

2.13 Scanning electron microscopy (SEM)

To determine the morphological structure of starch granules scanning electron microscopy was used (Hitachi, S-3400N, 340512-02, Japan). The sample was mounted on the aluminium slab using double sided, place the slab in the coating chamber to coat the sample with gold. The sample was observed at a magnification of 2000 X

EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

For the optimization of isolation of starch from *Amaranthus paniculates* RSM was used. 3 independent variables namely alkali concentration (0.00 - 0.75 %), sieve mesh size (100 - 300) and steeping time (1 - 24 hrs) along with 3 responses which are starch yield (%), protein content (%) and fat content (%) were used using boxbenken model with 17 runs. Equation obtained for the coded variables are:

Starch yield: $+35.35+2.05A +2.27B +2.89C +2.33AB +1.51AC +0.89BC -6.47A^2 - 0.90B^2 -0.15C^2$

Protein: $+1.14 -0.13A -0.21B -0.14C -0.05AB -0.09AC -0.05BC +0.46A^2 -0.15B^2 +0.11C^2$

Fat: $+0.50 -0.10A -0.05B -0.11C -0.05AB -0.03AC -0.02BC +0.19A^2 +0.10B^2 +0.13C^2$

Where, A is alkali concentration, B is sieve mesh size and C is steeping time. Linear interaction was shown by A, B and C and AB, AC, BC shows interaction regression coefficients whereas quadratic regression coefficients were shown by A^2, B^2 and C^2. Significance level were determined by analysis of variance (ANOVA). F- value determines the lack of fit and it should not be significant otherwise the model will not be fit. (Atalar and Dervisoglu, 2015). R^2 value determines the efficiency of the model. Design expert 12 software was used for the optimization.

III.   RESULT AND DISCUSSION

Physical properties

The physical attributes of Amaranth paniculates is given in Table 1. The diameter is found to be 0.5mm because of too small size of the grains the thousand kernel weight was found to be 0.76g, similar results were observed by (Kudos and Solanki, 2018).

Bulk density and true density was found to be 830 kg/m^3 and 1396 kg/m^3 respectively, similar pattern of result has been reported by (Sobulola and Onwuka, 2010) for locust bean seed. Angle of repose was found to be 25.65° this could be because of the small surface area of the grains due to which there will be less surface tension, similar pattern of results was observed by (Kudos and Solanki, 2018)

Table 1: Physical properties of Amaranthus paniculates

Diameter (mm)	0.5±0.01
Thousand kernel weight (g)	0.76±0.03
Bulk density (kg/m^3)	830±0.05
True density (kg/m^3)	1396±0.04
Porosity (%)	40.54%±0.01
Angle of repose (°)	25.65°

The values are expressed as mean ± SD of triplicate readings

The proximate composition of Amaranth paniculates is given in Table 2. The content of protein and fat is less as compared to the starch, it was of same trend as studied by (Choi et al,2004; Ritu Sindhu and Bhupender Singh,2016 and Narender Kumar et. al., 2013)

Table 2: Nutritional composition of Amaranthus paniculates

S.No.	Composition	Content(%)
1	Moisture	11.39±0.03
2	Protein	14.24±0.15
3	Carbohydrates	69.38±0.24
4	Fat	8.70±0.02
5	Fibre	2.95±0.01
6	Ash	3.75±0.04

The values are expressed as mean ± SD of triplicate readings

As *Amaranth paniculates* have nearly 70% of starch content, it is very important to standardize the process for its extraction. The process was standardized for the maximum starch yield with improved colour and minimum impurities.

The experimental design is given in table 3, Analysis of Variance (ANOVA) is listed in table 4 and the constrains were given in table 5.

Table 3: Experimental design

Runs	NaOH CONC (%)	Mesh size	steeping time (hrs)	starch yield (%)	Protein (%)	fat (%)
1	0.75	100	12.5	23.97	1.61	0.83
2	0	200	24	27	1.65	0.9
3	0.375	200	12.5	34.88	1.13	0.21
4	0.375	300	24	39.91	0.87	0.53
5	0.375	200	12.5	36.91	0.99	0.58
6	0	100	12.5	25.5	1.81	0.9
7	0.75	300	12.5	35.07	0.97	0.57
8	0.75	200	24	35.07	1.23	0.61
9	0	200	1	25.34	2.03	0.96
10	0.75	200	1	27.36	1.97	0.81
11	0.375	200	12.5	35.02	1.11	0.58
12	0.375	200	12.5	34.88	1.19	0.59
13	0.375	100	1	30.41	1.21	0.91

14	0.375	100	24	35.48	1.31	0.65
15	0.375	200	12.5	34.92	1.28	0.58
16	0	300	12.5	27.26	1.39	0.87
17	0.375	300	1	31.25	1	0.89

NaOH concentration, mesh size and steeping time are independent variables whereas starch yield, protein and fat percent are the response. All the responses are mean value of triplicate readings

Table 4: Analysis of variance (ANOVA)

Source (P>F)	Yield	Protein	Fat
Model	**0.0004**	**0.0114**	**0.0429**
A	0.0051	0.0632	0.3114
B	0.003	0.011	0.7607
C	0.0008	0.0545	0.2972
AB	0.143	0.5525	0.8855
AC	0.0741	0.3412	0.4320
BC	0.2533	0.535	0.0270
A^2	<0.0001	0.001	0.0046
B^2	0.2406	0.1071	0.7571
C^2	0.828	0.2181	0.0464
Lock as fit	0.0819	0.0764	0.1419
R^2	0.9611	0.892	0.8342

A, B, C denotes NaOH conc., sieve mesh size and steeping time respectively

Table 5: Process parameters and responses

Constraints			
Name	**Goal**	**Lower Limit**	**Upper Limit**
NaOH conc. (%)	is in range	0	0.75
Sieve size (mesh)	is in range	100	300
Steeping time (hrs)	is in range	1	24
Starch yield (%)	maximize	23.97	39.91
Protein (%)	minimize	0.87	2.03
Fat (%)	minimize	0.21	0.96

The process was standardized at 0.375 NaOH concentration, 300 sieve mesh size and 24 hrs of steeping which will give maximum starch yield of 39.91% with minimum fat and protein content i.e 0.53% and 0.87% respectively. ANOVA data shows that the model is fit as the lack of fit value is non-significant listed in table 4. R^2 value of starch yield, protein and fat are 0.9611, 0.8920 and 0.8342 respectively. The regression coefficient is shown by the equation given in section experimental design and statistical analysis. The 3-D graphical illustration was given in Figure 1 (Fig: A-C shows the effect of independent variables on starch yield, Fig: D-F shows the effect of independent variables on protein content, Fig: G-I shows the effect of independent variable on fat content) and the desirability level of each factor is shown in figure 2.
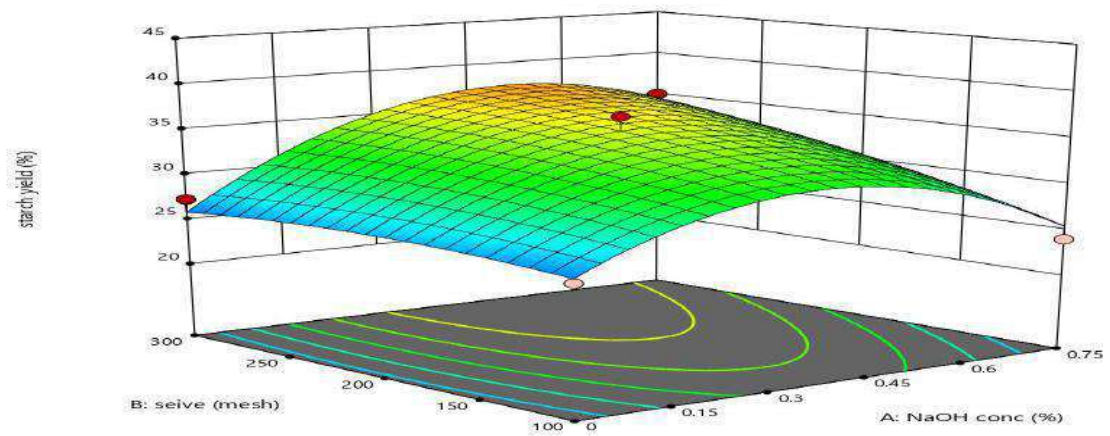
A) Effect of sieve size and NaOH conc on starch yield
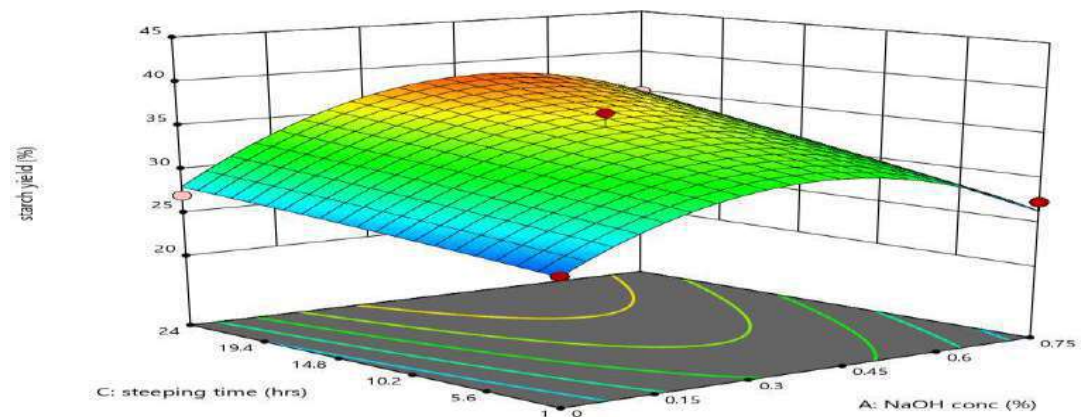
B) Effect of steeping time and NaOH Conc on Starch yield
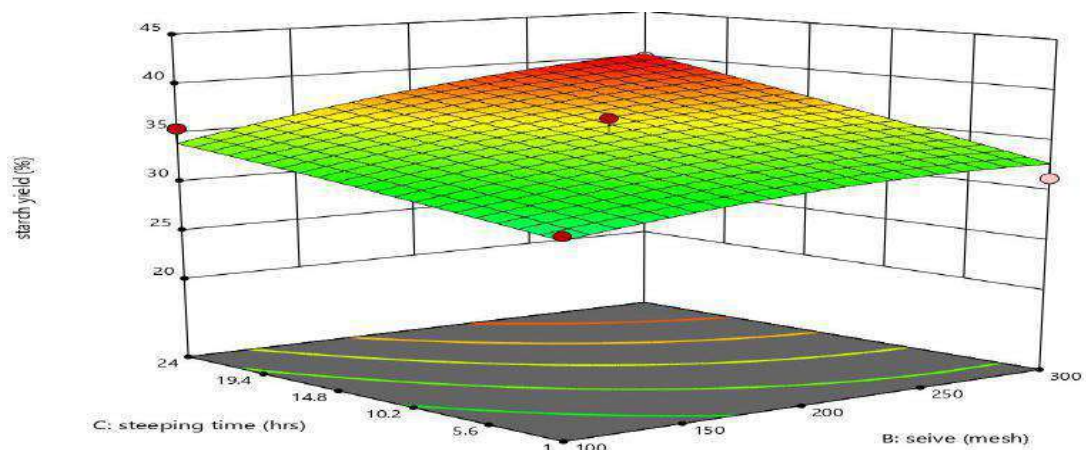
C) Effect of sieve size and steeping time on starch yield
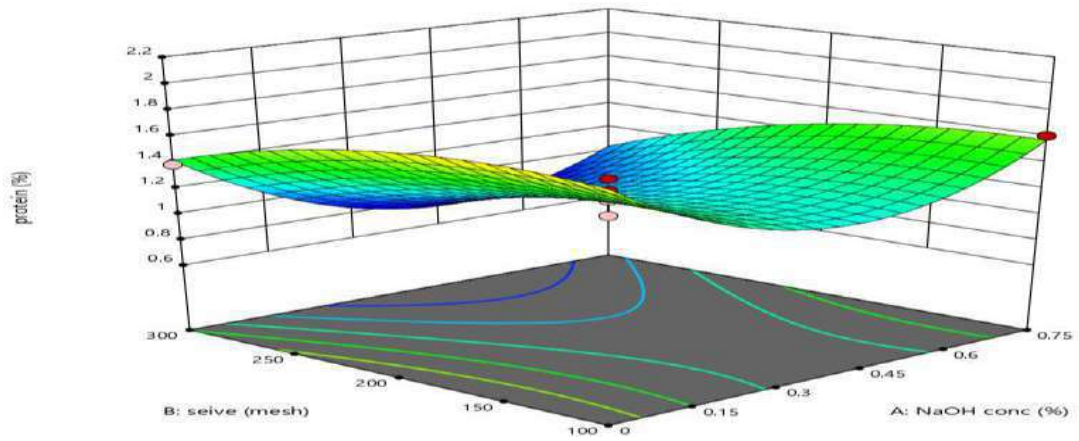
D) Effect of sieve size and NaOH conc on protein content
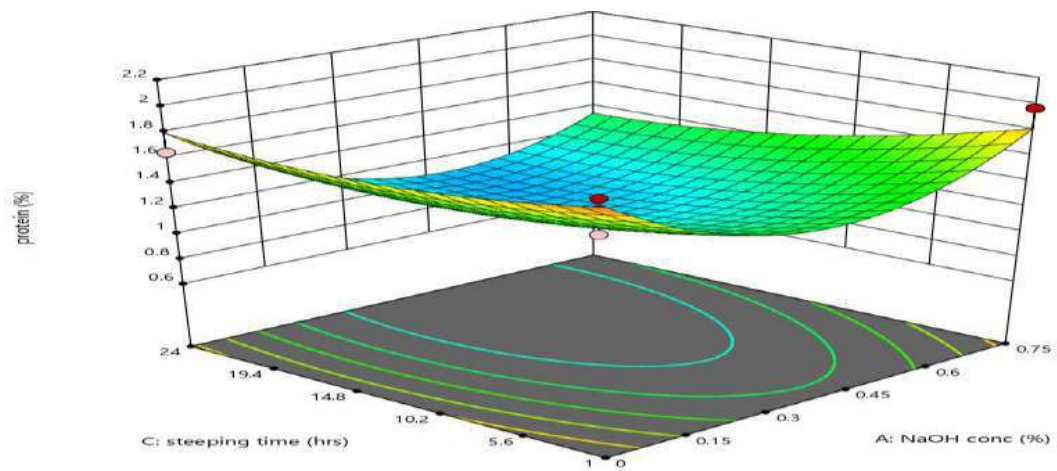
E) Effect of steeping time and NaOH conc on protein content
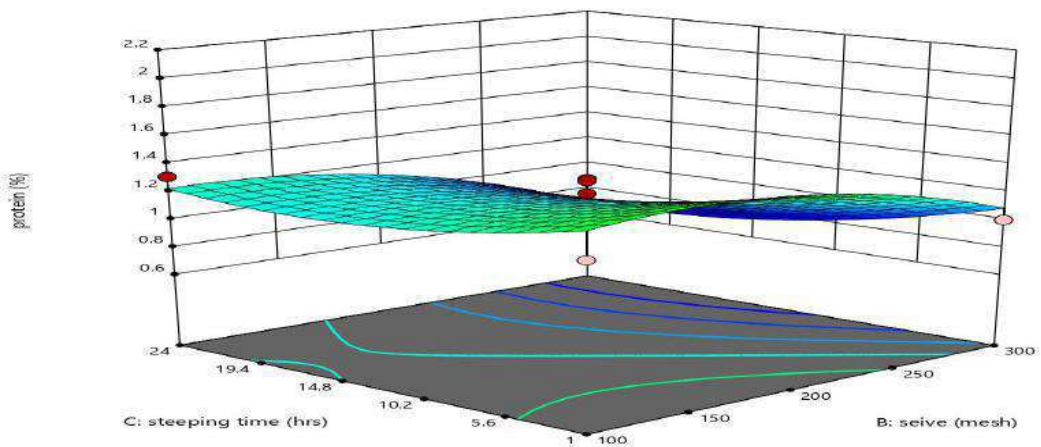
F) Effect of steeping time and sieve size on protein content
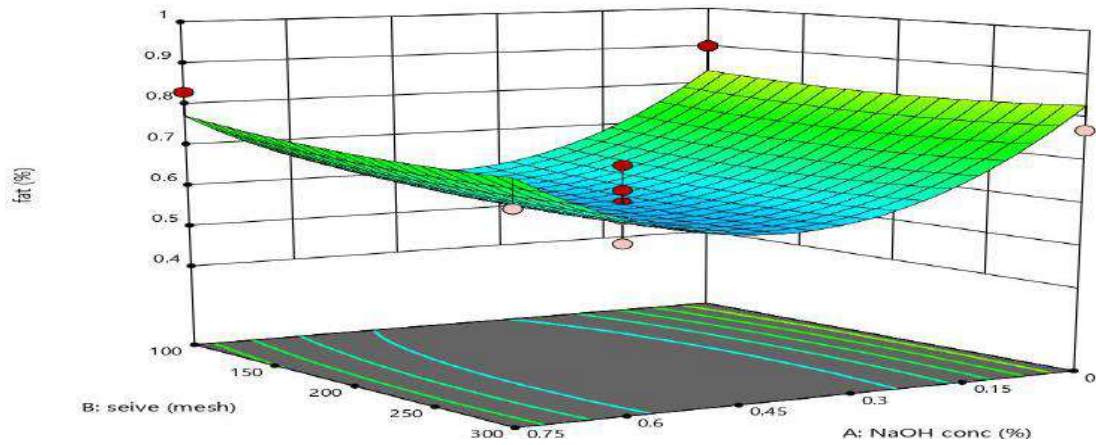
G) Effect of sieve size and NaOH conc on fat content
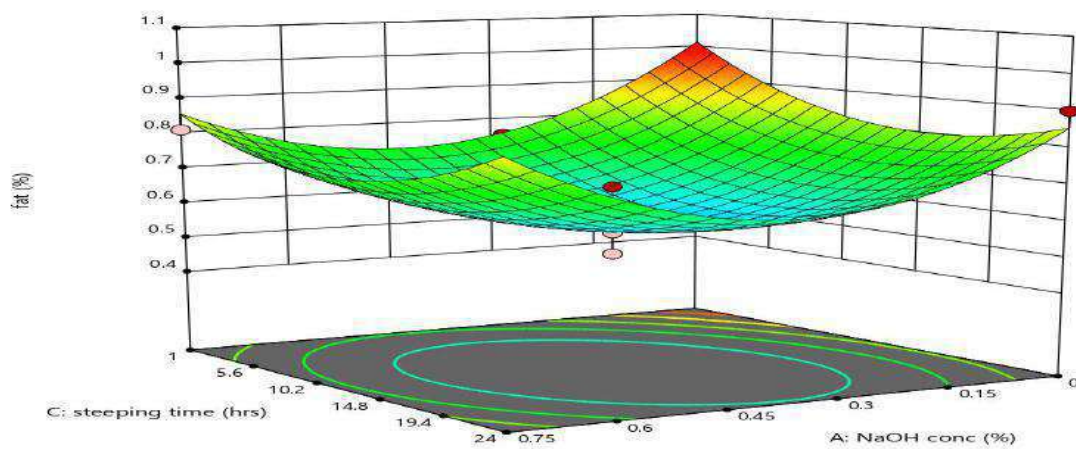
H) Effect of steeping time and NaOH conc on fat content
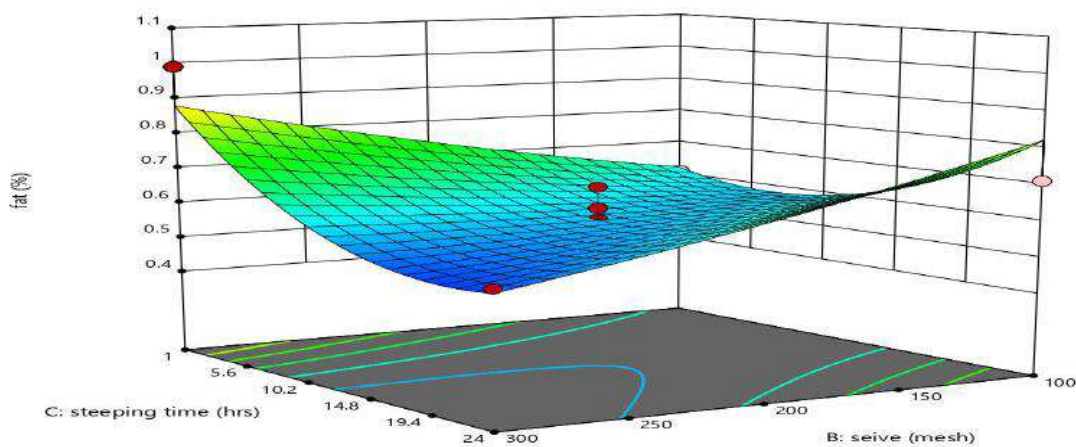
I) Effect of steeping time and sieve size on fat content

Fig.1: Response surface plots (3D) showing the effects of process parameters on : Starch yield, Protein content and Fat content
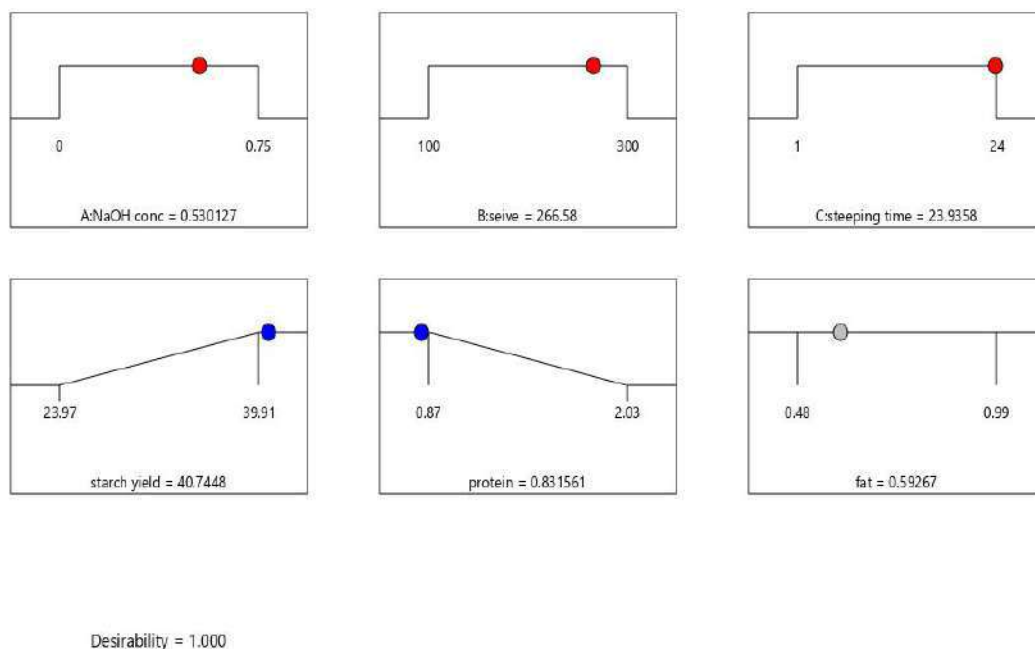
Fig.2: Optimum condition for the isolation of starch according to desirability function.

Steeping is done to loosen up the endosperm of the grain, with the decrease in steeping time the starch yield also decreases may be due the attachment of endosperm with the other covering of the grain. With the decrease in mess size of sieve the purity of starch increases. Taking all the aspects in considerations the steeping time, alkali concentration and sieve mesh size were standardized. Flour : alkali ratio, steeping time, centrifuge speed and centrifuge time was kept constant for all the samples.

After the standardization, the results obtained are given in Table 6. The starch yield was 39.91% and protein content was 0.87%. Functional properties such as solubility, swelling power are affected by the amylose content. To measure the extent of interactions between starch chain, within the amorphous and crystalline domains of the starch granule swelling power and solubility is determined. The amylose content was found to be 7.01%, the result is almost comparable to the result obtained by Ritu and Singh (2016), solubility was 73.43%. Due to high amylopectin concentration, the swelling power of amaranth starch was high as compared to the other starch sources like sweet potato, banana, etc. The solubility was found to be 12.56g/g, the result was comparable to the result obtained by Kong et al (2009). The water absorption capacity of starch was observed to be 117 % which was nearly similar to the results obtained by the Sindhu and Singh (2016). Flavour retention and mouth feel of the products is due to the interaction between the hydrocarbon chains of lipids and the non-polar amino acid side chains which are in relation to the oil absorption capacity. The oil absorption capacity was found to be

135% which is lower to the results obtained by Sindhu and Singh (2016) recorded 146% for amaranth starch. Overall trends that water absorption capacity is lower than the oil absorption capacity is similar to the observation by Adeniyi and Obatolu (2014). Acceptability of any product is somewhat based on the colour of the product and any colour or pigmentation in the starch is carried to the final product. L* was observed to be 97.62 which indicates the luminosity and b* and a* value observed are 3.69 and 0.97 respectively which indicates the presence of tint of red and yellow in the sample.

Table 6: Process standardization

Alkali % (NaOH)	0.375
Alkali volume: flour ratio	1:5
Steeping time (hrs)	24
Steeping temperature (°C)	4
Screen size (mesh) to filter slurry	300
Centrifuge speed	3000g
Centrifuge time (min)	20
Starch yield (%)	39.91 ± 0.10
Amylose %	7.01 ± 0.05
Solubility %	73.43 ± 0.31
Swelling power (g/g)	12.56 ± 1.21
L*	97.62 ± 0.67
b*	3.69 ± 1.13

a*	0.97 ± 0.04
Protein %	0.87±0.04
Bulk density (kg/m³)	610±0.03
Tapped density (kg/m³)	720±0.01
Water activity	0.37±0.02
Water absorption capacity (%)	117.34±1.12
Oil absorption capacity (%)	135.85±0.89

The value are expressed as mean ± SD of triplicate readings

The microstructure (Fig 3) revealed that the mean diameter of starch granule is 1.29µm with polygonal shape, no fissures are observed on the surface. The smooth surface indicates the low activity of amylase and no damaged starch was found which state that the isolation process do not cause any damage to the starch.
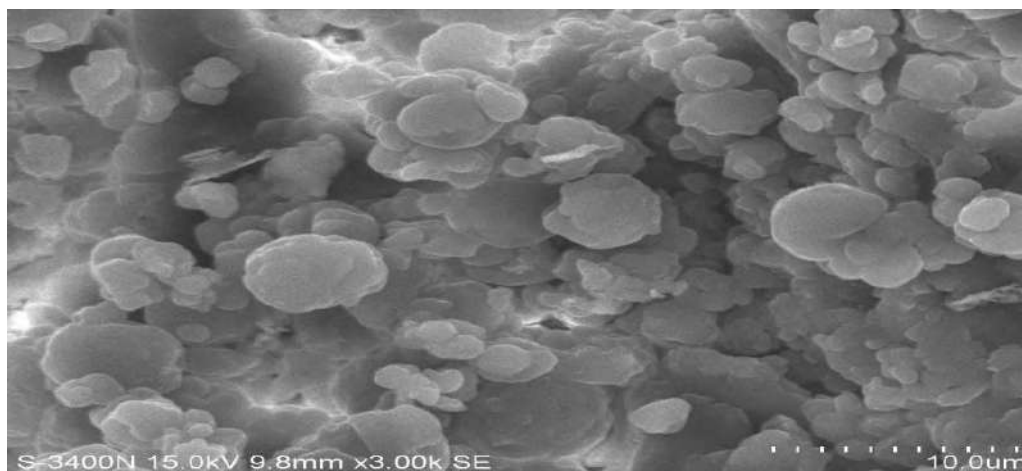
Fig.3: scanning electron microscopy view of amaranth starch

IV. CONCLUSION

The physical properties listed in Table 1, are very useful for the designing of different macheneries for amaranth grain processing. The physio chemical properties of Amaranth propose that it has a lower concentration of proteins, fat, fibre and ash which confirms the higher and pure concentration of starch. For the isolation of starch from *Amaranthus paniculates* (Rajgeera) the process was standardized at alkali concentration (NaOH) of 0.30% and screen size of 300 mesh for the filtration of slurry. At the standardized values the starch yield was 39.91%, protein content was found to be 0.78%, fat content noted was 0.53%, ash content was 0.66%, fibre content was 0.26% and the amylose content was found to be 6.87%, which confirms the purity of isolated starch and the effectiveness of the standardization process. Due to the small size of granules the starch can be used in various food and non-food industries. Further studies should be done on the starch structure and standardization of the process using different alkali solutions and on different varieties of amaranth from different regions.

INTEREST OF CONFLICT STATEMENT

The authors declare that there is no conflict of interest.

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The Social Construct on the adoption of Green Energy: Evidence with Solar in Ghana

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Abstract— Indicators of global warming encourage us to pursue sustainable consumption, as there is a necessity to resolve the ongoing environmental threat. The best option is to promote green consumption; however, despite varying awareness and contributions on the many benefits of renewable energy, developing countries such as Ghana have yet to fully benefit from it due to skepticism about its exorbitant price. Our study attempted to explore the Theory of Reason action model to understand this phenomenon using five variables (Knowledge, Environmental Concerns, Environmental beliefs, Attitude, and the willingness to pay). We did an in-depth analysis to understand the role each plays in influencing behavior towards green consumption. A partial least squares structural equation modeling (PLS-SEM) methodology was used for statistical analysis. Our results revealed interrelated effects as well as aggregated effects on variables. The domineering element expressed to encourage the willingness to pay for and use solar energy was knowledge and environmental concerns. Ultimately, it provided a framework for the Ghanaian Government and stakeholders on the best strategy to upscale solar energy introduction and to assist decision-makers in developing long-term energy policies to achieve long-term consumption sustainability.

Highlights

1. An alternate to combat climate change is the promotion of green Consumption

2. Solar technology is the fastest growing renewable energy in the market

3. An in-depth analysis to understand the feasibility of the theory of reason action

4. Knowledge plays a critical role in the upscale of solar energy in Ghana

5. Solar technology provides an innovative solution for the global warming

I. INTRODUCTION

The effect of global warming has prompted several countries to propose and enact policy changes aimed at reducing carbon emissions; as a result, economies are turning to alternative(renewable) energy sources (Ivanova, 2012). Considering its relative abundance and eco-friendly character, Solar energy is the best alternative(Malik & Ayop, 2020).Additionally analysts and experts think that

because of its low carbon content, it could aid in the promotion of sustainable development (Hao, Guo, Tian, & Shao, 2019).Ghana is yet to explore this option has it energy mix is highly thermal base. See Fig 1. Ghana's strategic national energy plan (2006-2020) set a goal of increasing renewable energy in the energy mix by at least 10% by 2020, but failure to meet that goal has resulted in an extension to 2030 due to abysmal results of 0.3% as of 2019(Energy Commission %J Main Report, 2006)
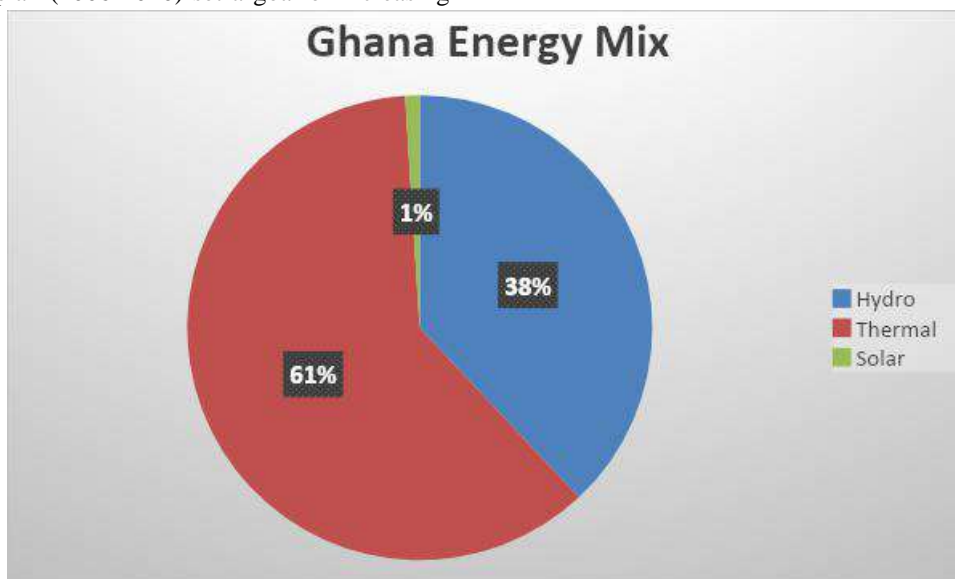
Source : Authors computation using Ghana Statistical Service Data

This has been attributed to the idea that developing countries commonly lack environmental knowledge and a sense of responsibility to protect the environment(Chan, 2001). Therefore Chan (2001) argues for contemporary work to be done in developing countries. Besides financial gains, encouraging public interest in Ghana's energy transition has tremendous benefits (Menyeh, 2021). An additional service is promoting energy awareness, climate change debate, and fostering new approaches to combating global warming(Bergman & Eyre, 2011; Bolton & Foxon, 2015; Devine-Wright, 2011). Prior research has also yielded contradictory findings regarding consumers' behavioral responses to green energy sources(Bang, Ellinger, Hadjimarcou, & Traichal, 2000). Another growing concern is the affordability for consumers. As a result, academic and public programs aimed at growing consumer acceptance of renewable energy are rising (Lin & Syrgabayeva, 2016). Widely used indicators are demographic, socio-economic status, and age groupings (E. Moula et al., 2013). However, the alternate module to use would be the Theory of reason attitude or Theory of plan behavior to understand motivation leading to consumption of green energy (Ajzen, 2002; Fishbein & Ajzen, 1977).

Literature has also primarily focused on the ex-post appraisal of the construction of residential solar power (Ahmad, Mat Tahar Razman, Cheng Jack, & Yao, 2017; Alsabbagh, 2019; Haw, Sopian, & Sulaiman, 2009). Besides, because of their particular social, economic, and political structure, research findings from developed countries cannot be applied to developing countries. (Dewan & Kraemer, 2000).In trying to fill the gap, we would study the public's opinion before the large-scale solar introduction in Ghana. Precisely assess to know how the application of Theory of plan behavior and Theory of reason action can foster the transition from fossil fuel to solar technology, imploring a survey tool questionnaire,

Ghana is a prime study candidate, as it could offer insights for neighboring countries to benefit from their experiences in fostering access to energy and overall sustainable growth. Furthermore, the research adds to the discussion on energy change. The successful introduction, production, and deployment of renewable energy, especially solar power, aims to mitigate the electricity crisis and meet the country's 2030 goal. Three goals were tried in this report. Initially, try to understand the features of Ghanaian consumers (the general public) and how they can buy green to counter global warming and reduce environmental damage. Secondly, to create a marketing strategy plan and educational feedback to determines the possible way to enhance the energy performance of Ghana's marketing, public officers, investors, and, most importantly, the governments of Ghana that promote and encourage the use of renewable energies.

The remainder of the analysis is structured as follows. The following section discusses the literature analysis, which explains the methods and evidence used, the findings examined, and the consequences and assumptions of the policy.

II. LITERATURE REVIEW

Numerous studies on the knowledge and appreciation of solar energy have emerged (Abdullah et al., 2017; Adenle, 2020; Agyekum, Velkin, & Hossain, 2020; Baharoon, Rahman, & Fadhl, 2016; E. Moula et al., 2013; Irfan, Elavarasan, Hao, Feng, & Sailan, 2021; Karjalainen & Ahvenniemi, 2019; Rai & Beck, 2015; Sommerfeld, Buys, & Vine, 2017). This has shown that consensus and knowledge are essential, depicting that the public and citizen's attitude significantly affect energy policy planning (Viklund, 2004). The downside has demonstrated that other indicators apart from pure science influence the buying power of consumers. This is in line with Benjamin K. Sovacool and Tambo (2016) notion that green energy consumption can be identified with technological and social spheres providing a lean way for society to contribute to sustainable consumption. Also, Batel and Devine-Wright (2015) illustrated how promoting clean energy sources could be viewed as a social change mechanism rooted in societal values. Therefore several jurisdictions and academics have been working on encouraging good public attitudes toward renewable energy resources through information sharing and education.

Literature indicated that environmentally aware people are liberal with a favorable outlook towards introducing new clean technology such as solar (Bidwell, 2016; Hansla, Gamble, Juliusson, & Gärling, 2008; Longo, Markandya, & Petrucci, 2008; Zyadin, Puhakka, Ahponen, & Pelkonen, 2014). Since they are familiar with environmental degradation harms humans (Longo et al., 2008), developed countries like Sweden, with high knowledge on the ecological issue, are more likely to embrace new clean technology(Ek, 2005).in line with the above, other related studies also affirmed that individuals with higher environmental preference were willing to proceed with the adoption of clean technologies(Di Maria, Ferreira, & Lazarova, 2010; Kollmuss & Agyeman, 2002)

Following from hoping to protect the environment and, by extension, defend themselves, some participants didn't mind paying for more to access such new technology(W. Abdullah, Zainudin, & Ishak, 2018; Alsabbagh, 2019) Though agreeing with the assertion premised on other engagement on the benefits of clean energy. Improved understanding will contribute to improved recognition and corporation in paying for Renewable Energy.

Another strand of studies perused the significance of knowledge on solar energy acceptance. According to (Kontogianni, Tourkolias, & Skourtos, 2013), knowledge is essential to designing energy policies and creating appropriate initiatives to promote sustainable energy

sources. Findings from (Bang et al., 2000; Martins, Madaleno, & Dias, 2020) collaborated on such results. They claim that, in general, there is a low degree of energy awareness, pointing out the need to educate customers to enhance their energy-related decisions. Especially young adult students were identified to be influenced most about the information and showed that the mindset of young people towards RE was influenced by RETs awareness (Halder et al., 2012). Young people displayed relatively optimistic attitudes towards solar energy and wind power because they were aware of them; however, they showed pessimistic attitudes because they were ignorant of forest bioenergy (Entele, 2020). Intimating that age influences Attitude towards renewable energy as consumer attitudes towards wind energy decrease with age and income, while optimistic attitudes towards green electricity decrease with age and income.

It was also revealing that demographics influenced awareness of renewable energy. It showed that the public's views on the use of RE were affected by various influences that ranged from country to country(Klick & Smith, 2010; Qu et al., 2011). Some findings also reiterated demographic factors have also been established as a significant factor in deciding the chances of being willing to pay a premium price for green energy. (Wang, Valchuis, Thompson, Conner, & Parsons, 2019)

Invariably decision concerning energy type (fuel) for electricity generation has dire consequences on global geopolitics, economy, and environment (Ahmad & Tahar, 2014). This makes it imperative to gain public support before making such a policy decision since there are critical roles to be played by the citizenry and society in the advancement of innovation regarding the technical and social domain of the generation, consumption, and implementation of clean energy B. K. Sovacool et al. (2015). A role easier executed if the public is well informed on the policy direction and have enough education

Therefore it has become essential to carry the people along if a policy to be implemented is successful. More importantly, when it concerns energy identified as the backbone for development. Sadly knowledge on solar energy technology is not as advanced as it should be (Pagliaro, Ciriminna, Pecoraino, & Meneguzzo, 2016), despite the groundbreaking efforts of Broman and other astute scientists. They argued for increased solar education early in the mid-1980s because of its far-reaching possible contribution to humanity and implication to the old order.

2.1 Theoretical Framework And Hypothesis Development

Underpinning Theory for this study would be the Theory of reasoned action and Theory of Planned Behavior (TPB) which was propounded in the late nineteen's by (Ajzen,

2002; Fishbein & Ajzen, 1977). This provides a basis to evaluate consumer behaviour and why they would take a course of action like paying for solar energy when introduced on a large scale in Ghana. Consumers might consider the implications and prefer to exhibit behaviors associated with beneficial effects before engaging in alternative actions. A broad range of research models have proven to be effective in forecasting and explaining the conduct of consumers using TRA, such as studies from (Alwitt & Pitts, 1996; Lin & Syrgabayeva, 2016; Polonsky, Vocino, Grau, Garma, & Ferdous, 2012). (Lin & Syrgabayeva, 2016; Pagiaslis & Krontalis, 2014) the Bang model was used, which gives greats insights into consumers' knowledge, attitude, environmental concerns, and their perspective on paying more or willing to buy.

2.2. Hypothesis Formulation

2.2.1. Environmental concerns

Due to environmental issues, environmental policies and the spread of environmentally friendly behaviors have become topical and advocated for (McCright, Xiao, & Dunlap, 2014). This serves as an antecedent that can affect their purchasing power(Diamantopoulos, Schlegelmilch, Sinkovics, & Bohlen, 2003). The majority of literature stipulates that environmental concerns are the precursor to others' valid construct like knowledge, convictions, and willingness to pay for more environmentally friendly products (Bang et al., 2000; Pagiaslis & Krontalis, 2014; Tilikidou, 2001; Tilikidou, Adamson, & Sarmaniotis, 2002). They feel a duty of service to protect the environment, leading to an attitudinal change espoused (Tan, 2011). It all boils down to a notion that residents worried about the environment are more likely to practice energy conservation and quality improvements (Urban & Ščasný, 2012). Other complementary studies have shown that environmental interest impacts behavioral and attitudes towards behavior patterns-- a rise in the environmental positive. Attitude influences willingness to purchase environmentally friendly technology (Chen & Tung, 2014; Clark, Kotchen, & Moore, 2003; Kalafatis, Pollard, East, & Tsogas, 1999). According to [48], when a concept has personal significance, such as on health or the future of children, it increases interest, contributing to knowledge seeking on the idea. This showed that customer concern for the environment directly influences renewable energy(solar) awareness. (Pagiaslis & Krontalis, 2014) The contrary opinion also doesn't ascertain a correlation between environmental concerns and attitude, though they agree to be an association (Gill, Crosby, & Taylor, 1986; Shrum, Lowrey, & McCarty, 1994; Stokols & Altman, 1987). Other strains of thought are also of the opinion that environmental concern should, in Theory, be positively

related to environmental knowledge; however, empirical results are mixed (Baharoon et al., 2016; Bang et al., 2000). Even so, with knowledge, others believe the level of knowledge may even lead to concern or prejudice against technology (Pagiaslis & Krontalis, 2014; Tilikidou, 2007).

To be able to identify the possible relationship below hypothesis are examined succinctly

H1a. Consumer environmental concerns have a positive effect on Knowledge

H1b. Consumer environmental concerns have a positive influence on environmental beliefs

H1c. Consumer environmental concerns have a positive impact on attitude towards solar Energy

H1d. Consumer environmental concerns have a direct positive effect on willingness to buy solar Energy

2.2.2. Consumers' knowledge of solar energy

Environmental awareness is described as a consumer's awareness of their environment and fundamental relationship with it, which leads to changed perspectives and significant environmental consequences(Lin & Syrgabayeva, 2016). Individuals with a basic understanding of the world have a distinct advantage of an appreciation for renewable energy and its benefit. This was demonstrated by (Mostafa, 2009), who argued that people with a high level of education and knowledge are prone to environmentally friendly products. In another vein, environmental attitudes are thought to shift as knowledge of the environment increases, and environmental knowledge and attitudes affect environmental policy(Arcury, 2008). Other scholars that agree with the assertion include (Egea & de Frutos, 2013; Pagiaslis & Krontalis, 2014; Polonsky et al., 2012). Some were not so convinced that there is a clear-cut correlation between knowledge, attitude, and willingness to purchase green products, as they represented a week correlation from their studies(Laroche, Bergeron, & Barbaro-Forleo, 2001; Pickett, Kangun, & Grove, 1993).

H2a.Consumers' environmental knowledge has a direct positive effect on environmental belief

H2b.Consumers' environmental knowledge has a direct positive effect on attitude towards solar Energy

H2c.Consumers' environmental knowledge has a direct positive effect on willingness to pay

2.2.3. Environmental belief

Theory reason behavior suggested a green behavior, which he described as an attitude influenced by beliefs(Ajzen, 2002). Their attitude shapes consumer attitudes toward the outcomes of their decisions(Bang et al., 2000; Fishbein & Ajzen, 1977). In general, it is essential to investigate the relationship between beliefs (being

behavioral and public) and green consumers. Environmental beliefs influence a broad range of green behaviors, indicate which variables to focus on, and provide a solid foundation for defining different goals(Bamberg, 2003; De Groot & Steg, 2007). Another relevance is that other customers agree that renewable energy slows climate change and global warming and reduces energy dependence, all of which are essential in marketing a green commodity like solar Energy (Hartmann & Apaolaza-Ibáñez, 2012). Other studies also revealed that attitudes about solar energy are positively related to the willingness to pay a higher price for green energy goods(Bang et al., 2000). Prior studies also concluded that public preferences and intentions to use or buy environmental interests are influenced by consumer values(Kalafatis et al., 1999; Mostafa, 2007)

H3a.Environmental beliefs and beliefs towards solar have a direct positive effect on attitude towards solar energy.

H3b.Environmental beliefs and Beliefs toward solar have a direct positive effect on the intention to pay to use solar Energy

2.2.4 Consumers' attitude toward solar Energy and WTP more for solar power

Scholars believe that global attitudes towards renewable energy are generally positive, increasing customers buying premium-priced green electricity.(Ek, 2005; Hansla et al., 2008; Salmela & Varho, 2006) Inherently, consumers participate in green practices because they care for the ecosystem (Bamberg, 2003; Fransson & GÄRling, 1999). The majority of previous research has found a connection between environmental attitudes and pro-environmental or green purchase decisions (Berndt & Petzer, 2011; Egea & de Frutos, 2013; Gerpott & Mahmudova, 2010)

H4.Consumers' attitude toward solar energy has a direct positive effect on their intention to pay a premium price for it

Graphical Representation of hypothesis
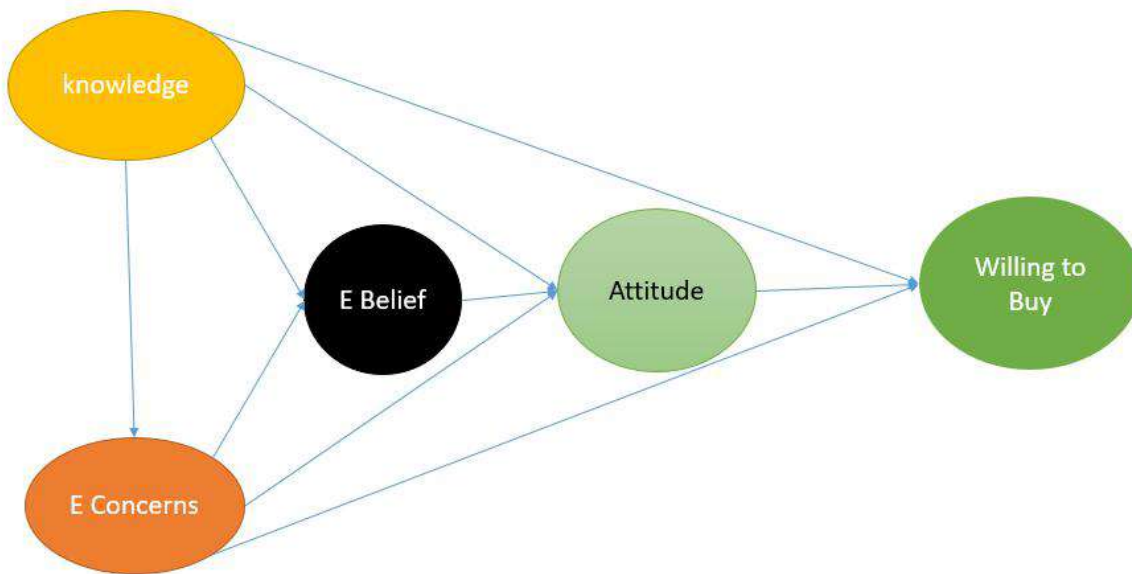
Fig.2: Proposed causal model (sample Picture like that of smart pls)

III. METHODOLOGY

3. Data and Methodology

For this case study approach, the researchers used a comprehensive, cross-sectional approach of self-administered questionnaires. Due to distance constraints, the use of Google Forms was employed to reach respondents in Ghana. This enabled us to solicit the response of the Ghanaian public easily.

3.1 Materials and Methods

3.1.1. Research design

The Author used a 5-point Likert scale was used to test the variables except for the demographics. The question was adopted and revised questions from [3, 11, 12] to be an appropriate scale for my intended work and fit this study's objectives.. Four hundred questionnaires were our intended target, but we collected 372.

3.1.2. Ethical consideration

The respondents were asked for both verbal and written concerns before data was collected. The respondents were made aware that their participation was entirely voluntary, and their privacy was guaranteed.

3.1.3 Statistical analysis and Reliability Test

Data obtained from the questionnaires were coded and analyzed with smart PLS as it provides more valuable results for casual relationships. For data analysis, a partial

least squares structural equation modelling (PLS-SEM) technique is used (partial least squares), a type of structural equation modelling (SEM), which can be extremely useful (Lowry & Gaskin, 2014).It ensures that analytic rigor and consistent estimates are fostered comparatively(Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016).Discrete variables like gender and educational status were described using

Table 1 shows the profile of the respondents. The table showed more dominant male respondents with 63.4% as against 36.6% for females. 81.8% of males were employed

frequencies and percentages. The research implied the use of Cronbach's alpha testing, mainly because of its usefulness in quantifying information from multiple items in a questionnaire, as indicated by (Christmann & Van Aelst, 2006). The test aimed to assess data accuracy and check for internal consistency from respondents (de Vet, Mokkink, Mosmuller, & Terwee, 2017). Most of the underlying theories were proposed by (Nunnally, 1994)

IV.   RESULTS

4. Presentation and discussion of results

4.1Respondent demographic information

There are substantial variations in the socio-economic backgrounds of the study. A total of 372 responses were used for data analysis, which represented an excellent valid rate.

and had one form of university degree with a high score of 95.8%. We also had a very youthful respondent with 75.5% within the bracket 25-34, 35-44.

Table 1. Descriptive Statistics for the Sample. N= 372

Variable	Options	Distribution	
		Frequency	Percent
	Male	236	63.4
	Female	136	36.6
Gender			
Age	18-24	79	21.2
	25-34	239	64.2
	35-44	42	11.3
	45+	12	3.2
Education Status	JHS/ SHS	19	5.1
	Undergraduate	220	59.1
	Postgraduate	133	35.8
Employment Status	Student	112	30.1
	Employed	240	64.5
	Unemployed	20	5.4

4.2. Measurement of Reliability and Validity

Table 2 Variable measurement and descriptive statistics.

Constructs	Items	Factor loadings	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Knowledge	KN1	0.829	0.948	0.961	0.961	0.831
	KN2	0.966				
	KN3	0.959				
	KN4	0.937				
	KN5	0.859				
Environmental concern	ECON1	0.986	0.966	0.969	0.976	0.909
	ECON2	0.955				
	ECON3	0.961				
	ECON4	0.911				
Environmental Beliefs	EB2	0.886	0.956	0.962	0.968	0.884
	EB3	0.965				
	EB4	0.957				
	EB5	0.951				
Attitude	AT1	0.944	0.97	0.97	0.978	0.918
	AT2	0.981				
	AT3	0.941				
	AT4	0.965				
Willingness to pay	WTP1	0.980	0.97	0.971	0.981	0.944
	WTP2	0.953				
	WTP3	0.982				

Cronbach's alpha and composite reliability values were examined to determine validity and reliability of the scale for the research —results of Cronbach's alpha ranged was higher than the recommended value of 0.7, showing desirable scale for research assessment. Given their respective loadings, the scale objects in the measurement model contributed significantly to this study, with a value between 0.829 - 0.986. it depicts excellent internal reliability see Table 2 (Bagozzi & Yi, 1988; Joseph F Hair, 2009). Taking the recommendations from (Fornell & Larcker, 1981), he argued that average variance above 0.50 convergent validity is achieved. The AVEs of all variables met the minimum requirement as the least was 0.831and the highest 0.918. Both reliability and internal consistency of all constructs are also confirmed by rho A and CR values.

Table 3. Construct means, standard deviations, correlations, and the results of discriminant tests.

	Mean	Standard Deviation	1	2	3	4	5
1.knowledge	4.166	0.800	0.912	0.380*	0.764*	0.775*	0.164*
2.Environmental Concerns	4.127	1.064	0.374	0.954	0.219*	0.209*	0.168*

3.Environmental Believe	4.180	0.884	0.734	0.216	0.940	0.694*	0.054*
4.Attitude	4.192	0.884	0.747	0.203	0.672	0.958	0.104*
5.willing to pay	3.934	1.180	0.158	0.163	0.052	0.101	0.972

Note: the lower triangle of the table shows the result of the Fornell-Larcker criterion. The square roots of the average variance extracted are offered in diagonal elements; the upper triangle depicts the results of HTMT.85 indicated with an asterisk.

The findings indicate that the tests are both valid and trustworthy. In variance-based measurement models, such as partial least squares, HTMT is a new indicator for measuring discriminant validity (PLS). Both were used to be on a safer side, despite Henseler's demonstration that the latest method, HTMT, outperforms the conventional Fornell-Larcker criterion (Henseler, Ringle, & Sarstedt, 2015). For the Fornell-Larcker criterion, the Author compared the pairwise correlations between the other latent constructs to the square roots of the AVE values. If the square root of the AVE is higher than the pairwise correlations for each construct of the measurement model, discriminant validity is defined, and this was the case with the results shown in Table 3.

Table 4 Hypotheses testing results

	β	STDEV	T Statistics	P Values	2.50%	97.50%	Remarks
H1a.EC -> KN	0.374	0.061	6.137	0	0.248	0.489	Sig
H1b.EC-> EB	-0.069	0.033	2.07	0.038	-0.134	-0.006	Sig
H1c ECs-> AT	-0.071	0.046	1.538	0.124	-0.167	0.016	Insig
H1d.EC->WTP	0.113	0.065	1.738	0.082	-0.013	0.239	Insig
H2a.KN -> EB	0.760	0.047	16.108	0	0.657	0.844	Sig
H2bKN -> AT	0.583	0.08	7.296	0	0.405	0.726	Sig
H2c.KN-> WTP	0.199	0.085	2.35	0.019	0.023	0.354	Sig
H3a.EB-> AT	0.259	0.083	3.132	0.002	0.103	0.428	Sig
H3b.EB-> WTP	-0.13	0.043	3.043	0.002	-0.205	-0.032	Sig
H4.AT -> WTP	0.017	0.075	0.22	0.826	-0.113	0.187	insig
	R^2	Q^2					
Knowledge	0.14	0.112					
Environmental Believe	0.543	0.474					
Attitude	0.595	0.54					
Willing to pay	0.045	0.039					

1.knowledge – Kn 2.Environmental Concern- EC 3.Environmental Believe –EB 4.Attitude-AT 5.willing to pay-WTP

4.2. Hypothesis result

4.2.1. Consistent PLS

A partial least squares structural equation modelling (PLSeSEM) technique was used to evaluate the proposed hypotheses because we are assured of in-depth outputs as suggested by (Joe F. Hair, Ringle, & Sarstedt, 2011). Hair advises we select PLS-SEM if the study is reflective of an evolution of an emerging classical model. Given that the current research model is a Ghanaian adaptation of Bang's model and interrogation of Lin's approach using PLS-SEM rather than covariance-based structural equation modelling is acceptable. Furthermore, instead of using conventional PLS, this analysis used consistent PLS (PLSc) to evaluate our proposed model(Benitez, Henseler, Castillo, &

Schuberth, 2020; Dijkstra & Henseler, 2015). Smart-PLS 3 evaluates the metric model's construct validity and tests the structural model's parameters.

4.2.2. Report on Relationship

To check the goodness of fitness of the model, we use standardized root mean square residual (SRMR) Henseler et al. (2014), which was 0.041, indicating it was fit for purpose and plausible, as it is less than the 0.08 parameter not to cross (Henseler et al., 2014; Henseler & Sarstedt, 2013). We also had R^2 reported in the table above. The R^2 value for the appropriate variable was used to evaluate each structural path; in general, the R^2 values were acceptable, so the research model's explanatory power was generally satisfactory except for a willingness to pay but the,

On the other hand, this finding is not surprising; it indicates that willingness to pay is affected by a wide range of factors outside the reach of this research. Q^2 was higher than 0. The results of Q^2 also confirm the endogenous constructs' predictive validity. A Q^2 value greater than 0 indicates that the model is predictive.

H1 investigate the relation between environmental concerns and the other variables

We had two distinctive results from the proposed test of the relationship between models, with two supported and vice versa

H1a. The study's findings reveal a positive and meaningful connection between consumers' concerns about solar energy and their awareness of it. (H1a: β=0.374 t= 6.137 p <0.001). H1b also tries to investigate the relationship between environmental concern and Believe. The results findings show there was a negative but significant relationship with (H1b: β= -0.069 t= 2.070 p=0.038). H1c. Although the study predicts a positive relationship between environmental concern and attitude, the result is not statistically significant. (H1c: β=-0.071t= 0.046 p =0.124).H1d. Also, evaluate the relationship between Environmental concerns and Willing to pay. The relationship also reveals the assertion is not supported. (H1d: β=-0.113 t= 1.738 p =0.124)

H2 Investigate the relation between knowledge and other variables

Knowledge showed a positive and significant relation to beliefs, attitudes, and willingness to pay to use solar energy. H2a: β=-0.760 t= 16.108 p <0.001 H2b: β=-0.583 t= 7.296 p <0.001, H2c: β=-0.199 t= 2.35 p <0.019

H3 Investigate the relationship between Environmental Beliefs and 1.Attitude 11. Willing to pay

Environmental believe has a positive influence and significant impact on attitude H3a: β=0.259 t= 3.132 p = 0.002 . Also it has negative impact but significant on willing to pay H3b: β=-0.13 t= 0.22 p = 0.002

H4 investigate the relation between attitude and willingness to pay

According to the study, a favorable customer attitude towards solar energy results in a high willingness to pay more for solar energy.However this was not supported by the results H3b: β=-0.017 t= 0.22 p = 0.826

Table 5 Indirect effects of construct

	Attitude			WTP		
	B	T Statistics	P Values	*B*	T-Statistics	P Values
EC	0.274	5.642	0	0.05	1.914	0.056
Kn	0.197	2.908	0.004	-0.086	1.313	0.189
E.B.				0.004	0.199	0.842

From Table 5 Indirect effects of construct The above results also describe the indirect effect on the attitude and the willingness to pay for solar energy with environmental concerns, knowledge, and environmental belief as parameters. This was inconsistent with what we envisage in our hypothesis; the results show that environmental concerns(β=0.274 t= 5.642 p > 0.001) and knowledge (β=0.197 t= 2.908 p = 0.004) have a significant indirect effect on attitude about solar energy where the same results indicated that Environmental concerns (β=0.050 t= 1.914 p = 0.056) , Knowledge (β=-0.086 t= 1.313 p = 0.189) and environmental Beliefs (β=0.004 t= 0.199 p = 0.842) had no indirect effects on willingness to pay for solar

V.   DISCUSSION

5. Discussion

This study attempted three objectives. To begin, try to understand the characteristics of Ghanaian consumers (the general public) and how to engage them in green purchasing as a tool for reducing environmental harm and combating global warming. Second, create a marketing strategy plan and educational feedback to determine the feasibility of large-scale promotion of solar energy into the overall electricity mix as a way of enhancing Ghana's energy performance, and finally, its valuable input for marketers, public officials, investors, and, most significantly, Ghanaian governments seeking to promote and facilitate renewable energy usage within the parameters of Sustainable Development Goal 7

Overall, the findings revealed that the Ghanaian republic has high regard for solar energy. They showed a high degree of knowledge of solar as a clean energy source, which is understandable given Ghana had gotten its electricity from a hydroelectric dam, another renewable energy source, since 1957, rendering them inherently vulnerable to learning about other sources. The respondents also showed a high degree of environmental concern. This isn't surprising, considering that customers being rational looks out for their best - care about their well-being and their children's future (Diamantopoulos et al., 2003; Tan, 2011). Thus, humans are rational creatures who would seek out their well-being if they don't want to see the environment deteriorate. The same can be said for the Environmental belief and attitude about solar energy though lukewarm. The public had a good outlook on environmental beliefs as they were concerned about increasing pollution and degradation. With attitude about solar energy, the receptiveness wasn't bad as well because of good knowledge about solar and the environment, but their effect on willingness to pay or intention to use solar wasn't too apparent and would be further discussed below

The study model showed that seven of the ten hypotheses suggested were accepted, but three were found not to be supported (H1c, H1d, and H4), and two of the seven supported hypotheses had a negative effect. This showed that our conceptual structure model shows comparatively significant support for the preliminary understanding proposed by the TPB than the TRA, implying that beliefs play a more prominent role in buying a green commodity, in this case, solar energy. This is mainly tangent with works (Alwitt & Pitts, 1996; Lin & Syrgabayeva, 2016; Polonsky et al., 2012). Again, the findings supported the hypothesis that consumers' attitudes towards solar energy are influenced more by their environmental beliefs than their environmental concerns(Bamberg, 2003; De Groot & Steg, 2007; Lin & Syrgabayeva, 2016)

Though bang theory(Bang et al., 2000) found concerns and knowledge to be the most important factor influencing buying decisions, our findings have demonstrated counterclaims that knowledge seems to be a dominant factor that leads consumers' decision for green commodities. A consumer with adequate information about the usefulness of solar energy in helping solve the social problem of climate change would aptly love to join the course. Therefore consumers who believe strongly in their duty to safeguard the environment regard environmentally friendly goods favorably and are willing to offer to pay a higher price for them(Kilbourne & Pickett, 2008)

In our research, we found a previously existing relationship. We were aware of the significance of environmental concerns and values(Kilbourne & Pickett, 2008). However, in the context of Ghana, the significance was only partial. We also noticed that ecological issues could positively and negatively impact beliefs because of their partial effects. This demonstrates that as one's knowledge of environmental issues increases, so does one concern for them, and vice versa. The current study also backs up previous research that shows a correlation between high levels of concerns and a desire to improve one's actions to be able to meet concerns

We also found findings that contradicted Chan (2001) assertion that consumers' environmental concerns had no discernible effect on their knowledge of solar energy or their desire to learn more about it. Curiosity is borne out of concern about the environment leading to awareness. Therefore the stakeholders involved would seek information to understand the peculiarly and have an opportunity to know what to do to have a solution to their concerns.

Furthermore, we discovered that awareness, environmental issues, and environmental beliefs all indirectly impacted attitude, indicating a moderation effect of other variables, but this did not influence willingness to pay as perceived by (Egea & de Frutos, 2013). This allows for a more in-depth analysis of attitude to distinctly impact willingness.

The results presented here relate to environmental conservation theory and practice and long-term quality of life. it also provided implication on other their party agencies, which would be discussed in the following chapters

5.1. Managerial implications

Policymakers,government officials, and even companies are enthusiastic about identifying the key determinants or factors on consumers, enabling them to tailor the best communication for people to sway the payment pattern to encourage sustainable consumption. In the broader sense of

environmental sustainability and long-term economic development, marketing can help better understand customer motivation and the various forms of demand influencers for solar energy.

According to the survey findings, the most influential factors driving the intention to make green purchases are knowledge and conviction. However, the negative impact of beliefs on willingness to pay, on the other hand, suggests that prior beliefs must be recognized and discussed in communication strategy. Such convictions may result from human nature's resistance to change; however, consumers' awareness and attitudes must be reinforced for practical and productive behavior change. Advertisers must illustrate to consumers the consequences and costs of depending on conventional energy sources and the real benefits of using renewable energy sources in good faith. Nonetheless, the current findings suggest that the solar industry has a lot of space for growth and development in general. Given that the solar industry and usage are still in their early stages in the energy market,

The Ghanaian society is very conservative and difficult to persuade, let alone persuade to pay more for new technology. As a result, more effective marketing, especially for the already shaped mind, and the education of prospective customers and buyers are needed to facilitate this bias. Another option is if neighboring countries and African states agree to design and implement environmental policies and actions to increase green consumption, especially solar consumption. Solar Energy will be much faster and easier to introduce to the market.

Unfortunately, since 2011 an incorporated law was established to help stimulate the prospect of an improved energy mix with a renewable energy emphasis(premium on solar) - the aim was a rise of 10%. However, by 2019 the target stood still at 0.08%. So the engagement of the stakeholder and public could enable improvement on the target delivery. Finally, education and training incorporation into the marketing campaign, the use of information technology and strategic implications, and the maximization of customer value across a product spectrum can contribute to the efficacy of green marketing.

VI.   CONCLUSION

6. Limitations and future research

Our analysis had some shortcomings in sample size, the variable we used, and the unknown bias we received from respondents. However, the drawbacks were largely compensated by the advantages and gains of the critical review and study results. Also, TRA and TPB have other alternate variables that we did not consider in this analysis.

This opens the door to further research. Our work allows advertisers to experiment with the best ways to convey persuasive information to persuade many people to switch to green consumption.

As researchers, we are also aware that other influences have a significant impact on actions or behaviors. The introduction of attributes such as societal expectations, materialism, perhaps social interaction, or even political expectations into further investigation would provide insight into their relevance to behavior norms.

Also, the aim is to reduce the effects of climate change while encouraging sustainable consumption; I propose other scholars integrate other social science hypotheses into future studies. Furthermore, the scope of research may be extended if appropriate secondary data sources exist for such tasks.

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Using Geostatistics to Map Received Power in Wireless Communication Networks

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Abstract—The literature analysis of propagation models has investigated different prediction methods to identify appropriate techniques for this purpose. The predictive algorithms of these models usually deal with large amounts of data, requires a sophisticated computer processing and knowledge, sometimes detailed of the topography of the terrain. For being based on measurements performed at specific locations, empirical models tend not to provide very reliable results when applied to regions that differ significantly from the original region This article proposes a method based on measured data that incorporates the effects of neighborhood on the calculation of received power (dBm) and uses the theory of geostatistics to estimate the extent of the spatial correlation between measurements of samples in the region of interest. The results show that it is possible to identify the vectors with better reception of the signal emitted by the base transceiver station by the spatial perspective of received power measurements (dBm) and to identify homogeneous zones and those zones where the service operator may or may not favor the user.

I. INTRODUCTION

Currently, a wide variety of communication channel models exist with theoretical and experimental foundations to predict path attenuation in mobile communications systems, and their development is one of the most important steps in mobile communication planning. A correct estimate enables the designer of mobile systems to predict the minimum power required to radiate from a transmitter to supply a predetermined area with acceptable coverage quality, which is of fundamental importance for the improvement of the frequency reuse technique and to implement projects with shared bandwidth (Liaskos et al., 2018) [1].

These models differ in their applicability in different types of terrain and different environmental conditions. Therefore, no model is appropriate for all situations. The land on which propagation occurs has varied topography, vegetation and buildings that are randomly distributed; however the propagation loss can be calculated.

To determine which model is most appropriate for a given region, measurement campaigns can be performed in the area of interest to evaluate the performance of each model. This evaluation involves comparing the statistical errors of each model in relation to measured values quantitatively. Through these statistical parameters, a table comparing the models considered can be constructed, which allows a statistical analysis to determine which model best fits the aforementioned study region. Classic statistics is traditionally used to develop propagation models (Haneda et al., 2016; Salous, 2013; Shu Sun et al., 2014) [2-4]. Thus, it is assumed that realizations of random variables are mutually independent. However, there are several phenomena that involve scenarios that show spatial dependence.

The propagation models are generally based on deterministic models [1,2], and modified, based on the results obtained from measurement campaigns in one or more regions [1]. The models obtained are given through the abacus, as model of Okumura (A.Mawjoud, 2013) [5], for example, or expressions which provide the median attenuation, like the models of Okumura-Hata(Arthur et al., 2019; Gao et al., 2020) [6,7], Ibrahim-Parsons (Rozal et al., 2012) [8], Walfisch-Bertoni (Neto et al., 2003) [9], Ikegami-Walfisch (Alqudah, 2013; Cheerla et al., 2018) [10,11], Blomquist and Ladell (Loo et al., 2017) [12] and Lee (Wang et al., 2016) [13].

The predictive algorithms of these models usually deal with large volume of data, requires a sophisticated computer processing and knowledge, sometimes detailed, the topography of the terrain. For being based on measurements taken at specific locations, the empirical models tend not to provide very reliable results when applied to regions that differ significantly from the original region [3].

Therefore, classical statistics is often used when disregarding the possible correlation between neighboring samples; thus the relationships that may exist between the sample units are not explored satisfactorily. One of the methods that incorporates neighborhood effects in the calculation of the received power (dBm) is the methodology proposed in this study, namely, received power mapping in wireless communications networks by spatial inference using the Kriging process developed by Matheron (Matheron et al., 2019) [14]. Based on this methodology the spatial plan of received power measures (dBm) can be identified and, the vectors of better signal reception emitted by the BTS (base transceiver station) can be identified by the gradient of lines of iso-values; moreover, homogeneous zones can be identified as well as those where users may or may not be favored by the service operator. Thus, estimates of statistics, graphs, dispersion and surface maps that spatially describe the behavior of the power variable of the received signal (dBm) were obtained.

II.   RELATED WORKS

Currently, many researchers employ geostatistical interpolation techniques for coverage prediction, based mainly on Kriging techniques. This Module includes a set of procedures necessary for geostatistical techniques (exploratory analysis, semivariogram generation and modeling and interpolation by kriging), aiming at the 2D analysis of spatially distributed data regarding the interpolation of surfaces generated from the georeferenced samples obtained from the received power. In [15], Konak (Konak, 2010) estimated signal propagation losses in wireless LANs using Ordinary Kriging (OK). In [16], Phillips et al. (Phillips et al., 2012) used OK on a 2.5 GHz

WiMax network to produce radio environment maps that are more accurate and informative than deterministic propagation models. Kolay et al.(Kolyaie et al., 2011; Kolyaie & Yaghooti, 2011)[17,18] used drive-tests to collect signal strength measurements and compared the performance of empirical and spatial interpolation techniques. Mezhoud et al.(Mezhoud et al., 2020) [19] proposed an approach for coverage prediction based on the hybridization of the interpolation technique by OK and a Neural Network with MLP-NN architecture, this methodology was motivated by the lack of quality of the MLP-NN test database, which satisfactorily enriched the network's training dataset. Faruk et al.(Faruk et al., 2019) [20] evaluated and analyzed the efficiencies of empirical, heuristic and geospatial methods for predicting signal fading in the very high frequency (VHF) and ultra-high frequency (UHF) bands in typically urban environments. Path loss models based on artificial neural network (ANN), adaptive neuro-fuzzy inference system (ANFIS) and Kriging techniques were developed. Sato et al.(Sato et al., 2021) [21] proposed a technique that interpolates the representative map of the mobile radio signal in the spatial domain and in the frequency domain.

III.   AREA OF STUDY

3.1. Area of Study

Belém, capital of the state of Pará, belonging to the metropolitan mesoregions of Belém. With an area of approximately 1064,918 km², located in northern Brazil, with a latitude of -01° 27' 21" and longitude of -48° 30' 16", altitude of 10 meters and distance of 2.146 miles of Brasília. The city is the capital of the Metropolitan Region of Belém, as with 2.100.319 inhabitants, is the 2nd most populous region, 12ª of the country 177ª of the world, well as being the largest urban agglomeration in the region. The city of Belém, considered the largest of the equator line, is also classified as a capital with the best quality of life in Northern Brazil. Fig. 1 shows an aerial view of the large urban center of the state capital bathed by the bay of Guajará.

Fig. 1: Partial view of the large urban center of Belém/PA (souce: https://cityofmangotrees.wordpress.com/2015/04/15/feliz-lusitania/, september 2021).

To observe the behavior of the received power (dBm), a measurement campaign involving 11 streets in the urban area of Belém - Pará, Brazil was performed. The acquisition of the verticalization and parcel measurements of buildings and residences, which resulted in a total of about 1800 points (from houses and buildings), was made by AUTOCADMAP and ORTOFOTO provided by the Company Development and Administration of the Metropolitan Area of Belem – CODEM.

The neighborhoods involved in the measurement campaign are located in the central region of Belém. The neighborhoods identified as Nazaré, Batista Campos and Umarizal present a high degree of vertical integration as a whole with more than 190 buildings and some that reach 70 meters high. The Alcindo Cacela, Conselheiro Furtado, Governor José Malcher, Magalhães Barata and Nazaré Avenues show a predominance of buildings of all sizes. These avenues have the greatest concentration of commercial buildings. In addition, there are many mango trees along the Magalhães Barata and Nazaré avenues.

3.2. Materials and Methods

3.2.1. Measurement Setup

The equipment used in the measurement setup included a transmission system and a receiving system. The transmission system consisted of a transmitting antenna positioned at a height of 35 m above the ground and operated by the local operator (Oi Celular). It was the 739632model produced by KathereinTM with dual polarization (± 45º) and operates within the range from 825 to 896 MHz with a gain of 15 dBi in vertical polarization.

The receiving system is the E7474A TDMA model produced by Agilent. The receiving antenna used in the measurements was the TPM 8003A monopole model produced by PlusTM, which operates in the range from 825 to 896 MHz with a gain of 3 dBi. It was mounted on a car and the received signal was collected by a laptop that had a PCMCIA card installed, which was the interface between the acquisition and storage system. In addition to the acquisition of the received power, the movement test system uses GPS coordination to determine the geographic position information of all measures.

3.2.2. Geostatistics

Geostatistics is used in spatial interpolation and quantification of uncertainty for variables that exhibit spatial continuity, i.e., that can be measured anywhere in the region of interest. It uses traditional statistical concepts such as random variables (RVs), cumulative distribution functions (CDFs), probability density functions (PDFs), expected value, and variance. In geostatistics, the RV represented by Z (u), where u is the vector of location coordinates, is related to a location in space. In this case, the main statistics are defined below (Gooverts, 1984; Isaaks, 1990) [22, 23].

The cumulative distribution function (CDF) provides the probability that the RV Z is less than or equal to a given z value, usually called the cut value.

$$F(u:z) = Pr\,o\,b\{Z(u) \leq z\} \qquad (1)$$

The probability density function (PDF) is derived from the CDF, assuming it is differentiable, i.e.:

$$f(u:z) = F'(u:z) \lim_{dz\to 0} \frac{F(u;z+dz)-F(u;z)}{dz} \qquad (2)$$

When the CDF is performed for a specific set of information, for example, (n) consisting of n neighboring data values Z(u) = z (u), a = 1,..., n, the notation "conditional to n" refers to the conditional cumulative distribution function (CCDF), which is defined as follows:

$$F(u:z|(n)) = Pr\,o\,b\{Z(u) \leq z|(n)\} \qquad (3)$$

The expected value, $E\{Z\}$, is the weighted average of n possible outcomes where each outcome is weighted by its probability of occurrence. In the continuous case and assumingthat the integrals exist, the expected value is defined as follows:

$$E\{Z\} = m = \int_{-\infty}^{+\infty} z.\,dF(u;z)$$

$$= \int_{-\infty}^{+\infty} z.\,f(u;z)dz$$

$$\approx \sum_{k=1}^{K} z_k'[F(u;z_{k+1}) - F(u;z_k)] \quad (4)$$

With $z_k' \in]z_k, z_{k+1}]$

Where $F(u;z)$ and $f(u;z)$ are the CDF and PDF, respectively. The integral $\int_{-\infty}^{+\infty} z.\,dF(u;z)$ was approximated by K classes with frequencies $[F(u;z_{k+1}) -$

$F(u; z_k)$]and z'_k is a value in the *k-th*class, for example, the center of the class.

The variance$Var\{Z\}$Var{Z}, defined as the squared expected deviation V.A. Z in relation to its average in the continuous case, is written as follows:

$$Var\{Z\} = \sigma^2 = \int_{-\infty}^{+\infty} (z-m)^2 dF(u;z)$$

$$= \int_{-\infty}^{+\infty} (z-m)^2 f(u;z)dz \ (z-m)^2 f(u;z)dz (5)$$

In many situations, it is desirable to know the pattern of dependence of one variable X in relation to another Y. The joint distribution of the results of a pair of random variables X and $Y$is characterized by the joint CDF (or bivariate), which is defined as follows:

$$F_{xy}(x,y) = Prob\{X \leq x, \text{ and } Y \leq y\} \qquad (6)$$

Which is estimated, in practice, by the proportion of data pairs jointly below the respective values (cut value) x and y. This distribution can be shown in a scatter diagram where each pair of data (x_i, y_i) is plotted as a point. The degree of dependence between two variables X and Ycan be characterized by the dispersion around the 45º line in the scatter diagram, as shown in Fig. 2.
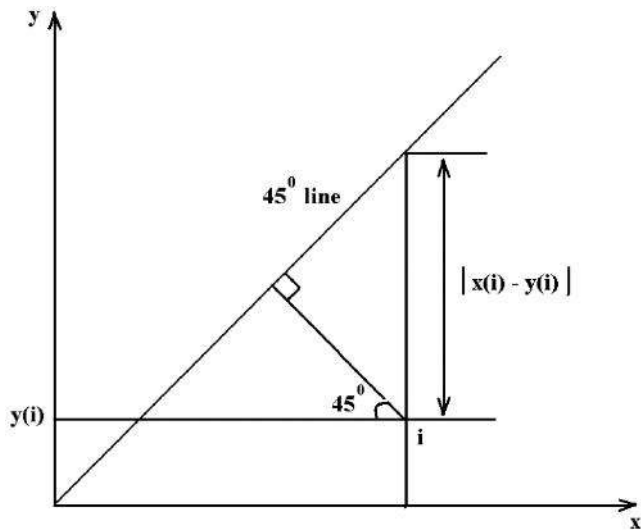
Fig. 2: Pair (x_i ,y_i) on a scattergram

The moment of inertia of the scatter diagram around the 45º line, called the "semivariogram" of the set of pairs (x_i, y_i) , is defined as follows:

$$\gamma_{XY} = \frac{1}{N}\sum_{i=1}^{N} d_i^2 = \frac{1}{2N}\sum_{i=1}^{N}(x_i - y_i)^2 \qquad (7)$$

The higher the value of the semivariogram, the greater the dispersion and the less closely related are the two variables X and Y.

The centered covariance (on the average, *m*), or simply covariance, is given by the following:

$$Cov\{X,Y\} = \sigma_{XY} = E\{XY\} = E\{[X-m_x].[Y-my]\}$$

$$= E\{XY\} - m_x.my \ (8)$$

The standard covariance between two RVs X and Y is known as the correlation coefficient, i.e.,

$$\rho_{XY} = \frac{\sigma_{XY}}{\sigma_X \sigma_Y} = \frac{Cov\{X,Y\}}{\sqrt{Var\{X\}.Var\{Y\}}} \in [-1,+1] \qquad (9)$$

The experimental relationship between the semivariogram and the covariance can be obtained by developing equation (7), which gives the following:

$$\gamma_{X'Y'} = 1 - \rho_{X'Y'} \in [0,2]\gamma_{X'Y'} = 1 - \rho_{X'Y'} \in [0,2]$$
(10)

Where $X'$and Y' are standardized variables$X' = (X - m_X)/\sigma_X$ and $Y' = (Y - m_Y)/\sigma_Y$.

The RVs X and Y can represent the same property measured in two different space locations, which are characteristic of regionalized variables at $x$and $x + h$ that are separated by a vector h (called the lag or distance between locations), and $X = Z(x), Y = Z(x + \boldsymbol{h})$.

In this case, the γ_{XY} semivariogram and the ρ_{XY} correlation measure the degree of variability or similarity between the two RVs X and Y.

This case is of particular interest in problems of spatial interpolation where an area (map) with a particular property, $Z(\boldsymbol{u})$, $\boldsymbol{u} \in \boldsymbol{A}, \boldsymbol{A}$area, must be identified from n samples of $Z(\boldsymbol{u})$. The combination of all n($\boldsymbol{h}$) data pairs of $Z(\boldsymbol{u})$over the same area with such pairs separated by approximately the same vector $\boldsymbol{h}$ (in length and direction) allows the characteristic (or experimental) semivariogram of the spatial variability in A to be estimated:

$$\gamma(h) = \frac{1}{2N(h)}\sum_{\alpha=1}^{N(h)}[z(\boldsymbol{u}_\alpha) - z(\boldsymbol{u}_\alpha + \boldsymbol{h})]^2 \qquad (11)$$

The semivariogram characterizes the degree of spatial dependence between two random variables $Z(\boldsymbol{u})$ and $Z(\boldsymbol{u} + \boldsymbol{h})$ separated by vector $\boldsymbol{h}$.

With a single sample, all that is known of a random function $Z(\boldsymbol{u})$is a single point. Then, if the values for the non-sampled locations must be estimated, the restriction that the regionalized variable is statistically stationary must be introduced. To summarize, the hypothesis of stationarity establishes that the first two moments (mean and variance) of the difference $[Z(\boldsymbol{u}) - Z(\boldsymbol{u} + \boldsymbol{h})]$are independent of the $\boldsymbol{u}$ location and are only a function of the vector$\boldsymbol{h}$.

When the semivariogram graph is the same for any direction of $\boldsymbol{h}$, it is called isotropic, and it represents a much simpler situation than when it is anisotropic. In the latter case, the semivariogram should be transformed before being used. Therefore, it is advisable to examine semivariograms forseveral directions to evaluate the existence of anisotropy.

The semivariogram is the preferred tool for statistical inference because it has some advantages over covariance (Matheron et al., 2019) [14]. For a continuous function to be chosen with semivariograms, it is necessary to satisfy the defined positive property. In practice, linear combinations of basic models that are valid, i.e., permissible, are used. One of the most used basic models in geostatistics is the spherical model, which is given below:

$$\gamma_{(h)} \begin{cases} 0, & |h| = 0 \\ C\left[\frac{3}{2}\left(\frac{|h|}{a}\right) - \frac{1}{2}\left(\frac{|h|}{a}\right)^3\right] & 0 < |h| \leq a \\ C & |h| > a \end{cases} \quad (12)$$

The C and components are called level and range, respectively. The level, also known as the "sill", represents the variability of the semivariogram until its stabilization. The range (or variogram amplitude) is the observed distance to the level where the variability stabilizes. It indicates the distance at which samples are spatially correlated, as shown in Fig. 3.
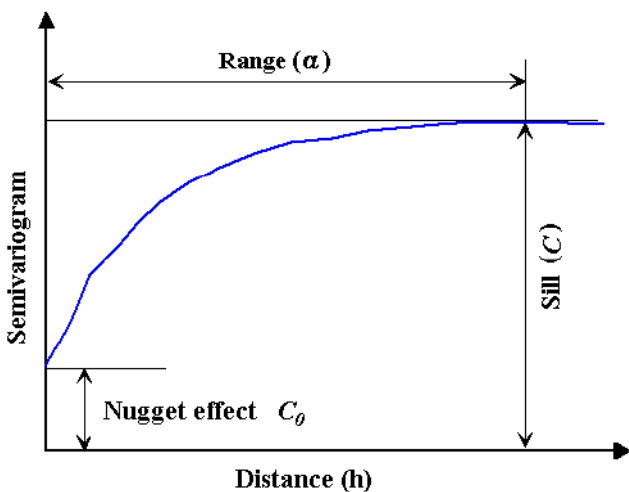
Fig. 3: Parameters of the semivariogram

After the model of spatial dependence between two random variables $Z(\boldsymbol{u})$ and $Z(\boldsymbol{u} + \boldsymbol{h})$ is established, the problem of estimating an unknown value $Z(\boldsymbol{u})$ from the values available can be addressed. The goal is not only to find an estimate $Z^*(\boldsymbol{u})$ of the unknown value, but also model the uncertainty of this estimate. The uncertainty depends on the available information: the observed $z_{(u)}$'s values and\the established model of spatial dependence.

Kriging is a generic name adopted in geostatistics for a family of algorithms of least-squares regression based on the linear regression estimator $Z^*(\boldsymbol{u}),$ which is given by the following:

$$Z^*(\boldsymbol{u}) - m(\boldsymbol{u}) = \sum_{\alpha=1}^{n(u)} \lambda_\alpha(\boldsymbol{u})[Z(\boldsymbol{u}_\alpha) - m(\boldsymbol{u}_\alpha)]$$
(13)

Where $\lambda_\alpha(\boldsymbol{u})$ is the weight assigned to each observed value of $Z(\boldsymbol{u}_\alpha)$ located within a certain neighborhood $W(\boldsymbol{u})$ centered at $\boldsymbol{u}.$ The $m(\boldsymbol{u})$ weights are chosen to minimize the estimation or error variance $\sigma_E^2(u) = Var[Z^*(\boldsymbol{u}) - Z(\boldsymbol{u})]$ under the non-biased condition of the estimator.

The ordinary kriging (OK) considers the local variation of the average restricted to the domain of stationarity of the average to the local neighborhood $W(\boldsymbol{u})$ centered on the location **u** to be estimated. In this case, the common average (stationary) $m(\boldsymbol{u}_\alpha)$ in equation 13 is considered. The unknown average $m(\boldsymbol{u}_\alpha)$ can be eliminated by considering the sum of the weights ($\lambda_\alpha(\boldsymbol{u})$) of the Kriging equal to 1, i.e.,

$$Z_{KO}^*(u) = \sum_{\alpha=1}^{n(u)} \lambda_\alpha^{KO}(u) Z(u_\alpha) \quad \text{with} \quad \sum_{\alpha=1}^{n(u)} \lambda_\alpha^{KO}(u) = 1$$
(14)

The minimization of error variance ($Var[Z^*(\boldsymbol{u}) - Z(\boldsymbol{u})]$) under the condition $\sum_{\alpha=1}^{n(u)} \lambda_\alpha^{KO}(u) = 1$, allows the weights λ_α to be determined from the following system of equations, called the ordinary Kriging system (normal equations with constraints):

$$\begin{cases} \sum_{\beta=1}^{n} \lambda_\beta^{KO}(\boldsymbol{u}) C(\boldsymbol{u}_\beta - \boldsymbol{u}_\alpha) + \mu(\boldsymbol{u}) = C(\boldsymbol{u} - \boldsymbol{u}_\alpha), \\ \sum_{\beta=1}^{n} \lambda_\beta^{KO}(\boldsymbol{u}) = 1 \end{cases} \quad (15)$$

Where $C(\boldsymbol{u}_\beta - \boldsymbol{u}_\alpha)$ and $C(\boldsymbol{u} - \boldsymbol{u}_\alpha)$ are, respectively, the covariance among points $\boldsymbol{u}_\beta$ and $\boldsymbol{u}_\alpha$ and $\boldsymbol{u}$ and $\boldsymbol{u}_\alpha$ and $\mu(\boldsymbol{u})$ is the Lagrange parameter associated with the restriction $\sum_{\beta=1}^{KO} \lambda_\beta(u) = 1$.

Unlike more traditional linear estimators, Kriging uses a weighting system that considers a spatial correlation model specific to the variable in study area A. Kriging provides not only a least squares estimate of the variable under study but also the associated variance error.

IV. ANALYSIS AND DISCUSSION OF RESULTS

Fig. 4 shows the data distributed in the study area. There are eleven streets in which measurements of the received power (dBm) were taken by the mobile station over fairly short distances (under 5 m) between measurements.
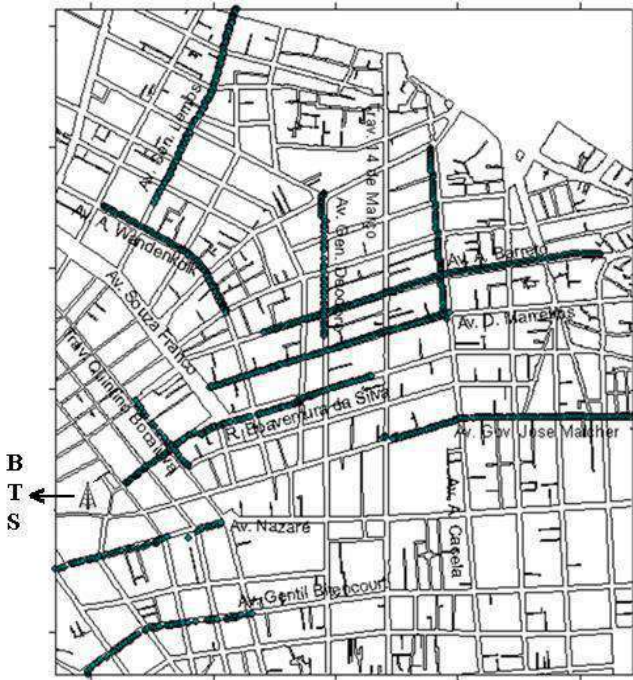
Fig. 4: Sampling points for power measurement in the study area [8]

Fig. 5 shows clearly that the distribution of the data evidences the slight asymmetry to the right, which indicates the presence of high values of received power (dBm). However, the values near the mean (-90.28) and median (-94.28) indicate that the distribution approaches normal values.
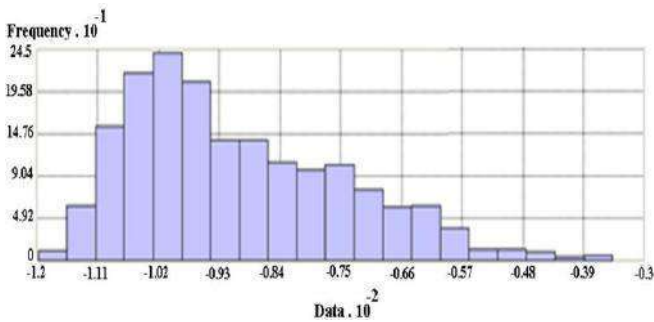
Fig. 5: Histogram for the received signal power (dBm)

To conduct the analysis and diagnosis of the effects of spatial autocorrelation samples, was used ARCGIS geostatistical module program(Johnston et al., 2001) [24] called ArcMap which is the application that is used for handling / generation of digital maps.

Fig. 6 presents a QQ-plot (quantil-quantil plot), which compares the received power distribution (dBm) with a standbard normal distribution, note that there is a reasonable approximation of the distributions.
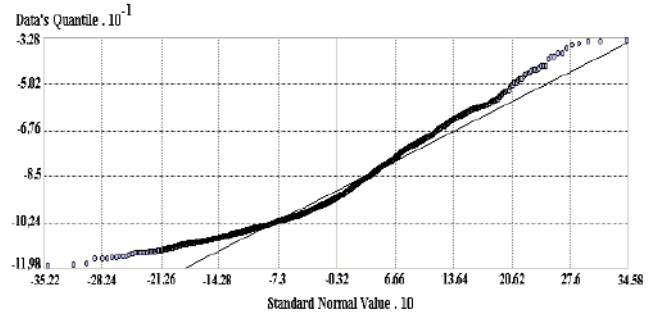
Fig. 6: QQ-plot for the power of the received signal (dBm)

The use of a geostatistical method requires that the data be spatially stationary (Pyrcz & Deutsch, 2014; Shiquan Sun et al., 2020; Tobler, 1989) [25-27]. It was observed that the distribution of the received power signal (dBm) shows higher peaks in certain directions, probably due to the short distance between the base station and the mobile station. This observation clarifies the presence of a spatial trend in the data. In this case, this trend should be removed and used for the geostatistical analysis because it is free of trends and therefore stationary. After the geostatistical analysis, the trend should be added to the results so that the predictions yield more accurate results. A first-order surface was used in this case to remove the trend, as shown in Fig. 7.
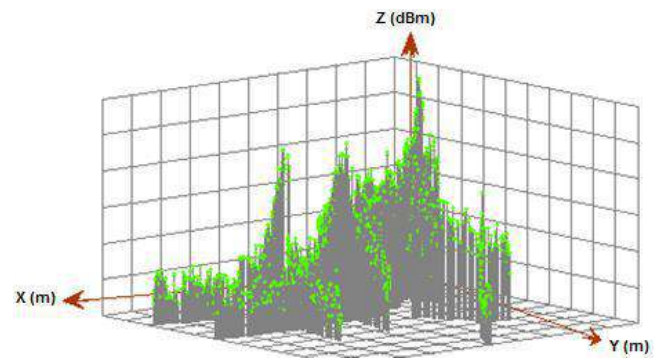
Fig. 7: Spatial distribution of power data of the received signal (dBm)

For the use of Kriging, foremost, an analysis is made by means of the spatial dependence of the semivariogram. Fig. 8 shows that the experimental points in the isotropic case semivariogram, where the samples show a range of spatial dependence around 30 meters. The semivariographic model in this case is given by:

$$\gamma(h) = 12.63C_0 + 194.3sph(335.06) \quad (16)$$

Where: C_0 is the nugget effect and $sph(335.06)$ is a spherical model for $h = 335.06$.
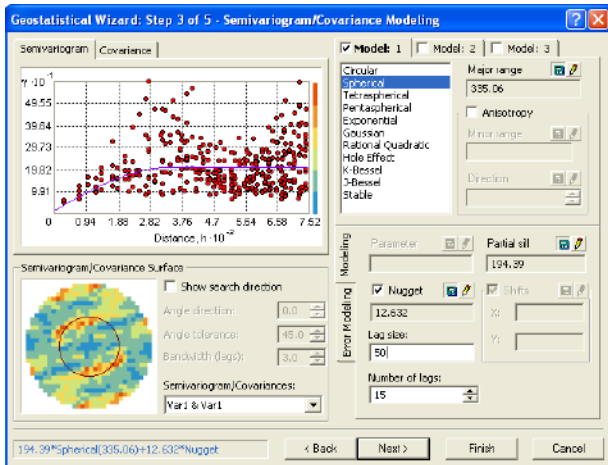
Fig. 8: Omnidirectional Semivariographic Model adjusted to the power of the received signal (dBm)
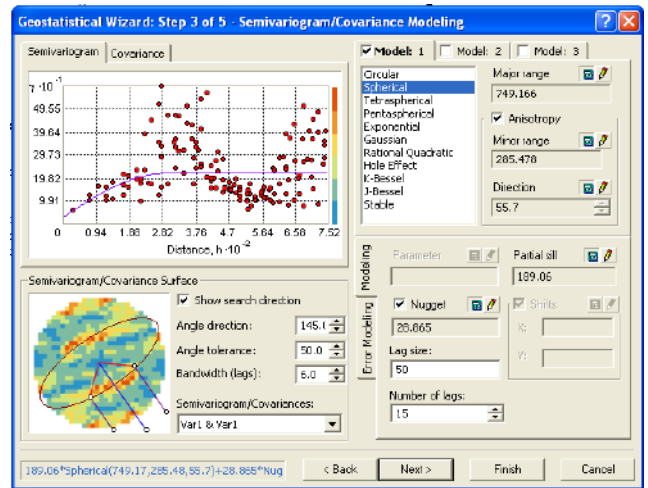
Fig. 10 : Directional Semivariographic Model in the 145º direction adjusted for the power of the received signal (dBm)

The semivariographic analysis showed the presence of an anisotropy from the southwest (SW) direction towards the northeast (NE) (Chilès & Delfiner, 2012) [28]. Because the trend was removed, the directional components of the spatial autocorrelation occur on a small scale, which will be included in the semivariographic modeling. The received power variable (dBm) was an ellipse of anisotropy with a major axis in the 57° direction (angle relative to geographic north) and minor axis in the 145° direction. Figs. 9 and 10 shows the semivariogram in both directions of 57° and 145°, respectively. The adjusted model, in this case, was represented by a spherical,

$$\gamma(h)_{57^\circ} = 29.19 + 189.06 \rightleftarrows Sph\left[\left(\frac{|h|}{749.17}\right) + \left(\frac{|h|}{288.32}\right)^3\right](17)$$

$$\gamma(h)_{145^\circ} = 28.76 + 189.06 \rightleftarrows Sph\left[\left(\frac{|h|}{283.93}\right) + \left(\frac{|h|}{749.17}\right)^3\right] \quad (18)$$

The nugget effect indicates that, around $13.38\% = (29.195/(29.195+189.06))*100$ of the total variability of the samples is due to the random component, and the remaining 86.62% is explained by the spatial autocorrelation component of the existing residues. The maximum and minimum ranges around 749.17 m and 288.32 m, respectively, indicate that there is an ellipse of influence of spatial contagion with maximumand minimum rays equal to the ranges; if these effects become negligible, the small spatial scale is determined from these limits. Thus, there is evidence that users who receive a signal with similar quality tend to be located close to each other.

Based on the framework defined by the variographic model, spatial inference was performed through the Kriging process to obtain a map of spatial distribution. The result of the mapping by Kriging for the received power (dBm) is shown in Fig. 11.
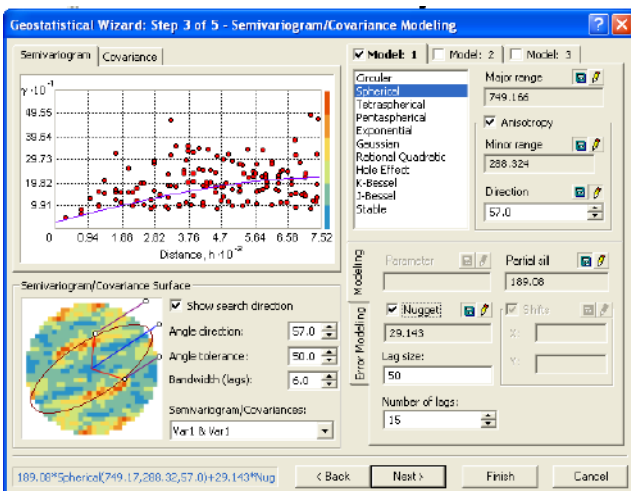
Fig. 9 :Directional Semivariographic Model in the 57º direction adjusted for the power of the received signal (dBm)
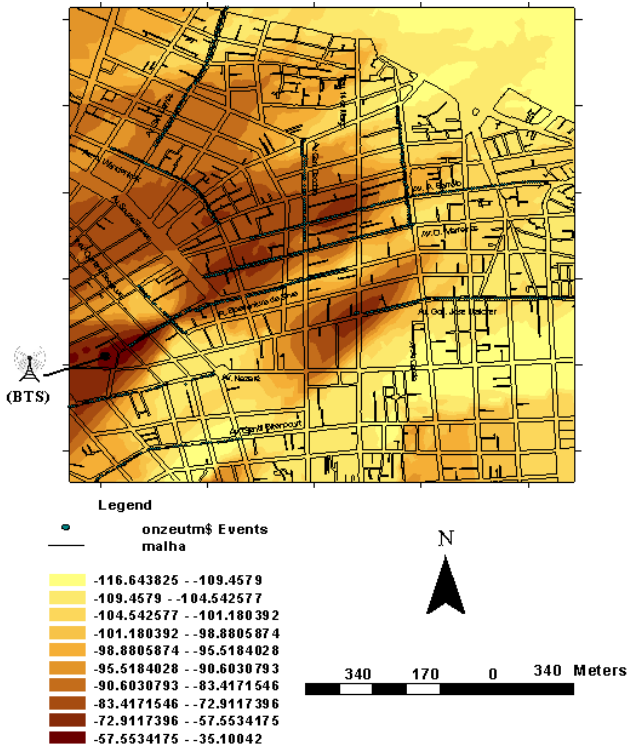
Fig. 11 : Spatial map of the received power (dBm)
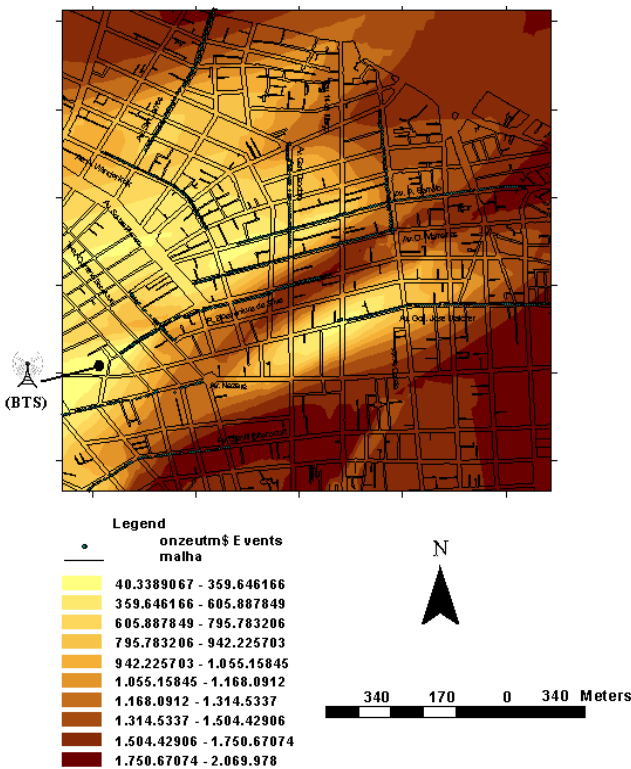
Fig. 12: Spatial map of the distance to the BTS

The map in Fig. 11 shows the spatial distribution using color levels to provide information about the distribution pattern of received power (dBm). The distribution of values shows the regions with higher levels of received power (dBm) in brown and the areas with lower signal strength in yellow.

The highest levels of power are observed mainly in three regions: on the Governor Jose Malcher Avenue corner with Trav. 14 de Março; a large region that starts near the Trav. 14 de Março corner with Antonio Barreto Avenue and extends toward the Visconde de Souza Franco Avenue and Boaventura da Silva street; and another small region near the Dr. Moraes street with Boaventura da Silva street. The BTS is located near this area.

Using the same methodology adopted for the received power variable (dBm), a map of the spatial distribution of the color levels that provides information about the spatial distribution pattern of the distance from the mobile station to the transmitting antenna is shown Fig. 12. The potential of the applied methodology can be observed when comparing the maps showing the spatial distribution of the received power (dBm) by the receiving unit and the distance between the transmitter and receiver antennas. As anticipated, lower power levels are observed at greater distances from the base station.

V.   COMPARISON OF RESULTS

Fig. 13 shows the variation of the received signal strength (simulated and measured) and theoretical models Okumura-Hata [6] and Ibrahim-Parsons [8] as a function of distance from the transmitter antenna along the eleven paths studied.
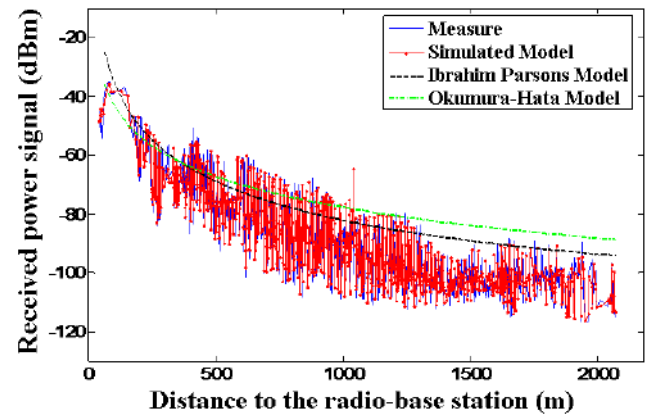
Fig. 13: The signal strength received by the mobile station and estimated by theoretical models and simulated

Each type of propagating approached showed some random variations regarding the classification of the analyzed environment. In the case of region analysis, simulations of all models were performed considering the involved characteristics of urban environment, whereas this environment predominate residences and buildings with an average height ranging from 3m to 100m, respectively. The parameters used in the analysis of models had the following values:

The receiving antenna height: $h_r = 1.5$ m.

The receiving antenna height: $h_t = 35$ m.

Operating frequency: $f = 877.44$ MHz

In order to perform a study more insightful for each model, were made for each data file, statistical analysis of the measures, aiming to measure the deviations between the simulated and measured values. This made it possible to obtain information to provide subsidy to state what the best model for characterizing the propagation environment for mobile cellular paths studied. Table 1 shows the average and standard deviation in dB for each model in relation to the values of received signal strength from the field.

Table 1:Comparison between the three theoretical models and the measured value for the paths involved in the measurement campaign

Measure/ Model	Mean squared error (dB)	Mean (dBm)	Standard deviation (dBm)
Measured	-	-89.7875	15.7682
Proposed model	0.37	-89.1993	16.1729
Ibrahim-Parsons	13.23	-79.8353	11.0324
Okumura et al.	16.54	-76.2427	8.8034

Through the analysis of graphs and the results shown in Table 1, one can deduce that the proposed model is resulting in lower average deviation compared with the field measurements. For this model, the mean square error with respect to the level of theoretical power is 0.37 dB Whereas the maximum acceptable deviation in the signal level received by the mobile in relation to the prediction, is 8 dB Note that the average and standard deviation calculated for the proposed model showed values very similar to those obtained for the data collected in the field (measured values).

However, among the theoretical models, nearest measured values is the template of Ibrahim-Parsons, with a mean square error of 13.23 dB The model of Okumura-Hata, that had the worst outcome, one should go through their adjustment coefficients. Possibly the urban environment analyzed for obtaining this model does not show many similarities with that found in the region studied in this study.

VI.   CONCLUSIONS

In view of the above, it can be concluded that the spatial inference allows the regions where the levels of received power (dBm) are either intense or not to be identified, which demonstrates the negative effects to the subscribers who are in regions with low signal levels. In addition, this methodology allows all parts of the region of interest to be assessed individually based on their geographical coordinates and not just a generic statement of values, as in traditional propagation models. From the spatial distribution map of the received power (dBm), it is possible to identify the areas that are over- or underestimated in terms of signal reception, which can result in increased investment by the local operator to those regions where the signal is weak. Moreover, the spatial mapping of the received power (dBm) can also help in planning and developing wireless communications networks because iso-value maps can be used to identify neighborhoods that benefit from having high received power (dBm) in a given city.

The model proposed showed an good result with mean square error in order of 0.37 dB in relation to the measured signal, considering the data of the eleven paths of measuring campaign; whereas for the models of Ibrahim Parsons and Okumura-Hata this error was on the order of 13.23 and 16.54 dB, respectively. This performance is due to the fact that the geostatistical model considered the georeferenced data, enabling the identification of the interaction effects in this same space, using a kriging process.Therefore, the spatial estimation techniques used for wireless communications networks should be applied to other scenarios to estimate the signal strength along all avenues of a given city.

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Credit Risk Analysis Applying Logistic Regression, Neural Networks and Genetic Algorithms Models

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Abstract—Most large Brazilian institutions working with credit concession use credit models to evaluate the risk of consumer loans. Any improvement in the techniques that may bring about greater precision of a prediction model will provide financial returns to the institution. The first phase of this study introduces concepts of credit and risk. Subsequently, with a sample set of applicants from a large Brazilian financial institution, three credit scoring models are built applying these distinct techniques: Logistic Regression, Neural Networks and Genetic Algorithms. Finally, the quality and performance of these models are evaluated and compared to identify the best. Results obtained by the logistic regression and neural network models are good and very similar, although the first is slightly better. Results obtained with the genetic algorithm model are also good, but somewhat inferior. This study shows the procedures to be adopted by a financial institution to identify the best credit model to evaluate the risk of consumer loans. Use of the best fitted model will favor the definition of an adequate business strategy thereby increasing profits.

I. INTRODUCTION

With the currency stability achieved by the Economical Plano Real in 1994, financial loans became a good business for the banks that no longer made such large profits from currency devaluation(Bresser-Pereira & Nakano, 2002). To replace this profitability, the need to increase investment alternatives was felt at the end of the inflation period. Thereafter institutions have endeavored to expand their credit portfolios. However, loans could not be offered at random to all the applicant clients, therefore ways to evaluate the candidates were required.

Some years ago, when applying for a loan, the client filled in a proposal for evaluation by one or more analysts(Abdou & Pointon, 2011). They then issued an opinion regarding the request. Although effective, the process was slow because it did not accommodate the analysis of many requests. As such, the model for the analysis of the concession of credit was initially introduced in financial institutions aiming to speed up evaluation of proposals.

Models of analysis for extension of credit known as models of credit scoring are based on historical information from the databank on existing clients, in order to assess whether the prospective client will have a greater chance of being a good or bad payer. The models of credit scoring are added to the institution's systems permitting on-line credit evaluation.

1.1 Objectives of the Study

Based on the data of a sample, the intention is to:

• Develop three credit scoring models by using three statistical/computational techniques: Logistic Regression, Neural Networks, Genetic Algorithms

• Compare the models developed in terms of the quality of fitness and prediction indicators;

• Propose a model for the classification of clients

II.   THEORETICAL BASIS

In this section, the theoretical concepts that will support the theme of this work will be presented.

2.1 Consumer Credit

The expression consumer credit may be understood as a form of trade where a person obtains money, goods or services and vouches to pay for this in the future, adding a premium (interest) to the original value (Crook et al., 2007).

Currently, consumer credit is a large industry operating worldwide. Major retailers spur their sales by supplying credit. Automobile companies, banks and other segments utilize consumer credit lines as an additional alternative to make profit. On the other hand, consumer credit injects resources into the economy, permitting production and economic expansion of a country, thereby bringing development to the nation (Lewis, 1992).

However to make credit widely available does not mean to distribute credit at random to all those requesting it; there is a factor associated to consumer credit which is crucial in the decision of making credit available or not: the risk.

2.2 Credit Risk

On the financial market, credit risk is the oldest form of risk (Caouette et al., 2008). It is the upshot of a financial transaction, contracted between the supplier of funds (giver of credit) and the user (taker of credit). Prior to any sophistication resulting from financial engineering, the mere act of lending a sum to someone entails the probability of it not being repaid, the uncertainty regarding return. This is, in essence, the credit risk which may be defined as the risk of a counterpart, in an agreement of credit concession, not to meet his/her obligation.

According to Caouette et al. (2008 p.1), "if credit may be defined as the expectation of receiving a sum of money in a given period, credit risk is a chance that this expectation is not fulfilled".

The activity of credit concession is a basic function of banks, therefore credit risk takes on a relevant role in the composition of an institution's risks and may be found in the operations where there is a transfer of money to the clients as well as in those where there is only a possibility of usage, the pre-conceded limits. Primary types of a bank credit operation are: loans, financing, discount of payables, advancement to depositors, advancement of exchange, leasing operations, surety bonds and warranties etc.

In these operations risk may take on different forms; to be conceptually familiar with them helps to orient management and mitigation.

In the universe of consumer credit, pledge of future payment involves the idea of risk. As the future cannot be fully predicted, all consumer credit involves risk, because assurance of payment does not exist (Lewis, 1992). Analysis of credit is charged with the task of estimating the risk involved in the concession or not of credit.

The maximum risk that the institution may accept relies on the policy adopted by the company. Risk presented by the applicant is of major significance for the process of credit concession, and various queries must be considered in its evaluation.

2.3 Evaluation of the Credit Risk

Evaluation of risk is the main issue for concession of credit. If the risk is poorly evaluated the company will certainly lose money, be it because of acceptance of clients who will generate losses to the business or because of the refusal of good clients who would generate profits for the business. Companies who have a better evaluation than their competitors in the concession of credit have an advantage over the others as they are less vulnerable to the consequence of the wrong decisions when providing credit.

Evaluation of risk of a potential client can be carried out in two ways:

1.   By judgment, a more subjective way involving a more qualitative analysis;

2.   By classifying the taker by means of evaluation models, involving a more quantitative analysis.

Currently, almost all large sized companies working with concession of credit use a combination of both.

The models called credit scoring are used for the evaluation of risk of credit by classification of the applicant. They permit measurement of the credit applicant's risk, to support the decision taking (concession or not of credit).

2.4 Credit Scoring Models

The pioneer of credit models was Henry Wells, executive of the Spiegel Inc. who developed a credit scoring model during the Second World War (Lewis, 1992).

Wells needed tools that would allow inexperienced analysts to perform credit evaluation, because many of its qualified employees had been recruited for the War.

During the fifties the scoring models were disseminated in the American banking industry. The first models were based upon pre-established weights for certain given characteristics, summing the points to reach a classification score.

More extensive use of the models in the sixties transformed business in the American market (Thomas, 2000). Not only companies in the financial area, but also the large retailers began to use credit scoring models to carry out credit sales to their consumers. Retailers such as Wards, Bloomingdale's and J.C. Penney were some of the pioneers in this segment.

In Brazil the background is shorter. Financial institutions started to make an intensive use of credit scoring models only in the mid-nineties.

There are some steps to be followed to construct a credit scoring model; such as:

1.   Survey of a historical background of the clients

The basic supposition to construct a model of credit evaluation is that the clients have the same behavior pattern over time; therefore models are constructed based upon past information. The availability and quality of the data bank are fundamental for the success of the model (Jain et al., 2020)

2.   Classification of clients according to their behavior pattern and definition of the dependent variable

In addition to good and bad clients there are also the excluded clients, those who have peculiar characteristics and should not be considered (for instance, workers in the institution) and the indeterminate clients, those on the threshold of being good or bad, still without a clear position about them. In practice, institutions consider only the good and bad clients to build the model because it is much easier to work with binary response models. This tendency to work only with good and bad clients is also noticed in academic works (Amaral & Iquiapaza, 2020; Gonçalves et al., 2013; Locatelli et al., 2015; Ríha, 2016).

3.   Selection of a random sample representative of the historical background

It is important that the samples of good and bad clients have the same size so as to avoid any possible bias due to size difference. There is no fixed number for the sample; however Lewis (1992)suggests a sample of 1,500 good clients and 1,500 bad clients to achieve robust results. Habitually three samples are used, one for building of the model, another for the validation of the model and a third to test the model.

4.   Descriptive analysis and preparation of data

This consists of analyzing, according to statistic criteria, each variable that will be utilized in the model.

5.   Choice and application of techniques to be used in the construction of the model

Logistic Regression, Neural Networks and Genetic Algorithms will be used in this work. Hand & Henley (1997)further stress Discriminant Analysis, Linear Regression and Decision Trees as methods that can be used in practice. There is no method that is clearly better than the others, everything depends upon how the elected technique fits the data.

6.   Definition of the comparison criteria of the models

Measurement for the comparison of the models will be defined here, normally by the rate of hits and the Kolmogorov-Smirnov (KS) statistics.

7.   Selection and implementation of the best model

The best model is chosen using the previously defined criteria. As such, the implementation of the model must be programmed. The institution must adjust its systems to receive the final algorithm and program its utilization in coordination with the other areas involved.

III.   METHODOLOGICAL PROCEDURES

3.1 Description of the Study

A financial institution wishes to grant loans to its clients and therefore it requires a tool to assess the level of risk associated to each loan to support the decision making process. To set up this project, information on the history of the clients that contracted personal credit was made available.

The product under study is personal credit. Individual credit is a rapid and practical consumer credit operation. The purpose of the loan does not need to be stated, and the loan will be extended according to the applicant's credit scoring.

Another characteristic of the product in question is the lack of requirement of goods as a guarantee of payment.The modality with pre-fixed interest rates with the loan terms ranging from 1 to 12 months was focused for this study.

3.2 The Data

To carry out this study a random selection was made in a universe of clients of the bank, 10,000 credit contracts, considered as good and 10,000 considered as bad. All these contracts had already matured, that is to say the sample was collected after the due date of the last installment of all contracts. This is an historical database with monthly information on the utilization of the product. Based upon this structure, the progress of the contract could be accompanied and particularized when the client did not pay one or more installments.

In the work, the sample is divided into three sub-samples coming from the same universe of interest: one

for construction of the model, 8,000 data (4,000 good and 4,000 bad), the second for validation of the constructed model, 6,000 data (3,000 good and 3,000 bad) and the third also with 6,000 (with the same equal division) to test the model obtained.

3.3 The Variables

The available explanatory variables have characteristics that can be divided into two groups: Reference File Variables, and Variables of Utilization and Restriction. Reference File Variables are related to the client and the Utilization and Restriction Variables regard the restriction of credit and notes about the client's other credit operations existing in the market.

The Reference File Variables as well as those of Utilization and Restriction are collected when the client contracts the product.

3.4 Definition of the Dependent Variable

This definition of the Dependent Variable, also called Performance Definition, is directly related to the institution's credit policy. For the product under study, clients delinquent for 60 or more days were considered Bad (default) and clients with a maximum delinquency of 20 days were considered Good.

Clients designated as undetermined represent a group whose credit behavior is not sufficiently clear to assign them as good or bad customers. In practice, clients who are not clearly defined as good or bad are analyzed separately by the credit analyst, based upon qualitative analysis.

3.5 Logistic Regression

In the models of logistic regression, the dependent variable is, in general a binary variable (nominal or ordinal) and the independent variables may be categorical (as long as dichotomized after transformation) or continuous(Almeida et al., 2020).

The model of Logistic Regression is a particular case of the Generalized Linear Models(Lopes et al., 2017). The function which characterizes the model is given by(Ye & Bellotti, 2019):

$$\ln\left(\frac{p(X)}{1-p(X)}\right) = \beta'X = Z$$

$\beta' = (\beta_0, \beta_1, \beta_2, ..., \beta_n)$: vector of the parameters associated to the variables

p(X)=E(Y=1|X): probability of the individual has been classified as good, given the vector X.

This probability is expressed by (Gonçalves et al., 2013):

$$p(X) = E(Y) = \frac{e^{\beta'X}}{1+e^{\beta'X}} = \frac{e^{Z}}{1+e^{Z}}$$

Initially, in this work all variables will be included for the construction of the model; however in the final logistic model, only some of the variables will be selected. The choice of the variables will be done by means of the method forward stepwise, which is the most widely used in models of logistic regression.

Fensterstock (2005)points out the following advantages in using logistic regression for the construction of models:

• The generated model takes into account the correlation between variables, identifying relationships that would not be visible and eliminating redundant variables;

• It takes into account the variables individually and simultaneously;

• The user may check the sources of error and optimize the model.

In the same text, the author further identifies some disadvantages of this technique:

• In many cases preparation of the variables takes a long time;

• In the case of many variables the analyst must perform a pre-selection of the more important, based upon separate analyses:

• Some of the resulting models are difficult to implement.

3.6 Artificial Neural Networks

Artificial Neural Networks are computational techniques that present a mathematical model based upon the neural structure of intelligent organisms and who acquire knowledge through experience.

It was only in the eighties that, because of the greater computational power, neural networks were widely studied and applied. Rojas (1996)underlines the development of the backpropagation algorithm as the turning point for the popularity of neural networks.

An artificial neural network model processes certain characteristics and produces replies like those of the human brain. Artificial neural networks are developed using mathematical models in which the following suppositions are made (Rojas, 1996):

1. Processing of information takes place within the so-called neurons;

2. Stimuli are transmitted by the neurons through connections;

3. Each connection is associated to a weight which, in a standard neural network, multiplies itself upon receiving a stimulus;

4. Each neuron contributes for the activation function (in general not linear) to determine the output stimulus (response of the network).

The pioneer model by McCulloch and Pitts (McCulloch & Pitts, 1943)for one processing unit (neuron) can be summarized in:

• Signals are presented upon input;

• Each signal is multiplied by a weight that indicates its influence on the output of the unit;

• The weighted sum of the signals which produces a level of activity is made;

• If this level exceeds a limit, the unit produces an output.

There are input signals $X_1, X_2, ..., X_p$ and corresponding weights $W_1, W_2, ..., W_p$ and the limit being k.

In this model the level of activity is given by:

$$a = \sum_{i=1}^{p} W_i X_i$$

And the output is given by:

y = 1, if a $\geq$ k

y = 0, if a $<$ k

Three characteristics must be taken into account in the definition of a model of neural networks: the form of the network called architecture, the method for determination of the weights, called learning algorithm; and the activation function.

Architecture relates to the format of the network. Every network is divided in layers, usually classified into three groups(Akkoç, 2012):

• Input Layer where the patterns are presented to the network;

• Intermediate or Hidden layers in which the major part of processing takes place, by means of the weighted connections, they may be viewed as extractors of characteristics;

• Output Layer, in which the end result is concluded and presented.

There are basically three main types of architecture: feedforward networks with a single layer; feedforward networks with multiple layers and recurring networks.

1. Feedforward networks with a single layer are the simpler network, in which there is only one input layer and one output layer. Some networks utilizing this architecture are: the Hebb Network, perceptron, ADALINE, among others.

2. Multilayered feedforward networks are those having one or more intermediate layers. The multilayer perceptron networks (MLP), MADALINE and of a radial base function are some of the networks utilizing this architecture.

3. Recurrent networks: in this type of network, the output layer has at least one connection that feeds back the network. The networks called BAM (Biderectional Associative Memory) and ART1 and ART2 (Adaptative Resonance Theory) are recurring networks.

The most important quality of neural networks is the capacity to "learn" according to the environment and thereby improve their performance (Deiu-merci & Mayou, 2018).

There are essentially three types of learning:

1. Supervised Learning: in this type of learning the expected reply is indicated to the network. This is the case of this work, where a priori it is already known whether the client is good or bad.

2. Non-supervised Learning: in this type of learning the network must only rely on the received stimuli; the network must learn to cluster the stimuli;

3. Reinforcement Learning: in this type of learning, behavior of the network is assessed by an external reviewer.

Berry & Linoff (2004) point out the following positive points in the utilization of neural networks:

• They are versatile: neural networks may be used for the solution of different types of problems such as: prediction, clustering or identification of patterns;

• They are able to identify non-linear relationships between variables;

• They are widely utilized, can be found in various software.

As for the disadvantages the authors state:

• Results cannot be explained: no explicit rules are produced, analysis is performed inside the network and only the result is supplied by the "black box";

• The network can converge towards a lesser solution: there are no warranties that the network will find the best possible solution; it may converge to a local maximum.

3.7 Genetic Algorithms

The idea of genetic algorithms resembles the evolution of the species proposed by Darwin: the algorithms will evolve with the passing of generations and the candidates for the solution of the problem one wants to solve "stay alive" and reproduce(Silva et al., 2019).

The algorithm is comprised of a population which is represented by chromosomes that are merely the various possible solutions for the proposed problem. Solutions that are selected to shape new solutions (starting from a cross-over) are selected according to the fitness of the parent chromosomes. Thus, the more fit the chromosome is, the higher the possibility of reproducing itself. This process is repeated until the rule of halt is satisfied, that is to say to find a solution very near to that hoped for.

Every genetic algorithm goes through the following stages:

Start: initially a population is generated formed by a random set of individuals (chromosomes) that may be viewed as possible solutions for the problem.

Fitness: a function of fitness is defined to evaluate the "quality" of each one of the chromosomes.

Selection: according to the results of the fitness function, a percentage of the best fit is maintained while the others are rejected (Darwinism).

Cross-over: two parents are chosen and based upon them an offspring is generated, based on a specific cross-over criterion. The same criterion is used with another chromosome and the material of both chromosomes is exchanged. If there is no cross-over, the offspring is an exact copy of the parents.

Mutation is an alteration in one of the genes of the chromosome. The purpose of mutation is to avoid that the population converges to a local maximum. Thus, should this convergence take place, mutation ensures that the population will jump over the minimum local point, endeavoring to reach other maximum points.

Verification of the halt criterion: once a new generation is created, the criterion of halt is verified and should this criterion not have been met, one returns to the stage of the fitness function.

The following positive points in the utilization of genetic algorithms must be highlighted:

• Contrariwise to neural networks they produce explicable results (Berry & Linoff, 2004)

• Their use is easy (Berry & Linoff, 2004)

• They may work with a large set of data and variables (Fensterstock, 2005)

Some of the disadvantages pointed out in literature are:

• They continue to be seldom used for problems of assessment of risk credit (Fensterstock, 2005)

• Require a major computational effort (Berry & Linoff, 2004)

• Are available in only a few softwares(Berry & Linoff, 2004)

Criteria for Performance Evaluation

To evaluate performance of the model two samples were selected, one for validation and the other for test. Both were of the same size (3,000 clients considered good and 3,000 considered bad, for each one). In addition to the samples, other criteria are used, which are presented in this section.

3.8 Score of Hits

The score of hits is measured by dividing the total of clients correctly classified, by the number of clients included in the model.

Similarly, the score of hits of the good and bad clients can be quantified.

In some situations it is much more important to identify a good client than a bad client (or vice versa); in such cases, often a more fitting weight is given to the score of hits and a weighted mean of the score of hits is calculated.

In this work, as there is not a priori information on what would be more attractive for the financial institution (identification of the good or bad clients), the product between the score of hits of good and bad clients (Ih) will be used as an indicator of hits to evaluate the quality of the model. This indicator will privilege the models with high scores of hits for both types of clients. The greater the indicator is the better will be the model.

3.9 The Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov (KS) is the other criterion often used in practice and used in this work(Fonseca et al., 2019; Lin, 2013; Machado, 2015).

The KS test is a non-parametric technique to determine whether two samples were collected from the same population (or from populations with similar distributions)(Jaklič et al., 2018). This test is based on the accumulated distribution of the scores of clients considered good and bad.

To check whether the samples have the same distribution, there are tables to be consulted according to the significance level and size of the sample (Siegel & Castellan Jr, 2006). In this work, as the samples are large, tendency is that all models reject the hypothesis of equal distributions. The best model will be that with the highest

value in the test, because this result indicates a larger spread between the good and bad.

IV.   RESULTS

This section will cover the methods to treat variables, the application of the three techniques under study and the results obtained by each one of them, comparing their performance. For descriptive analysis, categorization of data and application of logistic regression the SPSS for Windows v.21.0 software was used, the software SAS Enterprise Miner. 14.1 was used for the selection of the samples and application to the neural network; for the genetic algorithm a program developed in Visual Basic by the authors was utilized.

4.1 Treatment of the Variables

Initially, the quantitative variables were categorized.

The deciles (values below which 10%, 20% etc. of the cases fall) of these variables were initially identified for categorization of the continuous variables. Starting from the deciles, the next step was to analyze them according to the dependent variable. The distribution of good and bad clients was calculated by deciles and then the ratio between good and bad was calculated, the so called relative risk (RR).

Groups presenting a similar relative risk (RR) were re-grouped to reduce the number of categories by variable.

The relative risks were also calculated for the qualitative variables to reduce the number of categories, whenever possible. According to (Gouvêa et al., 2012)there are two reasons to make a new categorization of the qualitative variables. The first is to avoid categories with a very small number of observations, which may lead to less robust estimates of the parameters associated to them. The second is the elimination of the model parameters, if two categories present a close risk, it is reasonable to group them in one single class.

Besides clustering of categories, RR helps to understand whether this category is more connected to good or to bad clients. This method of clustering categories is explained by Hand & Henley (1997)

When working with the variables made available, heed was given to the following:

•   The variables gender, first acquisition and type of credit were not re-coded as they are already binary variables;

•   The variable profession was clustered according to the similarity of the nature of jobs;

•   The variables commercial telephone and home telephone were recoded in the binary form as ownership or not;

•   The variables commercial ZIP Code and home ZIP Code were initially clustered according to the first three digits, next the relative risk of each layer was calculated and later a reclustering was made according to the similar relative risk, the same procedure adopted byHand & Henley (1997);

•   The variable salary of the spouse was discarded from the analysis because much data was missing;

•   Two new variables were created, percentage of the amount loaned on the salary and percentage of the amount of the installment on the salary. Both are quantitative variables, which where categorized in the same way as the remainder.

4.2 Logistic Regression

For the estimation of the model of logistic regression, a sample of 8,000 cases equally divided in the categories of good or bad was utilized.

Initially, it is interesting to evaluate the logistic relationship between each independent variable and the dependent variable TYPE.

Since one of the objectives of this analysis was to identify which variables are more efficient for the characterization of the two types of bank clients, a stepwise procedure was utilized. The elected method of selection was forward stepwise.

With categorical variables, evaluation of the effect of one particular category must be done in comparison with a reference category. The coefficient for the reference category is 0.

Variables with a logistic coefficient estimated negative indicate that the focused category, with regard to the reference, is associated to a decrease of the odds and therefore a decrease in the probability of having a good client.

There are two statistical tests to evaluate the significance of the final model: the chi-square test of the change in the value of – 2LL (-2 times the log of the likelihood) and the Hosmer and Lemeshow test.

Table 1 presents the initial value of – 2LL, considering only the model's constant, its end value, the improvement and the descriptive level to measure its significance.

Table1: Chi-Square test

-2LL	Chi-Square (improvement)	Degrees of freedom	Significance
11090.355			
9264.686	1825.669	28	0.000

The model of 28 variables disclosed that the reduction of the -2LL measure was statistically significant.

The Hosmer and Lemeshow test considers the statistical hypothesis that the predicted classifications in groups are equal to those observed. Therefore, this is a test of the fitness of the model to the data.

The chi-square statistic presented the outcome 3.4307, with eight degrees of freedom and descriptive level equal to 0.9045. This outcome leads to the non rejection of the null hypothesis of the test, endorsing the model's adherence to the data.

4.3 Neural Network

In this work, a supervised learning network will be used, as it is known a priori whether the clients in question are good or bad. According to Potts (1998: 44), the most used structure of neural network for this type of problem is the multilayer perceptron (MLP) which is a network with a feedforward architecture with multiple layers. Consulted literature (Akkoç, 2012; Deiu-merci & Mayou, 2018; Olson et al., 2012; Ríha, 2016) supports this statement. The network MLP will also be adopted in this work.

The MLP networks can be trained using the following algorithms: Conjugate Descending Gradient, Levenberg-Marquardt, Back propagation, Quick propagation or Delta-bar-Delta. The most common (Rojas, 1996)is the Back propagation algorithm which will be detailed later on.

The implemented model has an input layer of neurons, a single neuron output layer, which corresponds to the outcome whether a client is good or bad in the classification of the network. It also has an intermediate layer with three neurons, since it was the network which presented the best outcomes, in the query of the higher percentage of hits as well as in the query of reduction of the mean error. Networks which had one, two or four neurons were also tested in this work.

Each neuron of the hidden layer is a processing element that receives n inputs weighted by weights Wi. The weighted sum of inputs is transformed by means of a nonlinear activation function f(.).

The activationfunctionused in thisstudywillbethelogisticfunction $\dfrac{1}{1 + e^{(-g)}}$, where

$$g = \sum_{i=1}^{p} W_i X_i$$

is the weighted sum of the neuron inputs.

Training of the networks consists in finding the set of Wi weights that minimizes one function of error. In this work for the training will be used the Back propagation algorithm. In this algorithm the network operates in a two step sequence. First a pattern is presented to the input layer of the network. The resulting activity flows through the network, layer by layer until the reply is produced by the output layer. In the second step the output achieved is compared to the desired output for this particular pattern. If not correct, the error is estimated. The error is propagated starting from the output layer to the input layer, and the weights of the connections of the units of the inner layers are being modified, while the error is backpropagated. This procedure is repeated in the successive iterations until the halt criterion is reached.

In this model the halt criterion adopted was the mean error of the set of validation data. This error is calculated by means of the module of the difference between the value the network has located and the expected one. Its mean for the 8,000 cases (training sample) or the 6,000 cases (validation sample) is estimated. Processing detected that the stability of the model took place after the 94th iteration. In the validation sample the error was somewhat larger (0.62 x 0.58), which is common considering that the model is fitted based upon the first sample.

Initially, the bad classification is of 50%, because the allocation of an individual as a good or bad client is random; with the increase of the iterations, the better result of 30.6% of error is reached for the training sample and of 32.3% for the validation sample.

Some of the statistics of the adopted network are in table 2.

Table2:Neural network statistics

Obtained statistics	Test	Validation
Misclassification of cases	0.306	0.323
Mean error	0.576	0.619
Mean square error	0.197	0.211
Degrees of freedom of the model	220	
Degrees of freedom of the error	7780	
Total degrees of freedom	8000	

Besides the misclassification and the mean error, the square error and the degrees of freedom are also presented. The average square error is calculated by the average of the squares of the differences between that observed and that obtained from the network.

The number of degrees of freedom of the model is related to the number of estimated weights, to the connection of each of the attributes to the neurons of the intermediate layer and to the binding of the intermediate layer with the output.

4.4 Genetic Algorithms

The genetic algorithm was used to find a discriminate equation permitting to score clients, and later, separate the good from the bad according to the score achieved. The equation scores the clients and those with a higher score are considered good, while the bad are those with a lower score. This route was adopted by Metawa et al., (2017) and Picinini et al. (2003).

The implemented algorithm was similar to that presented in Picinini et al. (2003). Each one of the 71 categories of variables was given an initial random weight. To these seventy one coefficients, one more was introduced, an additive constant incorporated to the linear equation. The value of the client score is given by:

$$S_j = \sum_{i=1}^{72} w_i \left(p_{ij} \right), \text{where}$$

S_j = Score obtained by client j

w_i = Weight relating to the category i

p_{ij} = binary indicator equal to 1, if the client j has the category i and 0, conversely.

The following rule was used to define if the client is good or bad:

If $S_j \geq 0$, the client is considered good

If $S_j < 0$, the client is considered bad

As such, the problem the algorithm has to solve is to find the vector W= $[\,w_1, w_2, ..., w_{72}\,]$ resulting in a classification criterion with a good rate of hits in predicting the performance of payment of credit.

Following the stages of a genetic algorithm, one has:

Start: a population of 200 individuals was generated with each chromosome holding 72 genes. The initial weight w_i of each gene was randomly generated in the interval [-1, 1] (Picinini et al., 2003)

Fitness Function: each client was associated to the estimate of a score and classified as good or bad. By comparing with the information already known a priori on the nature of the client, the precision of each chromosome can be calculated. The indicator of hits (Ih), will be the fitness function, that is to say, the greater the indicator the better will be the chromosome.

Selection: In this work an elitism of 10% was used for each new generation, the twenty best chromosomes are maintained while the other hundred and eighty are formed by cross over and mutation.

Cross-over: to chose the parents for cross-over the method known as roulette wheel was used for selection among these twenty chromosomes that were maintained(Oreski et al., 2012). In this method, each individual is given one probability of being drawn according to its value of the fitness function.

For the process of exchange of genetic material a method known as uniform cross-over was used(Galvan, 2016). In this type of cross-over each gene of the offspring chromosome is randomly chosen among the genes of one of the parents, while the second offspring receives the complementary genes of the second father.

Mutation: in the mutation process, each gene of the chromosome is independently evaluated. Each gene of each chromosome has a 0.5% probability of undergoing mutation. Whenever a gene is chosen for mutation, the genetic alteration is performed, adding a small scalar value k in this gene. In the described experiment a value ranging from -0.05 and + 0.05 was randomly drawn.

Verification of the halt criterion: a maximum number of generations equal to 600 was defined as the halt criterion. After six hundred iterations, the fit chromosome will be the solution.

Results of the algorithm that had the highest Indicator of hits are presented here.

After execution of the algorithm, variables with a very small weight were discarded. In the work by Picinini et al. (2003) the authors consider that the variables with a weight lower than 0.15 or higher than -0.15 would be discarded because they did not have a significant weight for the model. In this work, after performing a sensitivity analysis, it was decided that the variables with a weight higher than 0.10 or lower than – 0.10 would be considered significant for the model. This rule was not applied for the constant, which was proven important for the model even with a value below cutoff.

4.5 Evaluation of the Models' Performance

After obtaining the models the three samples were scored and the Ih and KS were calculated for each of the

models. Table 3 shows the results of classification reached by the three models.

Table 3: Classification results

	Training			Validation			Test		
Logistic Regression	Bad	Good	% Correct	Bad	Good	% Correct	Bad	Good	% Correct
Bad	2833	1167	70.8	2111	889	70.4	2159	841	72.0
Good	1294	2706	67.7	1078	1922	64.1	1059	1941	64.7
Total	4127	3873	69.2	3189	2811	67.2	3218	2782	68.3
Neural Networks									
Bad	2979	1021	74.5	2236	764	74.5	2255	745	75.2
Good	1430	2570	64.3	1177	1823	60.8	1193	1807	60.2
Total	4409	3591	69.4	3413	2587	67.7	3448	2552	67.7
Genetic Algorithms									
Bad	2692	1308	67.3	1946	1054	64.9	2063	937	68.8
Good	1284	2716	67.9	1043	1957	65.2	1073	1927	64.2
Total	3976	4024	67.6	2989	3011	65.1	3136	2864	66.5

All presented good classification results, because, according toPicinini et al. (2003): "credit scoring models with hit rates above 65% are considered good by specialists".

The hit percentages were very similar in the models of logistic regression and neural network and were somewhat lesser for the model of genetic algorithms. Another interesting result is that, except for genetic algorithms, the models presented the greatest rate of hits for bad clients, with a higher than 70% rate for bad clients in the three samples of the logistic and neural network models.

Table 4 presents results of the criteria Ih and KS which were chosen to compare the models.

Table 4: Comparison indexes

Ih	Training	Validation	Test
Logistic regression	47.9	45.1	46.6
Neural network	47.9	45.3	45.3
Genetic algorithm	45.7	42.3	44.2
KS	Training	Validation	Test
Logistic regression	38	35	37
Neural network	39	35	35
Genetic algorithm	34	30	32

KS values in all models can be considered good. Again, Picinini et al. (2003) explain: "The Kolmogorov-Smirov test (KS) is used in the financial market as one of the efficiency indicators of the credit scoring models. A model which presents a KS value equal or higher than 30 is considered good by the market". Here again, the logistic regression and neural network models exhibit very close results, superior to those achieved by the genetic algorithm.

In choosing the model that best fits these data and analyzing according to the Ih and KS indicators, the model built by logistic regression was elected. Although results were very similar to those achieved by neural networks this model presented the best results in the test sample, suggesting that it is best fit for application in other databases. Nevertheless, it must be highlighted that the adoption of any one of the models would bring about good results for the financial institution.

V. CONCLUSION

The objective of this study was to develop credit scoring predictive models based upon data of a large financial institution by using Logistic Regression, Artificial Neural Networks and Genetic Algorithms.

When developing the credit scoring models some care must be taken to guarantee the quality of the model and its

later applicability. Precautions in the sampling, clear definition of criteria for the classification of good and bad clients and treatment of variables in the database prior to application of the techniques were the measures taken in this study, aiming to optimize results and minimize errors.

The three models presented suitable results for the database in question, which was supplied by a large retail bank operating in Brazil. The logistic regression model presented slightly better results to the model built by neural networks and both were better than the model based on genetic algorithms.

This study did not aim at a more detailed approach of the techniques focused. Neural networks and genetic algorithms presented an extensive range of structures and variations that may (and must) be better explored. Genetic algorithms, as they are a rather flexible method, not yet widely researched in problems of credit concession, may be used in diverse forms to optimize results.

In this type of problem, new techniques such as survival analysis should not be overlooked and merit attention in future studies.

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Parameter estimation of the Weibull Distribution; Comparison of the Least-Squares Method and the Maximum Likelihood estimation

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Abstract— Weibull distribution is a very useful distribution in survival analysis, lifetime analysis, and reliability analysis. Several methods have been proposed to estimate the parameters of different distributions such as the method of moment, maximum likelihood, etc. In this paper, we analyze the 2-parameter Weibull distribution by simulating data on failure times of a product using the Monte Carlo approach and estimating the parameters of the distribution using the maximum likelihood estimation (MLE) and the least-squares method (LS). These methods were also investigated through applications in reliability analysis. The two approaches of estimating the parameters were compared, and the MLE obtained better performance than the least-squares method when the results for the parameters were assessed using the goodness of fit measures. Also, we obtained the asymptotic distribution of the MLE which was asymptotically efficient as the sample size increases. The inverse of the Fisher's information matrix which is the asymptotic variance-covariance matrix was also obtained.

I. INTRODUCTION

The Weibull distribution has gained much weight in the real world and is mostly used in reliability and lifetime analysis or survival analysis. The 2-parameter Weibull distribution has the shape parameter (β) and the scale parameter (η or α) whose values affect the characteristic life of the distribution, the reliability function, and the failure rate. Most distributions such as normal distribution, gamma distribution, inverse gamma, and some other common distributions have two parameters which makes the 2-parameter Weibull distribution of immense interest. According to Sun(1997), the Weibull distribution does not belong to the 2-parameter exponential family neither are the two parameters orthogonal. In estimating the parameters of the Weibull distribution, the method of moment achieved the best result when it was compared with other estimators such as the MLE and the LS using the mean square error (MSE) and the total deviation (TD) for the 3-parameter and 2-parameter Weibull distribution

(Razali *et.al*, 2009). Pobocikova *et.al* (2017) investigated the performance of six estimators using the Monte Carlo simulation for wind speed, the result of the study indicates that the maximum likelihood estimation method performs better in estimating the parameters of the 2-parameter Weibull distribution for wind speed when the bias and root mean square error (RMSE) were compared. However, according to Chu & Ke (2012), the least-squares method outwits the maximum likelihood approach when the sample size is small.

This paper aims to analyze the 2-parameter Weibull distribution by applying the Monte Carlo simulation to generate artificial data of failure times of a product through which we obtained the parameter estimates of the shape and scale parameters of the Weibull distribution by comparing the maximum likelihood estimation (MLE) method and that of the linear regression least-squares method. The two approaches of estimation were also applied to two different sets of data in reliability analysis.

The research also assesses the asymptotic efficiency of the maximum likelihood estimator of the shape and scale parameters of the 2-parameter Weibull distribution.

II.   MAXIMUM LIKELIHOOD ESTIMATOR

The density function of the 2-parameter Weibull distribution is given as

$$f(x) = \frac{\beta x^{\beta-1}}{\eta^{\beta}} \exp\left\{-\left(\frac{x}{\eta}\right)^{\beta}\right\} \quad x > 0 \ , \ \beta > 0 \ , \ \eta > 0 \tag{1}$$

The cumulative density function is given by

$$F(\mathrm{x}) = 1 - \exp\left\{-\left(\frac{x}{\eta}\right)^{\beta}\right\} \tag{2}$$

where β is the shape parameter and η is the scale parameter. The reliability function is given by $R(x) = \exp\left\{-\left(\frac{x}{\eta}\right)^{\beta}\right\}$, the

cumulative density function can be expressed in terms of the reliability function as $F(\mathrm{x}) = 1 - R\left(x\right)$.

Maximum likelihood estimation is a method used to estimate the parameter of a probability distribution. This is obtained by maximizing the likelihood function of the distribution. The maximum likelihood estimator of the Weibull distribution is given as follows:

$$\prod_{i=1}^{n} f(x_i) = \prod_{i=1}^{n} \frac{\beta x_i^{\beta-1}}{\eta^{\beta}} \exp\left\{-\left(\frac{x_i}{\eta}\right)^{\beta}\right\}$$

$$= \left(\frac{\beta}{\eta^{\beta}}\right)^{n} \prod_{i=1}^{n} x_i^{\beta-1} \exp\left\{-\left(\frac{x_i}{\eta}\right)^{\beta}\right\} \tag{3}$$

Taking the log of the likelihood in (3) we obtain the equation

$$L\left(f(\mathrm{x})\right) = n \log \beta - n\beta \log \eta + \left(\beta - 1\right) \sum_{i=1}^{n} \log(x_i) - \sum_{i=1}^{n}\left(\frac{x_i}{\eta}\right)^{\beta} \tag{4}$$

The scale parameter can easily be obtained with an analytical method; the shape parameter β is very difficult to be obtained by the analytical method, however, it can be obtained by using the Newton-Raphson method or the least square method (Guure *et al*., 2012; Al-Fawzan, 2000). We obtain the scale parameter by differentiating (4) and solving the equation

$$\frac{\partial L\left(f(x)\right)}{\partial \eta} = 0$$

$$\frac{\partial L\left(f(x)\right)}{\partial \eta} = -\frac{n\beta}{\eta} + \frac{\beta}{\eta} \sum_{i=1}^{n}\left(\frac{x_i}{\eta}\right)^{\beta} = 0 \tag{5}$$

$$\eta = \left(\frac{\sum_{i=1}^{n} x_i^{\beta}}{n}\right)^{\frac{1}{\beta}}$$

Asymptotic efficiency

The asymptotic efficiency of the 2-parameter Weibull distribution can be obtained as follows, We find the partial derivatives of the parameters by differentiating the log of the Weibull distribution.

$$\omega_{11} = \frac{\partial \log f(x)}{\partial \eta^2} = \frac{\beta}{\eta^2} - \frac{\beta(\beta+1)}{\eta^2}\left(\frac{x}{\eta}\right)^{\beta}$$

$$\omega_{22} = \frac{\partial \log f(x)}{\partial \beta^2} = -\frac{1}{\beta^2} - \left(\frac{x}{\eta}\right)^{\beta}\left(\log\left(\frac{x}{\eta}\right)\right)^{2}$$

$$\omega_{12} = \frac{\partial \log f(x)}{\partial \eta \, \partial \beta} = -\frac{1}{\eta} + \frac{1}{\eta}\left(\frac{x}{\eta}\right)^{\beta} + \frac{\beta}{\eta}\left(\frac{x}{\eta}\right)^{\beta}\log\left(\frac{x}{\eta}\right)$$

$$\omega_{21} = \frac{\partial \log f(x)}{\partial \beta \, \partial \eta} = -\frac{1}{\eta} + \frac{\beta}{\eta}\left(\frac{x}{\eta}\right)^{\beta}\log\left(\frac{x}{\eta}\right) + \frac{1}{\eta}\left(\frac{x}{\eta}\right)^{\beta}$$

We obtain the determinant using the Hessian matrix of the Weibull distribution and ignoring all negative terms.

$$H(\theta) = \begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix}$$

where $\theta = (\beta, \eta)$

$$|H(\theta)| = \frac{\beta+1}{\beta \, \eta^2}\left(\frac{x}{\eta}\right)^{\beta} + \frac{\beta(\beta+1)}{\eta^2}\left(\frac{x}{\eta}\right)^{2\beta}\left(\log\left(\frac{x}{\eta}\right)\right)^{2}$$, considering $\log x < x+1$ .We rewrite the determinant as

$$|H(\theta)| < \frac{\beta+1}{\beta \, \eta^2}\left(\frac{x}{\eta}\right)^{\beta} + \frac{\beta(\beta+1)}{\eta^2}\left(\frac{x}{\eta}\right)^{2\beta}\left(\frac{x}{\eta}+1\right)^{2} \qquad (6)$$

Considering $\frac{\eta_0}{2} < \eta < \frac{3\eta_0}{2}$ and $\frac{\beta_0}{2} < \beta < \frac{3\beta_0}{2}$ and define

$$\frac{4(\beta+1)}{\beta\eta_0^2}\left(\frac{2x}{\eta_0}\right)^{\beta} + \frac{4(\beta(\beta+1))}{\eta_0^2}\left(\frac{2x}{\eta_0}\right)^{2\beta}\left(\frac{2x}{\eta_0}+1\right)^{2} = h_{\beta,\,\eta_0}(x) \qquad (7)$$

We obtain the upper bound of $h_{\beta,\,\eta_0}(x)$ from (7), for any $x > 0$, $\left(\frac{2x}{\eta_0}\right)^{\beta} < \left(\frac{2x}{\eta_0}+1\right)^{2\beta_0}$

$$h_{\beta,\,\eta_0}(x) < \frac{4(2\beta_0+1)}{\frac{\beta_0}{2}\eta_0^2}\left(\frac{2x}{\eta_0}+1\right)^{2\beta_0} + \frac{4(2\beta_0(2\beta_0+1))}{\eta_0^2}\left(\frac{2x}{\eta_0}+1\right)^{2\beta_0}\left(\frac{2x}{\eta_0}+1\right)^{2} \qquad (8)$$

Then $\qquad E\left(h_{\beta,\,\eta_0}(x)\right) < E\left[\frac{4(2\beta_0+1)}{\frac{\beta_0}{2}\eta_0^2}\left(\frac{2x}{\eta_0}+1\right)^{2\beta_0} + \frac{4(2\beta_0(2\beta_0+1))}{\eta_0^2}\left(\frac{2x}{\eta_0}+1\right)^{2\beta_0}\left(\frac{2x}{\eta_0}+1\right)^{2}\right] < \infty$

The *kth* moment is given as follows:

$$E\left(X^k\right) = \eta^k\Gamma\left(1+\frac{k}{\beta}\right) < \infty$$

Therefore, based on Bahadur (1964) we have

$$\sqrt{n}\left(\hat{\theta}_n - \theta_n\right) \xrightarrow{d} N_k\left(0, \left[I_n(\theta)\right]^{-1}\right)$$

Hence we obtain the Fisher's information matrix $I_n(\theta)$ and its inverse, the information matrix is given as

$$I(\theta) = -E\begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix}$$

For us to obtain the Fisher information in a simplified form, we make the same assumption made by Sun (1997) that for $i \geq 1$,

we define $\gamma_i = \int_0^\infty \left[\log(y)\right]^i \exp(-y)dy$, and we let $Y = \left(\dfrac{x}{\eta}\right)^\beta$ be an exponential random variable with mean 1 whose density

function is expressed as $f(y) = \exp(-y), \quad y \geq 0$

$$\beta E\left\{\left(\frac{x}{\eta}\right)^\beta \log\left(\frac{x}{\eta}\right)\right\} = \int_0^\infty y\log(y)f(y)dy$$

$$\int_0^\infty \left[1 + \log(y)\right]\exp(-y)dy = 1 + \gamma_1$$

$$\beta^2 E\left\{\left(\frac{x}{\eta}\right)^\beta \left[\log\left(\frac{x}{\eta}\right)\right]^2\right\} = \int_0^\infty y\log(y)^2 f(y)dy$$

$$\int_0^\infty \left[\log(y)^2 + 2\log y\right]\exp(-y)dy = \gamma_2 + 2\gamma_1$$

The Fisher's information matrix can be expressed as

$$I(\theta) = \begin{pmatrix} \dfrac{\beta^2}{\eta^2} & -\dfrac{1+\gamma_1}{\eta} \\ -\dfrac{1+\gamma_1}{\eta} & \dfrac{1+\gamma_2+2\gamma_1}{\beta^2} \end{pmatrix}$$

The determinant of the information matrix $|I(\theta)| = \dfrac{\gamma_2 - \gamma_1^2}{\eta^2}$, where $-\gamma_1$ is Euler's constant and $\gamma_2 - \gamma_1^2$ is the variance of

$\log(\phi)$ where ϕ is an exponential random variable with a mean of 1.

$$\left[I(\theta)\right]^{-1} = \frac{\eta^2}{\gamma_2 - \gamma_1^2}\begin{pmatrix} \dfrac{1+\gamma_2+2\gamma_1}{\beta^2} & \dfrac{1+\gamma_1}{\eta} \\ \dfrac{1+\gamma_1}{\eta} & \dfrac{\beta^2}{\eta^2} \end{pmatrix}$$

III.   LEAST-SQUARES ESTIMATION

The least-squares estimation of the 2-parameter Weibull distribution is also important and can be used to estimate the parameters of the Weibull distribution inasmuch as the maximum likelihood is used. In estimating the parameter of the Weibull distribution, we will consider the cumulative density function and obtain a regression equation from which we can deduce the equations for estimating the parameters of the 2-parameter Weibull distribution. The cumulative density function of the Weibull distribution in (2) becomes:

$$\exp\left\{-\left(\frac{x}{\eta}\right)^{\beta}\right\} = 1 - F(\mathrm{x})$$

Taking the log of the reliability function, we obtain

$$\left(\frac{x}{\eta}\right)^{\beta} = -\ln\left[1 - F(\mathrm{x})\right]$$

$$\ln\left(\frac{x}{\eta}\right) = \frac{1}{\beta}\ln\left\{-\ln\left[1 - F(\mathrm{x})\right]\right\}$$

$$\ln(x) = \frac{1}{\beta}\ln\left\{-\ln\left[1 - F(\mathrm{x})\right]\right\} + \ln(\eta) \tag{9}$$

From (9), let $Y_i = \ln(x_i)$, $X = \ln\left\{-\ln\left[1 - F(\mathrm{x})\right]\right\}$, $a = \frac{1}{\beta}$ and $b = \ln(\eta)$, we write (9) as a linear function of the form $Y_i = aX + b$. By substituting Y_i and X into the least-squares formula, we will obtain the estimates for a and b through which we estimate the parameters β and η.

$$a = \frac{n\sum\limits_{i=1}^{n}\ln\left\{-\ln\left[1 - \hat{F}(\mathrm{x}_i)\right]\right\}\ln x_i - \sum\limits_{i=1}^{n}\ln\left\{-\ln\left[1 - \hat{F}(\mathrm{x}_i)\right]\right\}\sum\limits_{i=1}^{n}\ln x_i}{n\sum\limits_{i=1}^{n}\left(\ln x_i\right)^2 - \left(\sum\limits_{i=1}^{n}\ln x_i\right)^2} \tag{10}$$

$$b = \frac{\sum\limits_{i=1}^{n}\ln(x_i) - a\sum\limits_{i=1}^{n}\ln\left(-\ln\left[1 - \hat{F}(\mathrm{x}_i)\right]\right)}{n} \tag{11}$$

hence we have $\beta = \frac{1}{a}$ and $\eta = \exp(b)$, where $F(\mathrm{x})$ can be estimated by the mean rank approach (Pobocikova,2012),

$\hat{F}(\mathrm{x}_i) = \frac{i}{n+1}$.

IV.   SIMULATION AND ANALYSIS

In this study, we first simulated data using the Monte Carlo simulation. Random datasets were generated from the uniform distribution for the study. The datasets generated from the uniform distribution were sampled uniformly from the range of 0 and 1 to represent the failure times(hours) for a particular product. The randomly selected samples from the uniform distribution were simulated with the model $X = \eta\left(-\ln(z)\right)^{1/\beta}$ to represent the failure times for the product as a random sample from the Weibull distribution, where z has the uniform distribution (0,1). We simulated 36,000 failure times and chose $n = 50,100$, and 1000, we chose different scale and shape parameters to simulate the data for the Weibull

distribution, and the sample sizes n were chosen after each simulation, this was replicated 1000 times in each simulation. The shape parameter values β were chosen so that $\beta = 0.5$ will represent the scenario when $\beta < 1$ and the other values (2,3) of the shape parameter when $\beta > 1$, and $\beta = 1$ when we have constant failure times. The two parameters for the Weibull distribution were estimated through the use of the maximum likelihood estimation and the least-squares method. The performance of these two estimation techniques was compared using the goodness of fit measures. The maximum likelihood approach estimates the parameters of the 2-parameter Weibull distribution better than the least-squares method. The results for the parameter estimation using the maximum likelihood and

the least-squares method are tabulated in Table 1. By comparing the goodness of fit for the MLE and the LS, the MLE performs better in estimating the model parameters than the least-squares method.

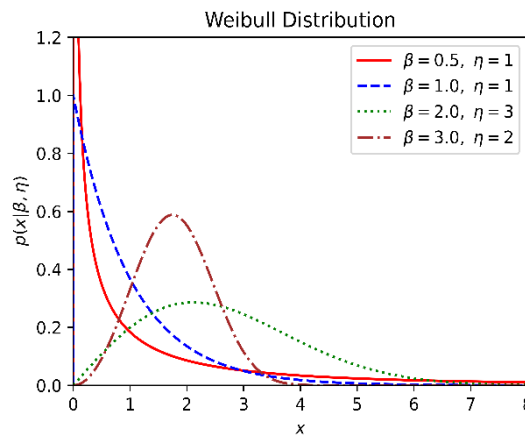The probability density function and the cumulative density of the different parameter values used to simulate the Weibull distribution for this study are shown in Fig.1. The probability plot and the cumulative density function (CDF) are shown in Fig. 2.

Table 1. Parameter estimation of the Weibull distribution

Maximum Likelihood Estimation

	Parameter Values		Estimates		Confidence Interval		Goodness of fit			
size	η (α)	β	$\hat{\eta}$ ($\hat{\alpha}$)(SE)	$\hat{\beta}$ (SE)	CI($\hat{\eta}$ ($\hat{\alpha}$))	CI($\hat{\beta}$)	Log-likelihood	AICc	BIC	AD
50	2	0.5	1.8310(0.5454)	0.4949(0.0544)	(1.0213,3.2829)	(0.3990,0.6138)	-87.4434	179.142	182.711	0.4928
	1	1	1.2068(0.1495)	1.2060(0.1315)	(0.9467,1.5384)	(0.9739,1.4934)	-54.8121	113.880	117.448	0.4579
	3	2	3.2545(0.2276)	2.1122(0.2389)	(2.8377,3.7325)	(1.6923,2.6363)	-88.0339	180.323	183.892	1.0994
	2	3	2.0121(0.0952)	3.1467(0.3563)	(1.8340,2.2075)	(2.5205,3.9285)	-47.8072	99.8696	103.438	0.4987
100	2	0.5	1.9099(0.4687)	0.4288(0.0344)	(1.1807,3.0896)	(0.3664,0.5018)	-170.569	345.261	350.348	0.5962
	1	1	1.2241(0.1171)	1.1052(0.0853)	(1.0148,1.4766)	(0.9501,1.2856)	-115.496	235.115	240.202	0.7073
	3	2	2.8691(0.1373)	2.1891(0.1756)	(2.6122,3.1512)	(1.8706,2.5617)	-160.233	324.589	329.676	0.8453
	2	3	1.9377(0.0720)	2.8296(0.2240)	(1.8017,2.0841)	(2.4229,3.3045)	-100.351	204.826	209.912	0.3510
1000	2	0.5	1.9012(0.1252)	0.5065(0.0125)	(1.6710,2.1631)	(0.4826,0.5315)	-1767.24	3538.5	3548.3	0.7730
	1	1	1.0413(0.0345)	1.0042(0.0247)	(0.9757,1.1112)	(0.9569,1.0538)	-1038.67	2081.36	2091.16	0.2608
	3	2	3.0284(0.0495)	2.0362(0.0505)	(2.9329,3.1270)	(1.9395,2.1376)	-1692.99	3389.98	3399.79	0.2070
	2	3	2.0028(0.0212)	3.1398(0.0776)	(1.9616,2.0449)	(2.9913,3.2956)	-944.250	1892.51	1902.32	0.3783

Least-squares Estimation

size	η (α)	β	$\hat{\eta}$ ($\hat{\alpha}$) (SE)	$\hat{\beta}$ (SE)	CI($\hat{\eta}$ ($\hat{\alpha}$))	CI($\hat{\beta}$)	Log-likelihood	AICc	BIC	AD
50	2	0.5	1.8310(0.5454)	0.4949(0.0544)	(1.0213,3.2829)	(0.3990,0.6138)	-87.4434	179.142	182.711	0.4928
	1	1	1.2010(0.1463)	1.2223(0.1329)	(0.9459,1.5248)	(0.9877,1.5125)	-54.8233	113.902	117.471	0.4810
	3	2	3.3544(0.3018)	1.7234(0.2069)	(2.8121,4.0014)	(1.3620,2.1806)	-89.7926	183.84	187.409	1.5810
	2	3	2.0162(0.1016)	2.9541(0.3382)	(1.8266,2.2254)	(2.3603,3.6972)	-47.9805	100.216	103.785	0.4353
100	2	0.5	1.9055(0.4938)	0.4123(0.0333)	(1.1467,3.1666)	(0.3519,0.4831)	-170.697	345.518	350.604	0.4999
	1	1	1.2004(0.1067)	1.1784(0.0897)	(1.0085,1.4289)	(1.0150,1.3680)	-116.000	236.124	241.21	1.0681
	3	2	2.9312(0.1672)	1.8901(0.1571)	(2.6211,3.2779)	(1.6059,2.2245)	-162.173	328.469	333.556	1.1726
	2	3	1.9515(0.0784)	2.6302(0.2117)	(1.8037,2.1114)	(2.2463,3.0798)	-100.866	205.855	210.941	0.3884
1000	2	0.5	1.8555(0.1157)	0.5229(0.0127)	(1.6420,2.0967)	(0.4985,0.5485)	-1768.47	3540.94	3550.75	1.4114
	1	1	1.0383(0.0341)	1.0122(0.0249)	(0.9736,1.1076)	(0.9646,1.0621)	-1038.74	2081.5	2091.31	0.3034
	3	2	3.0364(0.0507)	1.9972(0.0498)	(2.9387,3.1374)	(1.9019,2.0972)	-1693.37	3390.76	3400.56	0.2147
	2	3	2.0024(0.0213)	3.1323(0.0775)	(1.9611,2.0445)	(2.9841,3.2879)	-944.255	1892.52	1902.32	0.3718
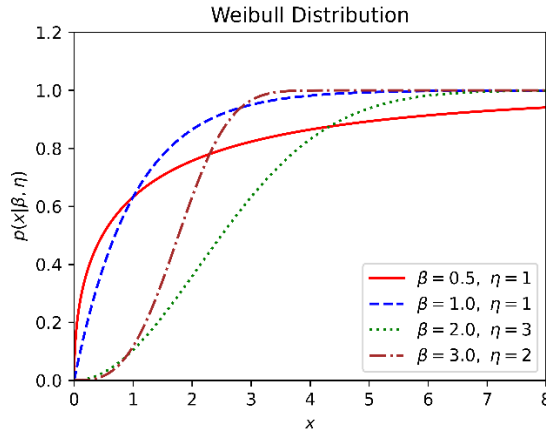
1A: *Probability density plots for the different parameter values*

1B: *Cumulative density plots for the different parameter values*

Fig.1: Plots of the probability density and cumulative density of the Weibull distribution with different values of the shape (β) and scale parameter (η (α)).
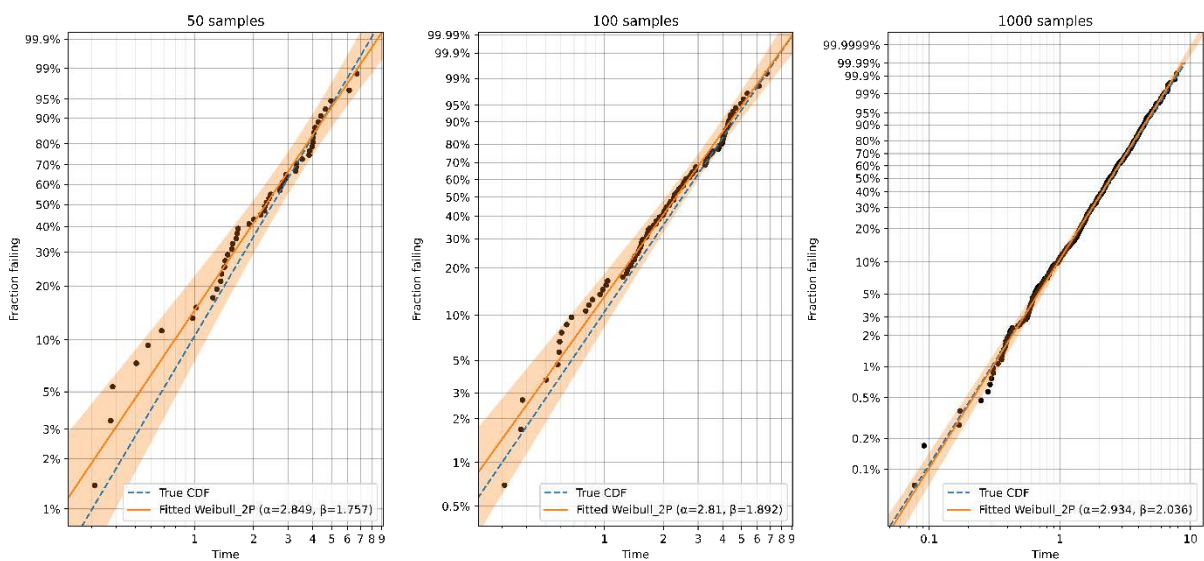

Fig.2: Plot of the cumulative density function and the probability plot of the data values of three different samples randomly selected from the Weibull distribution and their estimated values of the shape (β) and scale parameter (η (α)).

4.1 Applications in Reliability Analysis

Health

Considering the application of Weibull distribution in reliability analysis, we use the data on 128 randomly selected remission times (months) of bladder cancer patients. The data have been used by many researchers for different research activities, Zea *et al.* (2012) used the data comparing sub-model including beta-Pareto distribution and others, and the beta exponential Pareto distribution. Almheidat *et al.* (2015) also investigated the Cauchy-Weibull distribution with this dataset. We apply the Weibull distribution to fit the same data, however, we removed all outliers that are 2-standard deviation away from the mean from the dataset before fitting the Weibull distribution to the data. In order to ascertain that the correct distribution is fitted, we fitted many other distributions such as the Lognormal, Gamma, Exponential, Loglogistic, etc. to the data after removing all outliers from the data and then select the best distribution that fits the data. This reduces the sample size from 128 to 122 remission times of bladder cancer patients. Fig.3 indicates the fit of distributions to the data. The data for the 128 remission times (months) of bladder cancer patients are shown below in Table 2.

Table 2: Remission times (months) of bladder cancer patients

0.08	1.46	2.69	3.57	4.51	5.62	7.32	8.66
11.98	15.96	25.82	0.2	1.76	2.69	3.64	4.87
5.71	7.39	9.02	12.02	16.62	26.31	0.4	2.02
2.75	3.7	4.98	5.85	7.59	9.22	12.03	17.12
32.15	0.5	2.02	2.83	3.82	5.06	6.25	7.62
9.47	12.07	17.14	34.26	0.51	2.07	2.87	3.88
5.09	6.54	7.63	9.74	12.63	17.36	36.66	0.81
2.09	3.02	4.18	5.17	6.76	7.66	10.06	13.11
18.1	43.01	0.9	2.23	3.25	4.23	5.32	6.93
7.87	10.34	13.29	19.13	46.12	1.05	2.26	3.31
4.26	5.32	6.94	7.93	10.66	13.8	20.28	79.05
1.19	2.46	3.36	4.33	5.34	6.97	8.26	10.75
14.24	21.73	1.26	2.54	3.36	4.34	5.41	7.09
8.37	11.25	14.76	22.69	1.35	2.62	3.48	4.4
5.41	7.26	8.53	11.64	14.77	23.63	1.4	2.64
3.52	4.5	5.49	7.28	8.65	11.79	14.83	25.74
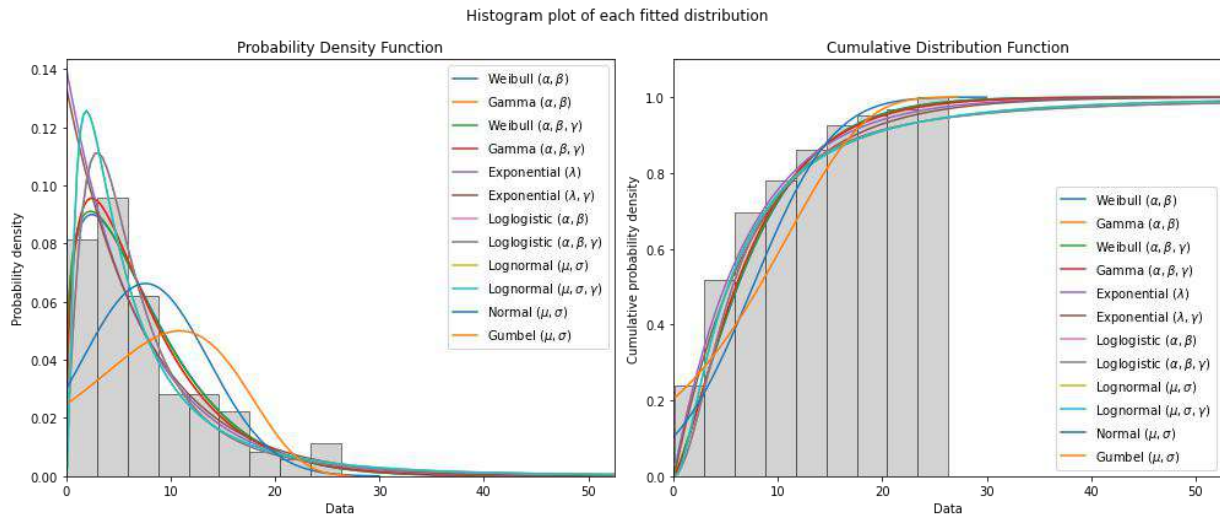
Fig.3: Histogram with each fitted distribution with the plots of its PDF and CDF.

Table 3: Comparison of the various distributions for the remission times data

Distribution	Alpha	Beta	Gamma	Mu	Sigma	Lambda	Log-likelihood	AICc	BIC	AD
Weibull_2P	8.204	1.276					-364.19	732.481	737.988	0.322
Gamma_2P	5.130	1.482					-364.34	732.787	738.294	0.262
Weibull_3P	8.128	1.258	0.0413				-364.11	734.421	742.63	0.315
Gamma_3P	5.130	1.482					-364.34	734.889	743.098	0.262
Exponential_1P						0.13153	-369.77	741.58	744.351	3.479
Exponential_2P			0.0799			0.13293	-368.19	740.483	745.99	2.16
Loglogistic_2P		1.864					-370.61	745.312	750.819	0.566
Loglogistic_3P		1.864	0				-370.61	747.414	755.623	0.566
Lognormal_2P				1.655	0.998		-374.72	753.539	759.046	1.365
Lognormal_3P				1.655	0.998		-374.72	755.642	763.85	1.365
Normal_2P				7.603	6.021		-392.13	788.35	793.857	4.218
Gumbel_2P				10.922	7.362		-420.56	845.226	850.734	8.34

Table 3 compares the various distributions using the AICc, and BIC and it was observed that the 2-parameter Weibull distribution is the best fit for the data. Fig. 4 shows the probability plot of each of the distributions compared, from Fig.4 there is an indication that the 2-parameter Weibull distribution fits better than the other distributions.

Probability plots of each fitted distribution
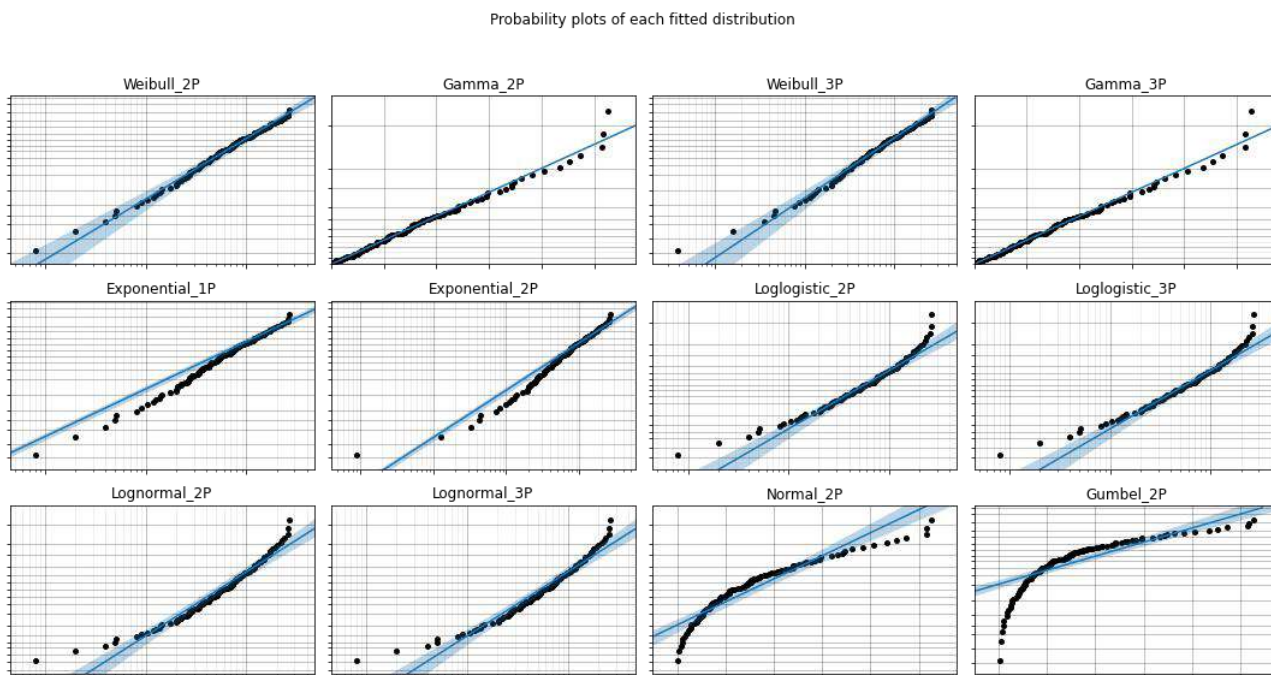
Fig.4: Probability plot of the remission times (months) of the bladder cancer patients for the various distributions.

The 2-parameter Weibull distribution is considered as the best distribution for the data, we, therefore, study the reliability of the remission times of the bladder cancer patients using the distribution chosen. The maximum likelihood estimation method and the least-squares method are considered in fitting the parameters of

the Weibull distribution, the results of the two methods are compared using the AICc and the BIC. The parameter estimates are shown in Table 4. The MLE approach performs better in estimating the parameters of the remission times of the bladder cancer patients compared with the least-squares method.

Table 4: Parameter estimate of the Weibull distribution for the remission times

	Parameter	Point Estimate	Standard Error	Lower CI	Upper CI	Log-likelihood	AICc	BIC	AD
MLE	Alpha	8.20364	0.613436	7.08528	9.49852	-364.19	732.481	737.988	0.322
	Beta	1.27557	0.0898488	1.11108	1.4644				
LS	Alpha	8.24435	0.63076	7.0963	9.57813	-364.24	732.576	738.084	0.317
	Beta	1.25165	0.08858	1.08953	1.43789				
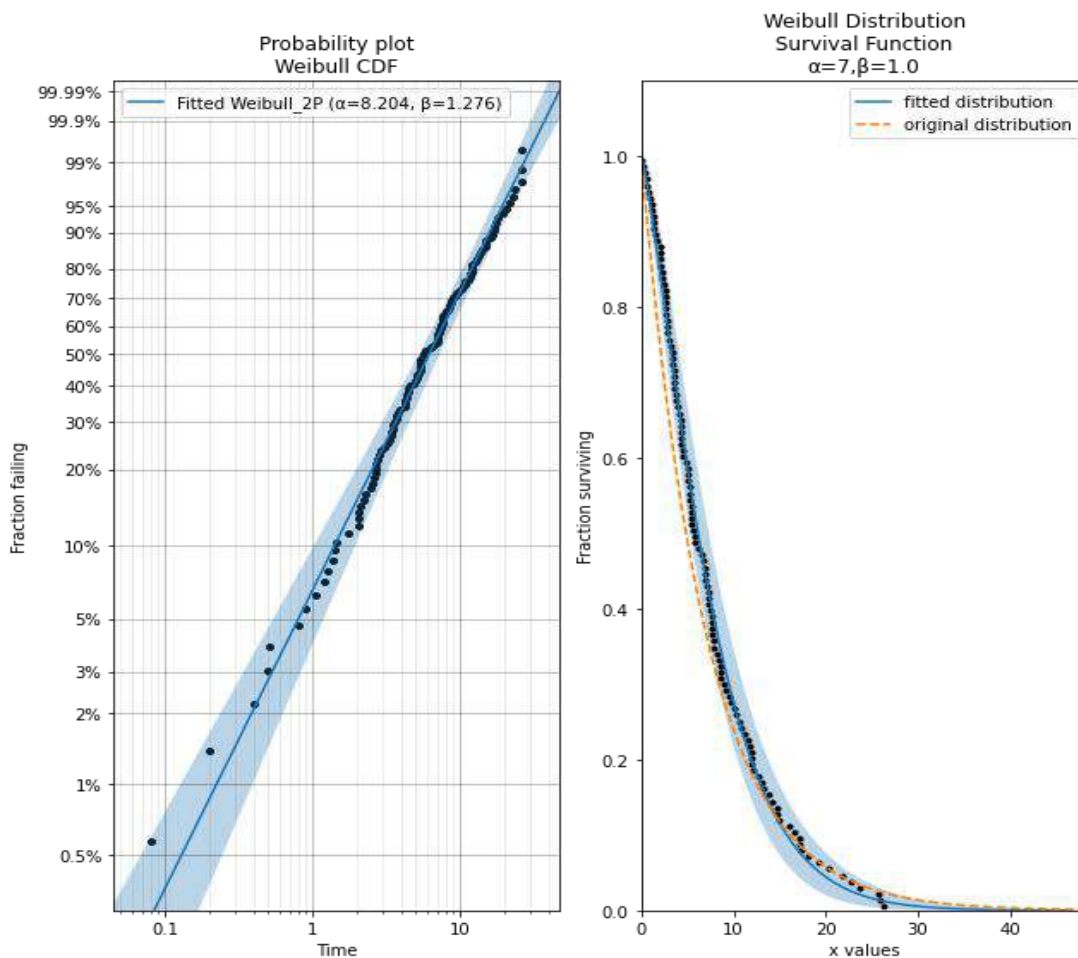
Fig.5: Probability plot and the plot of the reliability function for the remission times.

The plot in Fig.5 gives the probability plot for the Weibull distribution and the reliability function for the remission times (month) for the bladder cancer patients. The estimated shape parameter (1.276) using the MLE indicates that the remission rate of the bladder cancer patient increase as the remission time increases. The B10 life of the data was 1.4 months which indicates that we expect 10% of the bladder cancer patients to be remitted after 1.4 months.

Industrial

We again consider breaking stress of carbon fibers of 50mm length (GPa), the data was first used by

Nicholas and Padgett (2006), Lemonte (2011) using β - Birnbaum–Saunders distribution, Al-Aqtash *et.al* (2014) use the data to study the application of Gumbel-Weibull distribution. For our study, we remove all outliers that are 2- standard deviation away from the mean, this reduces the dataset from 66 to 59. The dataset was fitted with other distributions and the best distribution was the 2-parameter Weibull distribution. Fig.6 illustrates the fit of the distributions to the breaking stress of the carbon fibers data. The carbon fibers data is shown in Table 5.

Table 5: Breaking stress of Carbon fibers

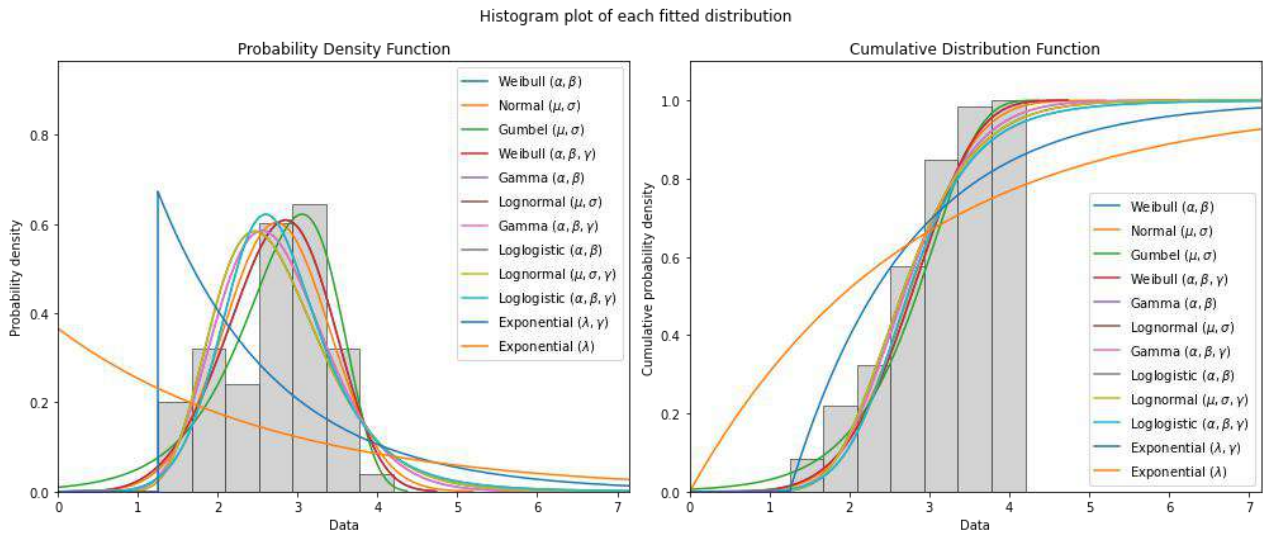|										
0.39	0.85	1.08	1.25	1.47	1.57	1.61	1.61	1.69	1.8	1.84
1.87	1.89	2.03	2.03	2.05	2.12	2.35	2.41	2.43	2.48	2.5
2.53	2.55	2.55	2.56	2.59	2.67	2.73	2.74	2.79	2.81	2.82
2.85	2.87	2.88	2.93	2.95	2.96	2.97	3.09	3.11	3.11	3.15
3.15	3.19	3.22	3.22	3.27	3.28	3.31	3.31	3.33	3.39	3.39
3.56	3.6	3.65	3.68	3.7	3.75	4.2	4.38	4.42	4.7	4.9

Fig.6: Histogram with each fitted distribution with the plots of its PDF and CDF.

Table 6: Comparison of the various distributions for the breaking stress of carbon fibers data

Distribution	Alpha	Beta	Gamma	Mu	Sigma	Lambda	Log-likelihood	AICc	BIC	AD
Weibull_2P	2.990	4.836					-58.2972	120.809	124.749	0.578
Normal_2P				2.736	0.661		-59.3269	122.868	126.809	0.771
Gumbel_2P				3.056	0.591		-59.9252	124.065	128.005	0.519
Weibull_3P	2.990	4.836	0.000				-58.2972	123.031	128.827	0.578
Gamma_2P	0.180	15.203					-61.4958	127.206	131.147	1.265
Lognormal_2P				0.973	0.268		-63.3661	130.946	134.887	1.595
Gamma_3P	0.180	15.203	0.000				-61.4958	129.428	135.224	1.265
Loglogistic_2P	2.723	6.619					-63.6408	131.496	135.437	1.192
Lognormal_3P			0.000	0.973	0.268		-63.3661	133.169	138.965	1.595
Loglogistic_3P	2.723	6.619	0.000				-63.6408	133.718	139.514	1.192
Exponential_2P			1.250			0.673	-82.3637	168.942	172.883	7.952
Exponential_1P						0.366	-118.378	238.827	240.834	15.551

Table 6 compares the distributions and the best distribution that best fit the breaking stress of the carbon fibers data after removing all observations that were 2-standard deviation away from the mean was the 2-parameter Weibull distribution. The comparison was done by using the AICc and BIC. From Fig.7, it can be observed that the probability plot of the 2-parameter Weibull distribution achieves a better result than the other distributions.

Probability plots of each fitted distribution
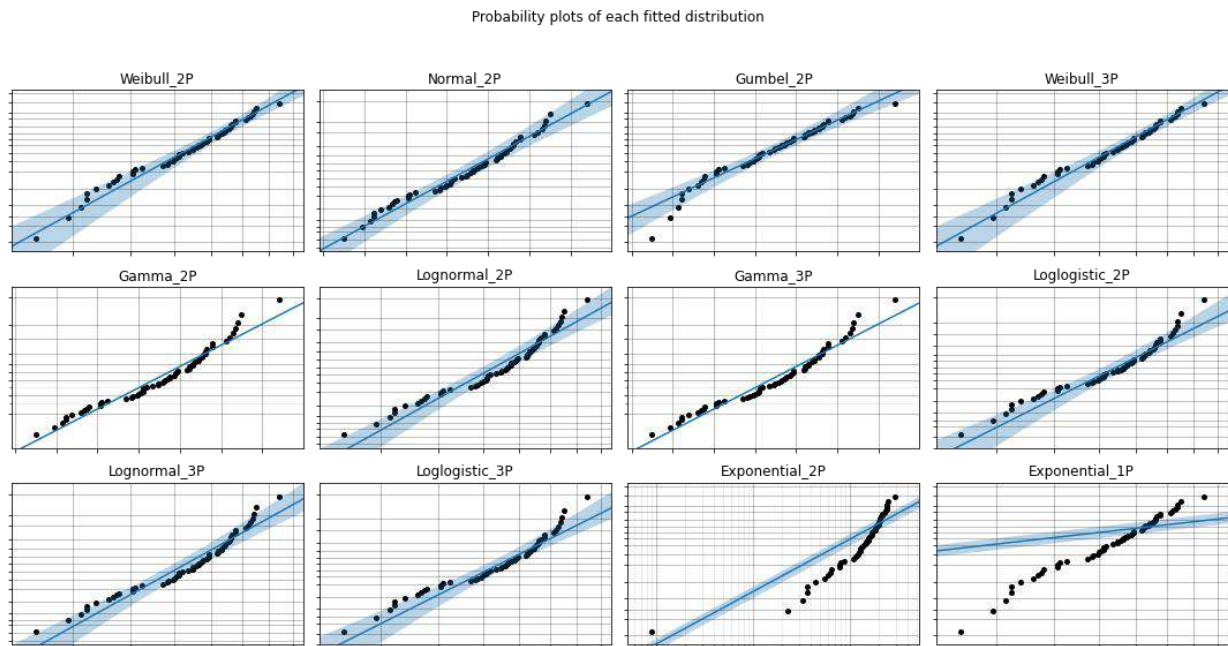
Fig.7: Probability plot of breaking stress of carbon fibers data for the various distributions.

We study the breaking stress of carbon fibers using the Weibull distribution to assess its reliability. We use the maximum likelihood estimation and the least-squares method to estimate the scale and shape parameter of the carbon fibers data, we compare these two methods using the AICc and the BIC. Table 7 presents the parameter estimate of the breaking stress of the carbon fibers using the 2-parameter Weibull distribution.

Table 7: Parameter estimate of the Weibull distribution for the breaking stress of carbon fibers

	Parameter	Point Estimate	Standard Error	Lower CI	Upper CI	Log-likelihood	AICc	BIC	AD
MLE	Alpha	2.99031	0.08466	2.8289	3.16093	-58.297	120.809	124.749	0.578
	Beta	4.83619	0.50136	3.94694	5.92579				
LS	Alpha	2.99167	0.08904	2.82214	3.17138	-58.436	121.086	125.027	0.547
	Beta	4.83619	0.50136	3.94694	5.92579				

Fig.8: Probability plot and the plot of the reliability function for the breaking stress of carbon fibers.

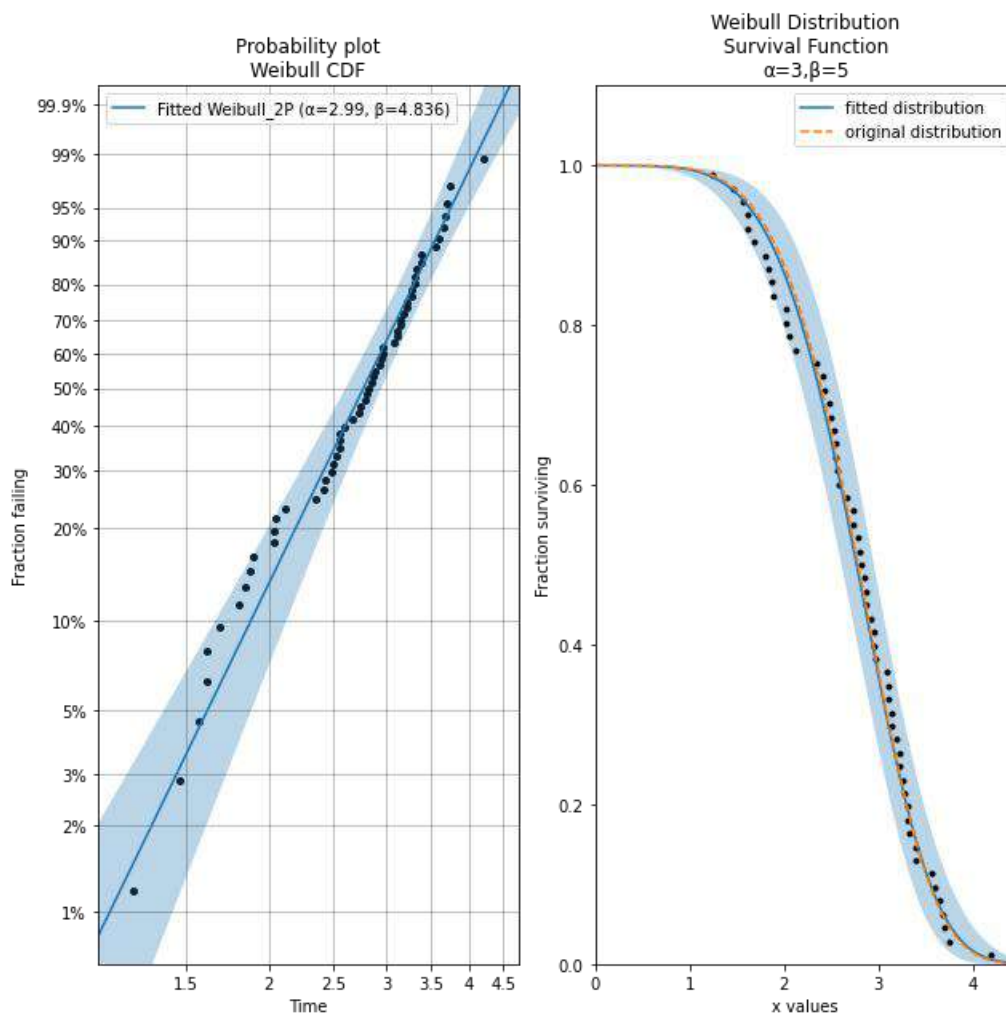The plot in Fig.8 gives the probability plot for the Weibull distribution and the reliability function for the breaking stress of the carbon fibers data. The maximum likelihood estimator gives the best estimate with an estimated shape parameter (4.836) which indicates that the rate of breaking stress increase as the stress time increases. The B10 life of the data was 2.77206 GPa which indicates that we expect 10% of the carbon fibers to break after obtaining breaking stress of 2.77206 GPa.

V.   CONCLUSION

The paper examines two approaches for estimating the parameters of the 2- parameter Weibull distribution. In this research, we compared two estimation methods using artificial data generated with Monte Carlo simulation and two real datasets. The research findings indicate that the maximum likelihood estimation method performs better than the least-squares approach.

In general, the Weibull distribution is very useful in many areas such as survival analysis, reliability analysis, etc. The estimation of the 2-parameter or 3-parameter Weibull distribution with or without censored data has gained much attention in these areas of study. In this paper, we compared the maximum likelihood estimation and the least-squares method, and by assessing the properties of the distribution and the estimates of the 2-parameter Weibull distribution using the goodness of fit measures. We observed that the maximum likelihood estimation performs better than the least-squares method and the ML estimator is asymptotically efficient as it converges in distribution as the sample size increases.

In order to investigate the application of the Weibull distribution in reliability analysis. We estimated the parameter of the Weibull distribution considering two different datasets using the MLE and LS and examined the failure rate of the datasets. The findings also indicate that the MLE performs better than the least-squares method.

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Influence of abutment transmucosal height on biomechanical behavior in narrow platform implants

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Abstract — The distribution and transfer of masticatory loads through prosthetic components, implants and peri-implant bone is a critical issue that can influence the rehabilitation treatment and result in its failure. Thus, this in silico study aimed to evaluate the influence of the transmucosal height of the prosthetic abutment and the diameter of the implants on the biomechanical behavior of dental implants. Two virtual models of 10 mm long Morse taper implants were built combining components with transmucosal (height 1.5 and 2.5 mm) in two diameters of platform (2.9 or 3.3 mm). Each set was positioned in a virtual bone model, where a lower central incisor was designed and exported for mathematical analysis. A 0.50 mm mesh was created after 5 % convergence analysis, and a 50 N load was applied to the incisolingual surface of the prosthetic crown at an angle of 30 °. The stress distribution generated by load was analyzed in the prosthetic components according to the von Mises stress criterion and in the cortical and medullary bones by means of shear stress. The use of an abutment with a 2.5 mm transmucosal height resulted in higher stress concentration values (758.86 and 731.63 MPa, 2.9x10 and 3.3x10 mm respectively) regardless of the diameter of the implant used. The increase in the diameter of the platform (3.3 mm) produced a slight reduction in the shear stress in the cortical bone. The medullary bone was not affected by the implant-pillar relationship. It was concluded that implants with a larger platform diameter and a higher transmucosal height decreased the stress concentration in the implant and in the cortical bone.

I. INTRODUCTION

The loss of a dental element impacts on aesthetics and self-esteem, decreasing the quality of life of patients (Kassebaum et al., 2014). It is in this context that implantology has enabled the replacement of lost teeth, through Osseo integrated implants, preserving the integrity of intraoral structures, in addition to recovering the aesthetics and functionality of the stomatognathic system (Gahlert et al., 2016). The need for planning for the

selection of implants involves several factors that must be considered, from clinical factors, as well as biomechanical fundamentals that affect the implant design and that should result in their success in various loading conditions, leading the professional to the best application of these requirements (Liu, 2018).

However, the use of implants in patients with alveolar ridges of limited dimensions, tooth agenesis and bone destruction resulting from periodontal disease or trauma is

still a challenge for the professional. However, the use of implants in patients with alveolar ridges of limited dimensions, tooth agenesis and bone destruction resulting from periodontal disease or trauma is still a challenge for the professional (Yaltirik et al., 2011). Thus, complementary surgical techniques such as bone grafting, maxillary sinus lifting, nerve repositioning and osteogenic distraction have been used and with predictable clinical results when properly indicated (Arora et al., 2015).

Due to the limitations of complementary surgical techniques, in recent years there has been a great advance in the development of osseointegrated dental implants, seeking to reduce the diameter of the platform, Ø < 3.75 mm. These implants were designed for restricted interdental spaces, in regions of lateral maxillary incisors and lower central and lateral incisors, without the need for the use of a complementary surgical technique or orthodontic movements, tending to be faster, with less morbidity, in addition to being less costly to treatment (Baggi et al., 2008).

These conditions are often found in the mandible, in the treatment to replace the lower incisors, which have limited space, due to the presence of teeth with the smallest cervical diameter of the arch and, generally crowded, with reduced prosthetic space (Klein, 2014).

As biological justifications, they suggested that the horizontal positioning of the implant/abutment interface farther away from the bone would show a greater surface area of the implant and would remove gap contamination from the alveolar bone, thus reducing the chance of marginal bone resorption of the peri-implant tissues (Romanos, 2014).

Previous studies with an average period of 19 months of loading have shown success rates, 96.66% comparable between treatment with reduced platform implants in areas of low bone volume with regular/conventional platform implants (Wu, 2016; Prasad, 2011).

The use of prosthetic intermediates in order to retain the crown depends on factors such as inter-occluded distance, distance from the implant to the teeth and/or neighboring implants, as well as gingival height (Shah, Lum, 2008). These factors will be paramount when selecting the intermediate height and width. Considering that reduced/narrow platform implants have less inferior bone-implant contact when compared to regular diameter implants, it is questioned what the influence of the height of the transmucosal in the distribution of stresses in the prosthetic components and peri-implant bone tissue is as it will be increased the proportion between crown and implant may affect the distribution of stresses (Bulaqi et al., 2015).

In vitro and finite element studies revealed that the stress values affecting the cortical bone are directly proportional to the dental implant platform, which means that especially small diameters result in stress peaks at the implant/bone interface. Thus, as a biological implication, inadequate implant overload possibly leads to peri-implant bone resorption, resulting in clinical complications and compromised treatment (Ryu, 2014).

Considering that there are still many doubts about the biomechanical performance of these implant systems with reduced platform, it is justified to carry out this laboratory analysis, in order to verify the possible distribution of stresses on abutments with 1.5 and 2.5 mm in height of transmucosal (distance from the top of the implant to the beginning of the prosthesis (distance between the top of the implant and the beginning of the prosthesis) and dissipation to the peri-implant tissue, with little report in the literature.

Therefore, the aim of this study is to evaluate the influence of transmucosal height on the biomechanical performance of prostheses on narrow-platform implants through finite element analysis.

II.   MATERIAL AND METHODS

This study was exempt from submission to the Research Ethics Committee of Faculdade São Leopoldo Mandic, as it is research that, individually or collectively, does not have as a participant the human being, in its entirety or parts of it, and involves it in a way direct or indirect, including the handling of your data, information or biological materials, Protocol number: 2019/0256.

1. Construction of Models

For the construction of the three-dimensional models, a CAD modeling software was used (SolidWorks 2013, Waltham, MA, USA). Two 10 mm long morse taper implants were created in two platform diameters (Ø): 2.9 ou Ø 3.3 mm. Thread parameters were based on commercial models, however without representing any specific manufacturer. All other dimensions and designs of the implant were identical, except for the platform diameter, which was one of the factors under study. Figure 1 illustrates the implant models.
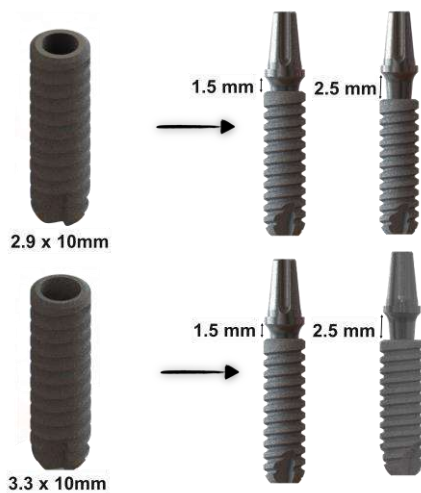
Fig. 1. Illustrates the composition of the four groups based on the combination of implants with a diameter of 2.9 or 3.3 connected to abutments with a transmucosal height of 1.5 or 2.5 mm.

Over these implants, "universal sleeve" pillars with transmucosal height of 1.5 or 2.5mm were positioned (Figure 1).

Thus, four models were obtained in which the independent variables of the study were implant diameter and transmucosal height; Ø 2.9 x 10 mm - 1.5 mm transmucosal; Ø 2.9 x 10 mm - transmucosal 2.5 mm; Ø 3.3 x 10 mm - 1.5 mm transmucosal; Ø 3.3 x 10 mm - transmucosal 2.5 mm (Figura 1).

To simulate a cemented lithium disilicate crown, a lawyer representing the cement, resin type cement (Ivoclar™) was created between the prosthetic crown and the abutment. Column surfaces that were converted followed by thickening of 50 µm thickness were selected. A solid prosthetic crown representing the mandibular central incisor belonging to a database was fitted over the cement surface. Using extrusion loft tools, adaptation of the cervical region was performed.

Both the crown and the cement were combined with each other using the subtraction tool, which created the internal space allowing the adaptation between crown-cement and abutment. illustrates the cement layer positioned on the surface of the pillar.

To create a bone model, an individualization of the peri-implant bone was performed in two pieces with the objective of simulating the cortical and medullary bone. The individualization of the bone model was performed since the area of interest for the study of tensions occurred in the implant-bone contact (periimplant bone). In the analysis steps, fixation measures were adopted, which

simulate the union of this peri-implant bone to a possible complete mandibular model.

Using the subtraction command, the external geometry of the implant was combined with the bone block, creating a "virtual surgical bed" where any interferences between bone-implant that could negatively interfere in the subsequent steps of analysis were eliminated. After placing the parts in the Solidworks assembly environment, the presence of interferences such as overlapping surfaces or gaps between parts was verified. Once detected, the occurrences were fixed in the modeling environment and reassembled. The models were exported to Ansys Workbench 14.0 software (to perform the mathematical analysis.

2. Math analysis

For the analysis it was necessary to create a three-dimensional mesh which divides the model into small portions called elements; each element is interconnected to another through us. For the present analysis, triangular elements of 0.50 mm were used as they are the ones that best adapt to curved surfaces.

To define the size of the element, a 5% convergence analysis was performed; this analysis consists of carrying out a load simulation with a hypothetical mesh, 1 mm for example; thus, the voltage value is computed and then the mesh is reduced (refined) to 0.90 mm elements and computed again. The difference between the first and second stress result is calculated.

Thus, successive refinements are carried out until a difference equal to or less than 5% is obtained between a mesh and the subsequent, more refined one. This indicates that continuing to refine (decreasing the element size) will not cause a significant difference in the stress values, it will only increase the number of elements, making the mathematical calculation more complex and requiring more processing resources. The number of nodes and elements obtained for each model are presented in the table 1.

Table 1 - Number of nodes and elements obtained for each model using a mesh of elements 0.50 mm in size.

	2.9 x 10 mm		3.3 x 10 mm	
	Transmucoso 1.5 mm	Transmucosal 2.5 mm	Transmucosal 1.5 mm	Transmucosal 2.5 mm
Nodes	57993	57700	61811	61392
Elements	32826	32655	35195	34924

For the fixation of the models, the external faces of the bone model were selected and the configuration of full constrain was used for the X, Y and Z axes. This type of constriction simulates the union of the individualized bone portion to a complete model. The inciso-lingual surface of

the prosthetic crown was selected for application of a 50 N load applied at 30° in relation to the long axis of the implant in the liguo-buccal direction intended for specific tests on implants and for being characterized as a scenario challenging for sets.

The present study was conducted using a homogeneous, isotropic and linearly elastic model. To characterize the mechanical behavior of the materials, each part was characterized using the modulus of elasticity and the Poison coefficient described in table 2. The data obtained were calculated and analyzed following the criteria of shear stress (MPa) for bone tissue and von-Mises stress (MPa) for abutments and implants.

Table 2 - Modulus of elasticity and Poisson's coefficient used to characterize the mechanical behavior of materials.

Material	Modulus of elasticity (MPa)	Poisson's Coefficient
Bone cortical	13.700	0.30
Medullary	1.370	0.30
Titanium	110.000	0.35
Lithium disilicate ceramic	91.000	0.23
Resin cement	18.300	0.30

III.   RESULTS

The data obtained are shown in table 3.

Table 3 - Shear stress values for bone tissue and von-Mises stress values for implants and abutments (MPa).

Groups	2.9x10mm		3.3x10mm	
	Group 1	Groupo 2	Groupo 3	Group 4
	Transmucosal 1.5mm	Transmucosal 2.5mm	Transmucosal 1.5mm	Transmucosal 2.5mm
Implant	515,28	381,11	335,89	309,04
Abutment	449,29	758,86	452,38	731,63
Cortical bone	33,15	29,63	22,64	21,02
Medullary bone	4,69	4,53	5,04	4,55

Regarding the behavior of tension in the cortical bone, the results of the present study demonstrated that the use of abutments with transmucosal 2.5 mm in height (Groups 2 and 4) resulted in lower values of tension in the cortical bone when compared to the use of abutments with transmucosal 1.5 mm (Groups 1 and 3) regardless of the diameter of the implants.

However, when comparing the same transmucosal height between different implant diameters, it can be observed that the use of implants with a diameter of 3.3 mm (Groups 3 and 4) resulted in lower values of tension in the cortical bone when compared to implants of diameter 2.9 mm (Groups 1 and 2) (Figure 2).
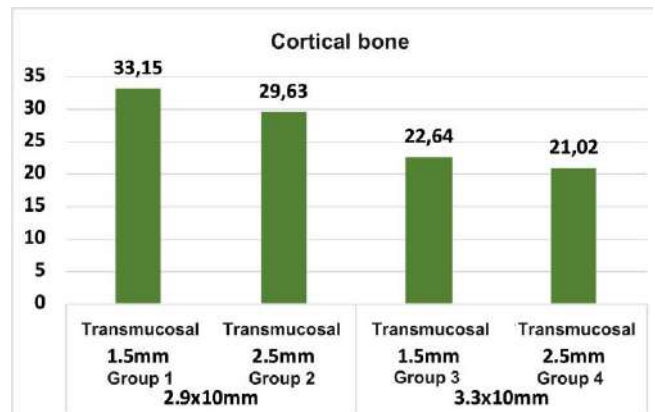
Fig. 2. Comparative graph of shear stress for cortical bone between groups.

Figure 3 qualitatively shows the peak stress concentration in the cortical bone, located in contact with the first threads of the implant in the cervical region. When using Ø 3.3 mm implants (Groups 3 and 4), a better stress distribution was observed when compared to Ø 2.9 mm implants (Groups 1 and 2) where a higher peak represented by the red color can be observed.

Fig. 3. Sectional view of the portion referring to the cortical bone. Warm colors (red/orange) indicate peak voltage concentrations.

Regarding the tension values in the medullary bone, a homogeneous distribution was observed between the groups, regardless of the implant diameter or height of the transmucosal pillar. Group 3 (Ø 3.3 x 10 mm - 1.5 mm transmucosal) had the highest tension value (5.04 MPa) while group 2 (Ø 2.9 x 10 mm - 2.5 mm transmucosal) had the lowest value (4.53 MPa) a slight difference of 0.51 MPa in voltage between these groups (Figure 4).

Fig. 4. Comparative graph of shear stress for the medullary bone between groups.

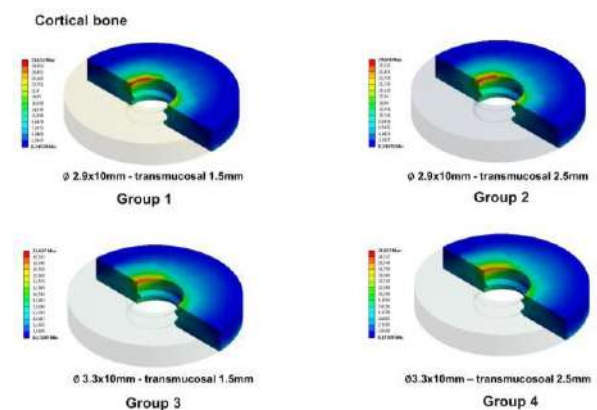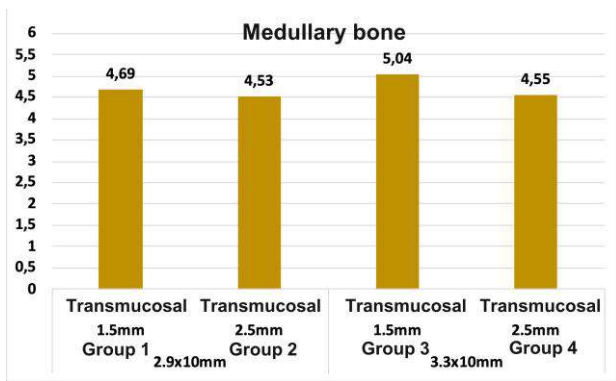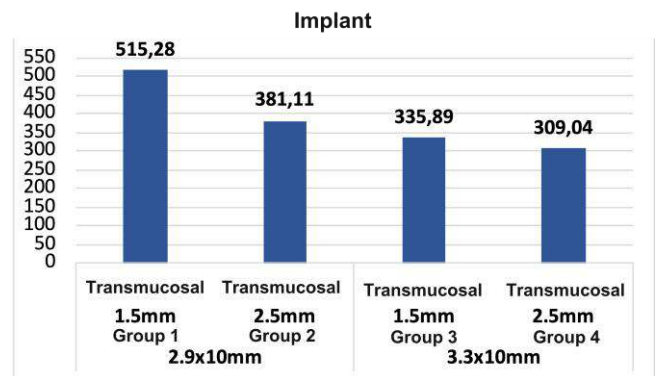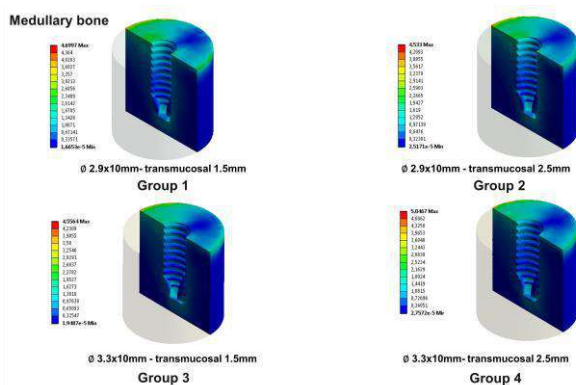*Fig. 6. Comparative graph of shear stress for the implant between groups.*

Fig. 5. Sectional view of the portion referring to the medullary bone. Warm colors (red/orange) indicate peak voltage concentrations.

Figure 7 demonstrates the maximum stress concentration peak in the implant located on the inner surface, close to the platform. A unilateral location of this peak was observed due to the direction of force application (lingual-vestibular) during the test.
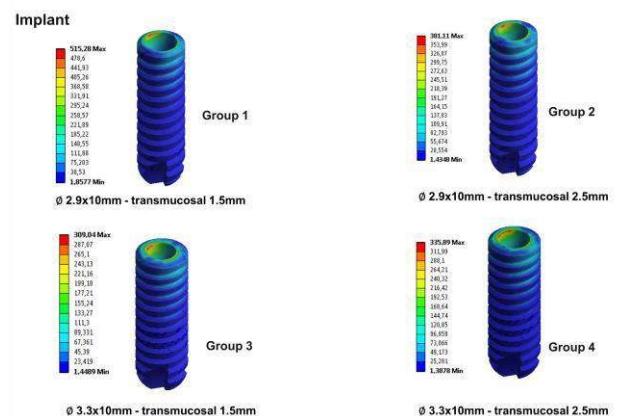
Fig.7: Peak von-Mises stress concentration located on the inner surface of the implant in contact with the abutment.

Regarding the von-Mises tension in the implant, a higher concentration can be observed when using implants with a smaller platform Ø 2.9 mm (Groups 1 and 2) compared to implants of Ø 3.3 mm (Groups 3 and 4), in which the group 1 (Ø 2.9 x 10 mm - transmucosal 1.5 mm) had the highest stress value (515.28 MPa).

The use of larger diameter implants (Ø 3.3 mm) as well as the use of 2.5 mm transmucosal abutments, group 4, contributed to the reduction of tension values in the abutments. Group 4 (Ø 3.3 x 10mm - transmucosal 2.5 mm) had the lowest stress concentration (309.04 MPa), indicating a difference of 206.24 MPa compared to group 1 (Ø 2.9 x 10 mm - transmucosal 1.5 mm) (515.28 MPa) (Figure 6).

Regarding the von-Mises tension values on the abutment, it can be observed that the height of the transmucosal exerted a greater influence on the increase in tensions than the diameter of the implant; the use of abutments with 2.5 mm transmucosal resulted in the highest concentration values (758.86 and 731.63 MPa) regardless of the diameter of the implant used. When comparing abutments with the same transmucosal height (1.5 mm, for example) associated with Ø 2.9 or Ø 3.3 mm implants, a slight reduction in tension can be observed when using implants with a diameter of Ø 3.3 mm. The same effect occurs for the pillars with transmucosal 2.5 mm in height (Figure 8).

Fig. 8. Comparative graph of von-Mises stress on columns.

The peak stress concentration in the abutments was located in the external region of the abutment, close to the region that is in contact with the platform, corroborating the location of maximum von-Mises stress in the implants (Figure 9).
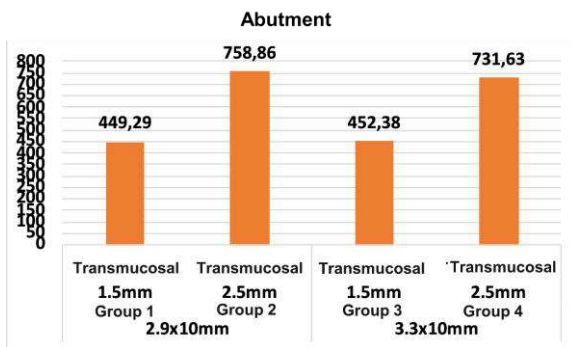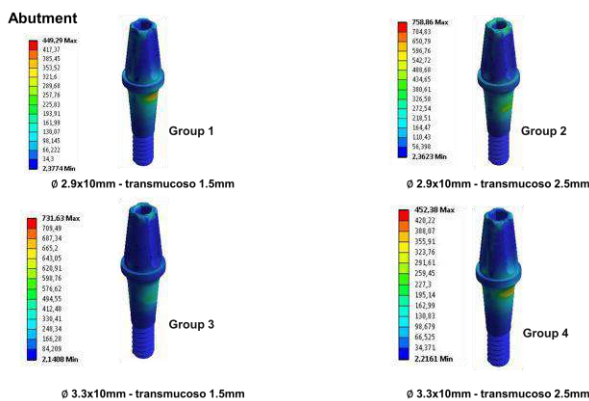

Fig. 9. Peak von-Mises tension concentration located on the external surface of the abutment in contact with the implant, close to the platform.

IV. DISCUSSION AND CONCLUSION

In recent decades, it is possible to observe an advance in implant dentistry, in an attempt to minimize the loads generated during mastication and transmitted directly to the surrounding bone, which can cause microfractures at the interface between the bone-implant, fracture of the implant and loosening of the components in the system of implant (Shemtov-Yona, Rittel, 2015).

Such responses can be triggered by microdamage to bone tissue as a direct consequence of the applied loads and point out that the height of the transmucosal can play a role in the equivalent tension in the bones. However, the scientific literature shows few studies that relate, based on biomechanical considerations, the maximum height of the transmucosal and the minimum tension generated in

different platform diameters (Schwarz, 2000; Wang et al., 2016).

Thus, the results of the three-dimensional finite element analysis, considering the limitations inherent in the present study, it is reasonable to conclude that the implant with greater transmucosal height and greater platform diameter showed significantly better dissipation of stresses in the implant and cortical bone tissue, suggesting that it is less susceptible to mechanical failure such as loosening and/or fracture.

Studies have found that placing the morse cone implant platform at the infraosseous level helps maintain the peri-implant bone crest, as well as the surrounding soft tissues, which may favor the maintenance and/or formation of gingival papillae, and enable better prosthetic resolution, resulting from sealing biologic of the interface area between the implant and the prosthetic abutment (Koutouzis et al., 2013; Macedo et al., 2016).

However, this positioning of the implants subcrystal can compromise the distribution of stresses, that is, the insertion of these implants at different bone levels, in relation to the bone crest, can influence the distribution and magnitude of stresses (Toniollo et al., 2012). This is because the variation that should exist in the transmucosal height of the prosthetic abutment, in order to compensate for the unevenness generated by the different depths at which the implants are positioned, can directly influence the distribution of stresses to the peri-implant tissues and bone loss (Bordin et al., 2019).

Thus, to accurately simulate the influence of transmucosal height on the actual behavior of the implant-abutment-prosthesis complex, providing data on biomechanical performance, such as stress analysis through computational modeling, the method was established in this study of finite elements, FEM, to make possible the analysis and solution of complex problems encountered in the treatment of patients with compromised dentition (Geng et al., 2001; Geng et al., 2004).

Regarding the shear stress in the cortical bone, it was observed that the diameter of the implant was more significant in relation to the height of the transmucosal. This is because the increase in the diameter of the implant provides a greater contact area between the implant-bone tissue, decreasing the stress concentration values. This finding is supported by studies that indicate that the corticalization range in the cervical region of the implant is extremely important for an adequate stress distribution (Chu et al., 2011; Macedo et al., 2018).

About the medullary bone, there was no significant difference between the groups, regardless of the implant diameter or transmucosal height, as most of these flaws

affect the cervical bone region, more specifically concentrated in the first threads of the implant. Since the cortical bone, because it has a lower elastic modulus than the trabecular bone, absorbs more tensions generated by the incident forces, which, in turn, are concentrated in the cervical region and in the surrounding bone, regardless of bone quality (Kitamura et al., 2004).

When evaluating the von-Mises stresses generated on implants, it was observed that groups 3 and 4, with a larger implant diameter, presented the most favorable stress distribution compared to groups 1 and 2 with a smaller implant diameter. This fact can be attributed to the increase in the diameter of the cervical area, generating a reinforcement region, that is, there is an increase in the platform wall, making it wider, stronger, resistant, which provides the dissipation of tension and consequently minimizes peak concentration (Canay, Akça, 2009; Schrotenboer et al., 2009).

Once this tension is relieved in the implant, there was an increase in the transmucosal region of the prosthetic abutments, close to the implant platform, at the implant-prosthetic abutment interface, as shown in the literature. Thus, it is suggested that the increase in transmucosal height provides a difference in the lever arm and sequentially increases the applied tension (Borie et al., 2018).

Another typical example of biomechanical complication occurs in short implants, where the misfit in the crown-implant ratio, under oblique forces contributes to the accumulation of tension in the prosthetic components and in the adjacent bone tissue, through the mechanism of operation of a lever (Quaranta et al., 2014, Moraes et al., 2015).

Therefore, it is possible to affirm that the clinical success of rehabilitations with implants is closely related to the way in which stresses are transferred from the implant to the surrounding bone, with minimal or even the absence of stresses that compromise the longevity of implants and implant-supported prostheses. This justifies the importance of performing mechanical and biomechanical tests aimed at analyzing and evaluating the behavior of implants and prostheses in a region that suffers great masticatory efforts.

It is concluded that a Morse Cone implant with larger platform diameter and greater transmucosal height of the prosthetic pillar presented better biomechanical performance in the implant and in the cortical bone.

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The Impacts Related to Labor Reform in the Civil Construction Segment

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Abstract—The labor legislation today serves to guide employers and employees to fulfill their duties and help them to understand their rights. With the changes, we can analyze the impact that legislation can have on certain segments, with this research being focused on the elaboration aimed at the civil construction segment. Therefore, the objective of this article is to demonstrate the impacts related to the reform in labor processes in the civil construction segment. The approach to the specific objectives was divided as follows: a) Conduct a survey with a company in the civil construction sector of the main labor processes in the 2017 period; and b) Present the impacts caused by the labor reform in these processes. The research is characterized as bibliographical, conducting a survey through a documentary format, in a descriptive way and developing qualitative analyses. Through the last labor reform, there was greater flexibility in agreements between the parties, that is, between employers and employees, bringing the power of choice with greater relevance taking into account the benefit of both parties according to the style of signed contract, being an employment relationship or via a simple service provision contract.

I. INTRODUCTION

Labor laws have been discussed since 1930 during the Getúlio Vargas government, which significantly advanced with the struggles and social movements of the working classes, putting pressure on the State to mediate the interests to which it was being approached (LUZ and SANTIN, 2010).

Over time, labor laws underwent changes and reforms, during the government of Fernando Henrique Cardoso (FHC) in 1994. According to Krein (p. 270, 2004) "*several specific measures were introduced in the field of labor relations that contributed to change the way of hiring and determining the use and remuneration of work in Brazil, stimulating a numerical and functional flexibilization of the labor market*". The last significant

change in legislation initiated in Brazil was the Temer government in 2017, thus bringing the new labor reform.

With the shift from the 20th century to the 21st century, changes were necessary for the elaboration of norms and laws, being thus modified for better understanding and better application, since technology and society are subject to transformations and by defenses of political debates for adjustments and flexibilities to the work, regulating the transformations according to Krein (2017). The Federal Senate (2018) approved the Labor Reform on July 11, 2017, being published by the Federal Official Gazette on July 14, 2017, which started counting 120 days according to Article 6 of Law 13,467. On November 11, 2017, the new Labor Reform came into force, changing some points to which entrepreneurs from small, medium and large companies are involved in the reform, reassessing their duties and application rights based on the changes that have occurred.

Because there are a high number of employees registered with construction companies, and people who look for these entities, it is also known that many labor problems can occur in connection with these contractors. As shown by Anjos and Leite (2013), this growth demonstrates the size and reality of industries and how much they are capable of influencing not only the economy, but the environment and society in general. Due to the aforementioned growth, the importance of this study is clear, as we will be able to analyze the impacts and changes of the labor reform, which will be clear to a long-term process, since the changes and changes in some sectors will be in new contracts signed to from the effective date of the law.

Through this reform, we seek to analyze the impacts that it can bring on labor processes, seeking, raising cases and reasons for origins and grounds that are taking place in forums linked to the civil construction sector.

The theme becomes interesting and relevant for businessmen, human resources sectors, personnel department, accountants, advisors in the labor areas and especially for workers who seek guidance, rights and impact analysis on labor reform, as it has divided opinions regarding advantages and disadvantages with the new changes.

With this in mind, the general objective of this work is to demonstrate the impacts related to the reform in labor processes in the civil construction segment; as specific objectives: a) carry out a survey with a company in the civil construction segment of the main labor lawsuits in the 2017 period; and b) present the impacts caused by the labor reform in these processes.

The article is divided into four more sections, in addition to this Introduction. In session 2 the theoretical framework is presented, in session 3 the method is found, and in sessions 4 and 5, the data analysis and conclusion, respectively.

II.   THEORETICAL REFERENCE

From the Industrial Revolution onwards, there was an advance in different professions, one of them being civil construction, which began to grow much more in 1930 during the Getúlio Vargas era. Moura and Soares Jr (2013) state that civil construction evolves according to society in relation to the elements, and concrete technology has advanced in Brazil.

With the establishment and emergence of the Industrial Revolution, extremely high values of labor were demanded, amidst the growth of industries, where the conditions of workers were precarious, with a proliferation of infectious and contagious diseases, mutilations and even death in factories (CRUZ, FERLA and LEMOS, 2018).

The work situation was not improving, as employees exceeded their 8-hour workload, which is currently allowed under the labor law. Women and children found themselves in work areas, performing their duties for more than 18 hours a day, being exposed to unhealthy environments, devoid of sanitized environments and being paid with amounts in half reserved for men (NUNES, 2009).

With the establishment of the CLT, the objective of the entire consolidation can be seen in "Art. 1° - This consolidation establishes the norms that regulate the individual and collective work relations, foreseen in it.".

As the years went by, the 1990s were ruled by Fernando Henrique Cardoso, marked by transformations in the Brazilian economy (COSTA, 2003), which automatically reached the strategies and brought changes in companies, affecting workers. There were two major political changes affecting the labor market: (COSTA, 2005) the flexibilization of work systems and the flexibilization/deregulation of the national legislative system for labor protection.

There are two great sociologists who have significant references in relation to work, they are Émile Durkheim (1858-1917) and Karl Marx (1818-1883) bringing definitions of work in general and relating the thoughts of both sociologists, who long ago also they were marked by the development of the work-oriented society. (WEISS and BENTHIEN, 2017; DONÁRIO and SANTOS, 2016).

According to Colmán and Pola (2009) "Marx characterizes work as an interaction between man and the natural world, in such a way that the elements of the latter are consciously modified to achieve a certain purpose. Work is the way in which man appropriates nature in order to satisfy his needs."

For Émile Durkheim, the social division of labor is directly linked to the evolution of a society, because from this evolution there was social differentiation, thus predominating an organic solidarity, defined as a solidary society where the union of individuals is attributed to the social division of labor. This type of solidarity is generated as a result of social differences, which generates union in individuals through the need generated by the exchange of services. Society is the point where human behavior affects the process of social evolution (CAETANO, 2014).

Analyzing the two authors, it is clearly understood the exploitation and precariousness of work directly and indirectly linked to the conditions of a capitalist and fragmented society, not defining what is said to be right or wrong in their convictions, taking into account the factors studied in their times and current society (SILVA, JUSTINO and SCHENATO, 2015). From this point onwards, there is a need, over time, for a labor reform, as society goes through several transformations as a result of time.

With the last Labor Reform of 2017 being Law 13,467, the main changes that have taken place in the legislation can be identified: time at the employer's disposal - change of uniform, fine due by the employer - non-registered employees, extinction of *in intinere* hours , work part-time, bank and hour compensation, rest and meal breaks, vacation split, pregnant and lactating employees versus unhealthy environment, greater freedom to negotiate the employment contract, creation and regulation of intermittent work, change in employee dismissal, creation and regulation of the termination of the employment contract by agreement between the parties, outsourcing.

As an example, we point out the outsourcing that was approved by the Federal Court of Justice - TJF with a vote of 7 votes in favor and 4 against, the outsourcing of any type of activity, including the final activities published by Estadão (2018).

III.   METHOD

For the preparation of this work, the method is essential for conclusion, because method is a way that a certain procedure will be applied to carry out the research and development of the same, reaching the related knowledge, which according to Pradonov and Freitas (2013), research means seeking answers to proposed questions.

The methods used for the elaboration of the research are emphasized in a bibliographical research, through materials reached that approached the subject, being articles, books, laws, specific theoretical materials in order to reach an answer to the problem.

This research was also classified as a documentary research through materials that received an analytical treatment (GIL, 2011), together with descriptive research, collecting, describing and analyzing information through labor processes to relate the impacts of labor reform in the construction segment civil.

Also observing what Gil (2011, p.28) mentioned, "*descriptive research has as its primary objective the description of the characteristics of a given population or phenomenon or the establishment of a relationship between variables*".

Analysis and interpretation have the objective of organizing the information so as to arise results and answers to the research problem, thus being able to establish categories, analyzing conditions that led to the filters of data collected through documents. The work will be involved in qualitative analysis through surveys that addressed and presented results that match the theme and objectives of the work developed. Qualitative analyzes according to Gil (2011, p. 175) are directly related to surveys in which the analytical procedures can be defined in advance, thus concluding with accurate information obtained in the research through the design of the methodology.

The table below was developed for a better understanding of what was done during the research, bringing greater understanding to each step taken in the methodology.

Table 1 - PreparationofMethodology

Step by step Methodology	
Orders	**Description**
Step1	A survey of documents related to labor lawsuits was carried out in two companies with the segment focused on civil construction. Becomingandcharacterizingitself as a documentaryresearch.
Step2	Conducting a bibliographic research, seeking content in several articles, books and laws to support researchaimed at labor reform.
Step3	Carrying out a qualitative analysis, evaluating each report, minutes and describing the 3 labor processes found to then make the most of quality information, making the research more relevant.
Step4	Development of a descriptive research through the analysis of each labor process, describing the possible situations in each labor request in the processes, according to the last labor reform.

Source: Prepared by the authors, 2019.

IV. DESCRIPTION AND ANALYSIS OF THE DATA COLLECTED

4.1 - Description of Process 1

Based on the analysis carried out in Process 1, the plaintiff was hired as an office assistant, being remunerated for R$931.00 (Nine hundred and thirty-one reais), admitted on 08/04/2014 and terminated on 26/02/2015. It can be observed that the plaintiff claimed in the labor process the following correspondents, namely: deviation of function, danger, IN NATURA salary, termination of employment contract, working hours and breaks during work shifts.

According to the field research, it was evident that when large quantities of concrete are produced, a concrete laboratory is needed that will analyze whether the concrete manufactured and supplied by the company has reached the necessary strength to which the consumer requested, removing small portions of concrete, called "test body". Usually in these laboratories the presence of some of these professionals is required: civil engineer, laboratory technician, building technician, and others trained in the area. The plaintiff, when he alleged the deviation of function in his petition, referred that he performed services in concrete laboratories, since the company he worked for existed the concreting activity, and he was a contract for the performance of an office assistant.

However, in his speech, he confirmed that there was a building technician in the company and the engineer responsible for the quality analysis of the concrete produced. Therefore, there were people qualified to perform the function of laboratory technician and the defendant, using this information in reverse to try to benefit from the request for deviation of function, ended up losing when the judge ruled as groundless the request. Following the second request, being the danger, as he did not perform the function of a laboratory worker that exposed the performance of agents harmful to health, the request was rejected.

Following the analysis carried out in the process, the IN NATURA salary request was dismissed, since the worker's food supply was offered to enable the provision of services and not be added to remuneration purposes.

There is no compensation in the termination modality of the employment contract, as proven, it was the plaintiff who expressed interest in terminating the employment agreement and proved that his other requests are deemed unfounded. According to Art. 483 of the CLT:

Art. 483 - The employee may consider the contract terminated and claim due compensation when:

a) services superior to their strength are required, protected by law, contrary to good customs, or outside the contract;

b) is treated by the employer or his superiors with excessive rigor;

c) be in manifest danger of considerable harm;

d) the employer does not fulfill the obligations of the contract;

e) perform the employer or his agents, against him or people of his family, an act harmful to honor and good reputation;

f) the employer or its agents offends him physically, except in the case of self-defense, self-defense or that of others;

g) the employer reduces his work, being this by piece or task, in order to significantly affect the importance of wages.

And as there were none of these aspects both on the part of the employee and on the part of the employer, the judge dismissed the request for termination of the employment contract.

In the request for the working day, the plaintiff claimed to work overtime, which was not proven in his time sheet developed by the plaintiff and presented by the defendant's defense, thus the request being rejected.

On the other hand, when requesting an intraday break, the author had a 30-minute break for rest and food. Thus, according to Art. 71 of the CLT, which by law the employee is entitled to at least 1 hour of rest and food, with this the request was granted, as it was proven in the timesheet of the same.

4.2 - Description of Process 2

Based on the analysis carried out in Process 2, the author was hired as a construction worker, being remunerated respectively in the hiring periods in 2 companies of the same economic group, being admitted on the dates according to the table:

Table 2 - Admission and Remuneration Date

Admission Date	Wage
02/04/2013	R$ 850,00
02/05/2014	R$ 880,00
08/06/2015	R$ 931,00
09/05/2016	R$ 1.008,00

Source: Prepared by the authors, 2019.

When entering the labor process, the plaintiff claimed the following requests: overtime, unhealthy conditions, work break, salary difference, prior notice, +1/3 vacation and fine for non-compliance with the collective agreement.

Analyzing the processes, minutes and expert reports, the overtime request that the employee requested was dismissed by the judge, as it was proven through the control of the timesheet filled in by the plaintiff himself, not consistent with his request.

Referring to unhealthy conditions, according to expert reports, the plaintiff was not exposed to unhealthy environments as it did not include risks to his health and involvement with chemical agents. Accordingto Art. 194 ofthe CLT:

"Art. 194 - The employee's right to the unhealthy or hazardous work premium shall cease with the elimination of the risk to his health or physical integrity, pursuant to this Section and the rules issued by the Ministry of Labor." (CLT, 2017, p.40).

The labor claim for unhealthy conditions was rejected since there was no type of risk to his health in accordance with Art. 194 mentioned. The plaintiff also claimed that he had never received the Personal Protective Equipment (PPE's), but it was proven by the defendant's defense that he received it and proving through the PPE delivery forms.

There was a request for payment for the break during work hours, as the defendant claimed that he did not comply with the minimum 1 hour rest period provided for by law. After analyzing the documents and time sheets by the lawyers and judge, the request was considered groundless, since the time determined by law for rest and food was proven through the time sheets.

In the salary difference requirement, the defendant's defense demonstrates that he was paid below the amount in accordance with the Collective Labor Convention - CCT, implying that the employee was paid below what was stipulated by the convention. Thus, it was analyzed and proved that the construction company followed the collective civil construction conventions and paid the salary as stipulated by the convention, and the request for a difference in salary was dismissed.

Of the legal natures, the sums granted by the judge are: prior notice, vacation plus 1/3 of the monthly remuneration and fine for non-compliance with the collective agreement that were in accordance with the plaintiff's requests.

4.3 – Description of Process 3

Based on the analysis of Process 3, the plaintiff was hired in 2014, 2015 and 2016 by companies from the same economic group, as a compactor roller operator.

The plaintiff filed a labor lawsuit in 2017 requesting the payment of prior notice, vacation + 1/3, FGTS and overtime difference.

Analyzing the available hearing minutes regarding the labor process, it was proven through the score sheets signed by the employee that there was no overtime difference, even though the time filled was British, and for this reason it was dismissed by the judge, since the employee contradicts itself in its request.

When the employee was informed through the notice that his employment relationship would be terminated by the employer, he was not paid by the same as right, and the payment of the prior notice for the 3 years (2014, 2015 and 2016) was thus granted by the judge.

In 2014, in addition to the payment of the notice mentioned above, there was approval by the judge regarding the +1/3 vacation and the payment of the FGTS. In the period that the employee was dismissing, he

had not completed 1 year of the contract, and with that the employer, in the termination term, should pay the proportional vacation plus the proportional 1/3 vacation related to the prior notice and the severance pay of the Severance Indemnity Fund for Employees (FGTS). Being thus judged as founded by the judge.

4.4 – Result Discussions

According to the analyzes carried out in the labor lawsuits discussed in the previous items, we carried out an analysis of the impacts they would have under the new labor reform in the civil construction segment, which

brought changes and would be sentenced by the judge otherwise.

4.4.1 - Process Analysis 1

There are several requests that were requested by the employee to the judge that there would be possibilities of change if requested at the time of approval of the new labor reform. For a better understanding, a checklist was carried out followed by the following tables to improve the analysis between the requests and the possible impact that occurred with the new reform.

Table 3 - ProcessAnalysis1

Process1			
Item	Requests	BeforeRenovation	AfterRenovation
A	Deviation of function	Unfounded	Unfounded
B	Periculosidade	Unfounded	Unfounded
C	Salário IN NATURA	Unfounded	Unfounded
D	Modalidade Rescisória do Contrato de Trabalho	Unfounded	Unfounded
E	Jornada de Trabalho	Unfounded	Depends
F	Intervalo Intrajornada	Proceeding	Depends

Source: Prepared by the authors, 2019.

In Process 1, the request for deviation of function (item A) after the labor reform would remain unfounded if the employee continued in a registered form, and if it was agreed between the parties in writing through an employment contract, there would be no tools to file that request. In the case of requests for hazardous work, IN NATURA salary and termination of the employment contract (item B, C, and D), it would also remain unfounded after the reform, as they would be issues analyzed if there was a record in the work card and there were no changes in the law in the respective requests, on the contrary, if there was a simple employment contract for the provision of services, the employee would not be entitled to benefits.

Now, in relation to requests for working hours (item E) and work breaks (item F), after the reform, it will depend on the contract signed in writing between the employee and the employer, since today it has as an aid to the compensation of hour banks, and the employer and

the employee having the freedom to choose and sign what is best for both parties.

So, in relation to Process 1, many of the requests will depend on the style of bond between the employee and the employer, being registered via work card or just through simple service contracts, signed by both parties, being governed, for example, by Article 442-B of Law 13,467/2017:

"Art. 442-B. Hiring the self-employed person, having fulfilled all legal formalities, with or without exclusivity, continuously or not, removes the quality of employee provided for in art. 3rd of this Consolidation."

4.4.2 - Process Analysis 2

Analyzing Process 2, we can verify requests by the defendant that could or could not be granted by the judge after the labor reform, but it would depend on the situation and the relationship of that employee with the company. So we can look at it item by item, followed by the chart below.

Table 4 – Process2Analysis

Process2			
Item	Requestes	BeforeRenovation	AfterRenovation
A	Overtime	Unfounded	Depends

B	Unhealthy	Unfounded	Improcedente
C	Intraday break	Unfounded	Depends
D	Wage gap	Unfounded	Depends
E	Earlywarning	Proceeding	Depends
F	Vacation + 1/3	Proceeding	Depends
G	Fine for Non-compliance with the Collective Agreement	Proceeding	Depends

Source: Prepared by the authors, 2019.

Regarding the table above, referring to Process 2, it can be analyzed that of all the requests, the only one that would remain unchanged and would continue to be rejected by the judge is the unhealthy claim (item B), as there were no changes after the reform, except for pregnant women who work in unhealthy environments and need medical authorization to continue their activities.

In the case of requests for overtime and work breaks (item A and C), they would depend on the situation and what is signed, being via contract or registration in the portfolio, because after the reform, even the employee being registered in the portfolio, there may be written agreements between the employee and the employer, and changes may occur at any time in the contract between the parties. As an example, an employee in the role of a servant, who works in the civil construction segment, is registered via a work card and works 8 hours a day. Suddenly he started working 9 hours a day Monday to Friday for 2 weeks. Totaling 10 overtime hours worked in the working month. The employer decides to make the following agreement with the employee: pay 2 overtime hours and 1 day off during the week to compensate for the overtime worked.

The salary difference item (item D) will depend on the employment contract established with the employer, whether or not the employee is registered. The salary issue will also depend on the collective agreement that defends the segment of the area, if the employee is registered in a work card, the value of his/her remuneration cannot be lower than what was stipulated by the agreement, nor decrease the initial value of the first registration over time. In the case of an employment contract, if an amount is paid much higher than what the agreement stipulated and the employer chooses to reduce it to the minimum required by the agreement, the employer can perform this procedure supported by law. According to Art.611 of the CLT, the relationship of unions with the economic categories of a certain segment of work is in force and demonstrated by law:

"Art. 611. Collective Labor Agreement is an agreement of a normative nature, by which two or more Unions representing economic and professional categories stipulate working conditions applicable, within the scope of their respective representations, to individual labor relations."

In item E of prior notice request, it will depend on the situation, after the reform, what changed is that the employee cannot take their vacation without being aware of whether they will receive prior notice or not, as no surprises are accepted after the reform. for both parties. When this employee returns from vacation, he cannot be dismissed immediately, as the employer must give at least 30 days' notice, and the employee cannot go to work in another company without paying all the charges by law, falling to the ground the hiring letter, because just as the employer needs to announce it in advance, the employee also needs it, according to Art.487 of the CLT. So, in relation to Process 2, it would depend on the employee's situation so that the judge can dismiss or not after the labor reform.

Assuming an example, an employee who is working in a company and has 2 years of employment with a registered work card. The employer decides to give prior notice and communicates it to the employee. According to the law, this worker must fulfill the 30 days referring to his 12 months of contract and the equivalent of 3 more days per year worked. Since he had worked for a 2-year contract with the company, the employee would have to comply with his 33 days of notice and be paid for the time worked. If the employer does not give notice, the employee is entitled to wages corresponding to this time.

Now, if the employee decides to work at another company, he should notify the employer 30 days in advance to comply with the notice, since the rule works for both parties. If the employee fails to give notice as a result of starting to work at another company, the employer may deduct the wages corresponding to this period.

And in the last two requests (item F and G) of vacation + 1/3 and fine for non-compliance with the

collective agreement, after the reform it would also depend on the situation whether the employee has a relationship through registration in the work card or through a simple contract of service provision. In these situations of requests, if the employer has an employment relationship via a work card, he will receive it and the judge would judge as well founded, now if it is only a service provision contract, he will not receive any type of remuneration and the judge would dismiss the request as unfounded.

4.4.3 - Process Analysis 3

And as an aid to the analysis of the last process, a list was drawn up of what the situation would be like before and after the labor reform, for better understanding, exposure and presentation of the results.

Table 5 - ProcessAnalysis3

Processo 3			
Item	Requests	BeforeRenovation	AfterRenovation
A	Aviso Prévio	Proceeding	Depends
B	Férias + 1/3	Proceeding	Depends
C	FGTS	Proceeding	Depends
D	Horas Extras	Unfounded	Depends

Source: Prepared by the authors, 2019.

In relation to Process 3, in the first prior notice request (item A), it would be the same situation described in the previous process. It will depend on the situation, after the reform, what has changed is that the employee cannot take his vacation without being aware of whether he will be notified or not, as after the reform, no surprises are accepted for both parties. When this employee returns from vacation, he cannot be dismissed immediately, as the employer must give at least 30 days' notice, and the employee cannot go to work in another company without paying all the charges by law, falling to the ground the hiring letter, because just as the employer needs to announce it in advance, the employee also needs it, according to Art.487 of the CLT.

Vacation + 1/3 and FGTS charges (item B and C) will depend on the situation if the employee is registered through a work card or if a simple contract is signed by both parties. Because if an employment contract is signed, the employer is not entitled to vacation + 1/3 and FGTS is not collected.

Using as a model, an employee who has been registered and has an employment relationship via a work card, has been in the company for 1 year and 5 months and has not yet taken advantage of his vacation period + 1/3

that he has a right supported by law. The same is waived and starts to comply with the prior notice. When the employer is to pay all the benefits to which the employee is entitled, vacation + 1/3 will have to be paid proportionally to the period of 1 year and 5 months, referring to the time the employee provided his services for the given entity. In the case of only one service contract signed, the employee does not have the right to vacation + 1/3 and the FGTS charges.

Regarding the last request for overtime (item D), it will depend on what was agreed (always in writing) between the employee and the employer, whether it is a simple contract or employment relationship, entering the compensation of hours in the case of overtime, may be paid or not. According to Law 13,647/2017, the compensation of hours or the payment of overtime is governed by the article and paragraph below:

"Art. 59. The daily duration of work may be increased by overtime, in a number not exceeding two, by individual agreement, collective agreement or collective bargaining agreement."

"§ 6 The working hours compensation regime established by individual, tacit or written agreement, for compensation in the same month is lawful."

For example, an employee via a simple service provision contract who has a contract to provide their services on Monday, Wednesday and Friday for 8 hours/day. Suddenly on Monday this employee worked 2 extra hours. He can be paid, or compensated, for these hours on Wednesday by working just 6 hours. But these decisions must be agreed upon by both parties.

V.   CONCLUSION

The purpose of this research was to evaluate the impact of the labor reform in the civil construction segment, analyzing several processes that would provide us with guidance for carrying out the analyzes and demonstrating the impact it would have after the reform. Given all that was developed in the research, the general objective was to demonstrate the impacts related to the reform in labor processes in the civil construction segment, this was achieved through 3 labor processes that were analyzed and presented the possible impacts of each of the court requests in which the defendants filed actions.

In pursuit of the specific objectives, namely: carrying out a survey with a company in the civil construction sector of the main labor lawsuits in the 2017 period and presenting the impacts of the labor reform on these same processes. They were achieved, demonstrated and described, based on possible events, depending on the

links between employers and employees and the situations in which they were developed, carried out and agreed upon by both parties.

It can be observed that after the labor reform, there was greater flexibility between companies and employees in terms of hiring, both through a work contract and through an employment relationship through a work card.

O maior impacto da reforma nestes processos trabalhistas está em decorrência do modelo de contrato firmado entre as partes. Nas análises dos 3 processos trabalhistas, se o contrato de trabalho estiver atrelado no mesmo modelo, o impacto dentro dos processos não acontecerão substancialmente. Este resultado porque, dependeria da situação do contrato firmado entre as parte. Caso o empregado, esteja sob a nova reforma, a partir da lei 13.467/2017, e não mudar o estilo de contrato de trabalho não haverá nenhum tipo de benefício ou malefício (dependendo do ponto de vista de quem estará analisando).

The research showed us that after the labor reform, labor lawsuits tend to decrease precisely because of this accessibility of agreement between the parties. Both the company and the employees will have to analyze very well before, with their lawyers, to file labor lawsuits, since after the labor reform in Art. 790-B explains that the costs of fees and expenses of the lawsuits will be paid by the one who miss the action.

This research was initially limited to the access to information we had for the preparation of each analysis carried out in labor processes, as there were limitations to access each process.

This work also had a bias towards the accounting part and not the law, as it has the function of assisting and demonstrating the impacts for the accounting sectors helping to help with accounting advice in companies, both for employers and employees at the time of define the means of hiring, this research being defined as accounting analyses.

Finally, given all the results achieved in the survey, which were centered on the impact of the labor reform in the civil construction segment, suggestions for further research are suggested, to analyze the impact of the labor reform in the transport sector, or to analyze the impact of labor reform in the outsourcing process and service provision contracts in the civil construction segment.

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Stressing factors in nurses who work in the sector of urgency and emergency

Fatores estressores em enfermeiros que atuam no setor de urgência e emergência

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Abstract— Currently, stress is considered one of the main health problems that has been gaining importance, due to the proportion of its impact on people's lives. The objective of the research was to verify the main stress factors among nurses in the urgency and emergency sector and their influence on nursing care. Methodology: qualitative-quantitative, descriptive, cross-sectional field research, whose sample consisted of 30 nurses. For data collection, a form prepared by the researchers was used, containing questions about sociodemographic and occupational characteristics of nurses, open questions to verify the influence of stress on nursing care, and to investigate the main stressors in nurses, an instrument was used. adapted from the "Nurses Stress Inventory". Results: the research revealed that situations that generate stress are mainly associated with the lack of human resources (90%) and materials (80%), both pointed out by nurses as being often or always stressful factors. These factors and the work overload combined with the professional's unpreparedness are recognized by most nurses as a negative influence on work and on the care provided to the patient. Conclusion: the results indicate that nurses working in the urgency and emergency sector are exposed to stressful situations that can compromise the care provided to the client. The identification of these stressors is essential for the development of strategies that alleviate the stressors, providing better working conditions, humanization and safety in health care.

Resumo— Atualmente, o estresse é considerado um dos principais problemas de saúde que vem ganhando importância, devido à proporção de seu impacto na vida das pessoas. O objetivo da pesquisa foi verificar os principais fatores de estresse entre enfermeiros (a) do setor der urgência e emergência e sua influência na assistência de enfermagem. Metodologia:

*pesquisa de campo quali-quantitativa, descritiva, de caráter transversal, cuja amostra foi composta por 30 enfermeiros. Para coleta dos dados utilizou-se um formulário elaborado pelas pesquisadoras, contendo questões sobre características sociodemográficas eocupacionais dos enfermeiros, questões abertas para verificar a influência do estresse na assistência de enfermagem, e para averiguar os principais fatores estressores em enfermeiros utilizou-se um instrumento adaptado do "Inventario de Estresse em Enfermeiros" (IEE). **Resultados**: a pesquisa revelou que as situações geradoras de estresse estão associadas principalmente a falta de recursos humanos (90%) e falta de materiais (80%) ambas, apontadas pelos enfermeiros como sendo fatores muitas vezes ou sempre estressores. Sendo esses fatores e a sobre carga de trabalho aliado ao despreparo do profissional reconhecidos, por maior parte dos enfermeiros como influência negativa no labor e na assistência prestada ao paciente. **Conclusão**: os resultados indicam que os enfermeiros que atuam no setor de urgência e emergência estão expostos a situações estressoras, que podem comprometer a assistência prestada ao cliente. Sendo a identificação destes fatores estressores essencial para que se possa desenvolva estratégias para amenizar os agentes estressores, proporcionado melhores condições de trabalho, humanização e segurança na assistência em saúde.*

*Palavras- chave— **Estresse, Enfermagem, Urgência e emergência.***

I.   INTRODUCTION

Currently, stress is considered one of the main health problems which has been gaining importance due to the proportion of its impact on the lives of people. According to the World Health Organization (WHO), stress it affects 90% of the world population (OLIVEIRA et al., 2018).

For the International Labor Organization (ILO) occupational stress they are effects that occur in the worker's body and can cause damage your health (OLIVEIRA et al., 2018). According to Silva and Batista (2017), stress in addition to harming health, it negatively influences the lives of those who work with health. The Health Education Authority ranks nursing in fourth place among the most stressful professions in the public sector (VALERETTO; ALVES, 2014).

Among the various stressors exposed by nursing professionals who work in the hospital environment, it is possible to mention: the interpersonal relationship and multi-professional; acting in urgent and emergency situations; deficiency of material and human resources, resulting in an overload of work. the variables that promote the development of occupational stress, which can jeopardize the safety of patients who depend on these professionals (MUNHOZ et al., 2018). Urgent and emergency nursing has advanced significantly in recent years for being a specialty of great relevance and for the number high number of accidents and urban violence that often culminate with people in critical condition and at risk of death. From this perspective, it is understood that in the hospital institution the urgency and emergency sector is a factor triggering the existence of stress in nurses (SANTOS et al., 2018).

According to Andrioli, et al. (2018), the stress on professionals working in the Emergency Room (ER) is very common, as they are the first to welcome patients upon arrival at the hospital. These professionals are faced

daily with difficult situations such as those involving decision-making and quick service. Knowing that the urgency and emergency sector is characterized by the number of patients at high risk of death, where the professional is faced with unpredictable circumstances, exhausting work hours, family demands and agility in a short time to provide excellent assistance (FREITAS, et al., 2015). And that stressed professionals can have serious consequences for themselves and for the people they care for (OLIVEIRA; CUNHA, 2014).

It is important to recognize stressors in the work environment and their consequences in the health-disease process, in order to seek solutions to alleviate and address them, preventing damage to workers' health, in order to provide safe care to its users. Thus, this study aims to characterize nurses (a) who work in urgency and emergency; verify the main factors that generate stress in these nurses and verify whether stress influences nursing care.

II.   MATERIAL AND METHODS

It is a qualitative-quantitative, descriptive, field research of character cross section. Held between January and March 2019. The universe population were nurses working in the Urgency and Emergency sector of a public hospital in Cacoal/RO.

The inclusion criteria were: being nurses who work in the aforementioned sector, with more than 1 year of professional experience and who accepted participate in the survey. Thus, it was decided to exclude the nurses from vacation or away for any reason (medical certificate and maternity leave) in the period of the survey, as well as those unable to respond to the survey. Thus, the sample consisted of 30 professional nurses.

For data collection, a form prepared by the researchers was used, containing questions on sociodemographic and

occupational characteristics, 03 open questions were inserted to verify the influence of stress on customer care, and to investigate the main stressors in nurses - used an instrument adapted from the "Nurses Stress Inventory", which allows investigating the main stressors and their frequency in the nurses' work activities (STACCIARINI; TRÓCCOLI, 2000).

From that instrument, 26 items were selected for this research, subdivided into three categories (Interpersonal Relationships, Career Stressful Roles and Intrinsic Work Factors), whose answers range from 1 to 5, that is, (1) never, (2) rarely , (3) sometimes, (4) many times, (5) always.

After authorization from the Research Ethics Committee (CEP) of the Faculty of Biomedical Sciences of Cacoal under Opinion No. 3,095,761, the chosen institution for the study, she was contacted to obtain authorization for the research and also collaboration to enable data collection. Then it was performed approach of nurses (a), where it was clarified about the research objectives, guaranteed confidentiality, anonymity of participants, and other conduct ethics provided for in Resolution 466/2012 of the National Health Council, which deals with of research involving human beings (BRASIL, 2012), and all participants signed the Informed Consent Form.

Data were tabulated and consolidated on a basis constituted in the program Word® and Excel® version 2013. The statistics used were descriptive using relative frequency and absolute frequency. The statistical analysis was structured in tables that best represent the results.

Regarding the open questions, data analysis was performed by reflective readings, followed by organization and interpretation of answers. In what refers to the data categorization phase, the information was analyzed according to Bardin's (2016) content analysis methodology. In order to guarantee the anonymity of the subjects they were identified with the letter "E", followed by the numeral cardinal indicating the temporality of the interviews.

III. RESULTS AND DISCUSSION

During the period of data collection, there was a sample loss of some subjects for not meeting the inclusion criteria. Thus, 30 nurses who work in the Urgency and Emergency sector participated in this study. The results showed a predominance of 63.3% females. The age group of nurses ranged from 23 to 59 years, with a higher concentration of 23 to 29 years 40%. It was observed in the study that the majority of nurses interviewed also

exercise the role of head of the family, as with regard to marital status, 63.3% of professional nurses claimed to be married. More than half of the population surveyed, 63.3% said they had children. As for data related to the work context, in relation to the professional category researched, 46.7% are nurses at the beginning of their career, that is, they have 1 to 5 years of professional experience, 50% said they have a single employment relationship with workload. 40 hours/week, and 66.7% work in both shifts, that is, day and night. As shown in table 1.

Table 1 – Sociodemographic and occupational characteristics of professional nurses working in the Urgency and Emergency sector of a public hospital in Cacoal/RO, 2019.

	DATA	N	%
SEXO	Male	11	36,7
	Female	19	63,3
AGE RANGE	23 - 29	12	40
	30 - 39	10	33,3
	40 - 49	5	16,7
	50 - 59	3	10
MARITAL STATUS	Single	8	26,7
	Married	19	63,3
	Divorced	3	10
SONS	Yes	19	63,3
	Not	11	36,7
BOND LABOR	1	15	50
	>1	15	50
CHARGE TIME	40h/week	15	50
	>40h/week	15	50
TIME SERVICE	15 years	14	46,7
	6 - 10 years	9	30
	11 - 15 years	3	10
	>15 years	4	13,3
SHIFT	Both	20	66,7
	Day only	10	33,3
	only night	0	0

Source: Prepared by the Authors (2019).

Table 2- Distribution of responses from nurses working in the Urgency and Emergency sector, according to the category – "Interpersonal relationships". Cacoal/RO, 2019.

Situations that can represent a source of tension or stress	Frequency of stressful situations					
DATE	**N**		**R/AVMV/S**			
	N	%	N	%	N	%
Relationship with the medical team Relationship with fellow nurses	2 3	(6,7) (10)	8 5	(26,7) (16,7)	8 5	(26,7) (16,7)
Provide care to critically ill patients	5	(16,7)	11	(36,6)	11	(36,6)
The amount of work has made me tired	0	(0)	21	(70)	21	(70)
Take responsibility for the quality of service	2	(6,7)	16	(53,3)	16	(53,3)
that the institution provides	1	(3,3)	12	(40)	12	(40)
Serving family members of patients	0	(0)	20	(66,7)	20	(66,7)
Solve unforeseen events that happen on site	2	(6,7)	8	(26,7)	8	(26,7)
of work	0	(3,3)	21	(70)	21	(70)
Team work	1	(3,3)	8	(26,7)	8	(26,7)

Caption: (**N**) never (**R**) rarely / (**AV**) sometimes (**MV**) many times / (**Y**) Always

Source: Prepared by the Authors (2019).

It is verified, in this study, that there is a predominance of female nurses, married and with children, a result that is already expected since the nursing team, historically, is mostly female. According to a survey by the Federal Council of Nursing (COFEN) and FIOCRUZ conducted in 2015, 84.6% of nursing professionals were female and this trait has been present since the formation of the professional area (LOMBARDI; CAMPOS, 2018). Trettene et al. (2016), report that women, while working outside the home, manage their lives as mothers and wives, worry about their children and home care, developing multiple activities that can be interpreted as stressors. Study carried out by Santos et al. (2018), with nurses working in urgency and emergency units, observed that there was a significant number above the average of stress in nurses who were married and who had children. Thus, it is inferred that women, to this day, are the majority in the exercise of the profession, and that the fact of being married and having children can be aggravating to stress, considering that the individual's concerns increase, especially in relation to the responsibilities inherent to the family.

Regarding the variables age group and length of service, it was noted in the studied sample that 40% of professionals are between 23 and 29 years old, that is, they are young adults and 46.7% with less than 6 years of service. Studies carried out on Burnout Syndrome state that the prevalence of Burnout is higher in younger nurses, with little experience and who work with highly complex patients, since inexperienced, they end up becoming more tense in the face of complications that may arise during their shift. Especially for those under 30 years of age (VASCONCELOS; MARTINO; FRANÇA, 2018; FRANÇA et al., 2013). Regarding the number of jobs and weekly working hours, it was found that there were no differences. However, it is worth mentioning that nurses who have a double employment relationship are more subject to stress due to having a double work shift, often without the necessary break between them. This situation generates physical wear and tear, as well as social harm to the worker (OLIVEIRA; CUNHA, 2014). Other research showed that sleep deficit reduces cognitive and task performance capacity, exposing professionals and clients to accidents and failures (LIMA et al., 2013). This condition suggests that nurses with multiple employment relationships are exposed to a higher probability of developing stress. It can significantly interfere in the quality of life of these professionals.

It is also noted that most nurses work in both shifts, that is, they spend 24 hours at the workplace, which can be a contributing factor to occupational stress. Because according to Sena et al. (2018), nursing workers who spend 24 hours in the work environment are susceptible to changes in their quality of life, especially night shift workers. Since, there is greater psychophysiological wear, as they carry out their activities at a time when the body's functioning is reduced. Thus, causing decreased alertness, low performance, irritability, stress, bad mood, depression, among others. Inoue et al. (2013) report that night work causes higher levels of stress and worse sleep quality. For Vidotti et al. (2018), shift work is associated with several changes in biological functions, which lead to physical and mental health problems. To investigate the main stressors that nurses may be exposed to, the following categories were evaluated: Interpersonal Relationships, Career Stressful Roles and Intrinsic Work Factors.

In the category of interpersonal relationships, the items, serving a large number of people (70%), amount of work has made me tired (70%) and solving unforeseen events that happen in the workplace (66.7%), were the main factors generators of stress in these nurses, because according to them, these functions often or always leave them stressed. Still, regarding the nurses' responses to the stressors mentioned above, 30%, 30% and 33.3% respectively, stated that these factors rarely and sometimes cause stress, that is, for all nurses these factors represent a source of stress. As shown in table 2.

It is observed that the unforeseen events that happen in the workplace, the high demand for care and the work overload are conditions that can generate physical and mental exhaustion for nurses.

According to Santos et al. (2019)

> The workload in emergency rooms exposes nursing professionals to occupational stress, as the difficulties found in the emergency sector, whatever the reason, can directly reflect on nursing care and care, and especially on their health.

The authors also mention that this work overload is a result of the high demand of patients, the inadequate number of professionals in the sector, the amount of service per person.

In the study by Miorin et al. (2018), participants reported that work overload is tiring and inhumane, for both the worker and the client, since work overload leads to physical and emotional exhaustion. In this sense, nursing professionals are forced to perform their activities mechanically, without time to evaluate the activities developed and thus compromising patient care.

Among the occupational stressors pointed out by nurses in the category of stressful roles in the career, there is the restriction of professional autonomy (50%), working in inadequate facilities (70%) and unhealthy environment (53.3%), all mentioned as many sometimes or always cause stress. Other factors were pointed out as rarely and sometimes causing stress. As shown in table 3.

Table 3- Distribution of responses from nurses working in the Urgency and Emergency sector, according to the category – "Career stressors roles".

Cacoal/RO, 2019.

Situations that can represent source of tension or stress	Frequency of stressful situations		
DATE	**N**	**R/AV**	**MV/S**

	N	%	N	%	N	%
Working with unprepared people	1	(3,3)	16	(53.3)	13	(43,4)
Working in a competitive climate	7	(23,3)	17	(56,7)	6	(20)
Working in an unhealthy environment	2	(6,7)	12	(40)	16	(53,3)
Restriction of professional autonomy	1	(3,3)	14	(46,7)	15	(50)
work on premises	2	(6,7)	7	(23,3)	21	(7 0)
inadequate physical	0	(0)	22	(73,5)	8	(26,7)
Have a short deadline to fulfill orders	1	(3,3)	17	(56,7)	12	(40)
Feeling powerless in the face of the tasks to be performed	1	(3,3)	18	(60)	11	(36,7)

Caption: (**N**) never (**R**) rarely (**AV**) sometimes (**MV**) many times (**Y**) Always

Source: Prepared by the Authors (2019).

It was observed in this study that the urgency and emergency sector have conditions that contribute to occupational stress, and that such conditions pointed out by nurses can increase their vulnerability in relation to the agents that cause stress.

In the study by Trettene et al. (2016), the restriction of professional autonomy was also identified as a factor that predisposes nurses to stress. According to the authors, nurses recognize the difficulties related to leadership and work organization. The condition of articulating the individual, relational and organizational dimensions, necessary for the exercise of leadership, makes its practice complex, which elucidates the difficulty faced in the daily work of nursing. With regard to inadequate facilities and unhealthy environment. Melo et al. (2013), suggest that nurses become more vulnerable to stress in an inadequate physical environment, which may compromise their performance in the exercise of their functions.

According to RATOCHINSKI et al. (2016), working in inadequate, unhealthy and unsafe conditions directly influences the professional's physical and psychological well-being.

Table 4 presents the intrinsic factors of work. In this category, most nurses mention all items as being often or always situations causing stress, with emphasis on the lack of human resources (90%), lack of material needed for work (80%) and making physical effort to fulfill the job (63.3%), since 100% of respondents mentioned the three items as a stressor at work.

Table 4- Distribution of responses from nurses working in the Urgency and Emergency sector, according to the category – "Intrinsic factors to work". Cacoal/RO, 2019.

Situations that can represent a source of tension or stress	Frequency of stressful situations					
DATE	N		R/AV		MV/S	
	N	%	N	%	N	%
Develop activities beyond my Occupational role	2	(6,7)	6	(20)	22	(73,3)
Lack of material needed for the job	0	(0)	6	(20)	24	(80)
lack of human resources	0	(0)	3	(10)	27	(90)
Feeling emotional exhaustion with work	1	(3,3)	12	(40)	17	(56,7)
Answer for more than one role in this job	2	(6,7)	11	(36,6)	17	(56,7)
Run different tasks simultaneously	2	(6,7)	11	(36,6)	17	(56,7)
Make physical effort to do the job.	0	(0)	11	(36,7)	19	(63,3)
Administer or supervise the work of other people	1	(3,3)	14	(46,7)	15	(50)

Caption: (**N**) never (**R**) rarely (**AV**) sometimes (**MV**) many times (**Y**) Always

Source: Prepared by the Authors (2019).

It is notorious in the percentage distribution that for most nurses, situations related to intrinsic work factors cause higher levels of stress, that is, often or always represented a source of tension or stress in these professionals.

According to Trettene et al. (2016), the scarcity of human resources, the inadequate staffing is directly related to the overload of activities that compromise the quality of care and patient safety, generating psychological changes, demotivation and consequently occupational stress.

Still, specific aspects of nursing work in the urgent and emergency scenario require the nursing team to develop activities that require physical effort, and which, added to the inadequacy of human resources, compromise the quality of nursing care.

The lack of materials was also pointed out by all nurses as a source of tension or stress. According to Azevedo et al. (2018), the lack of materials in sufficient quantity and quality for adequate care, as well as the unpredictability of these resources and equipment make it difficult to plan nursing actions, expose patients at risk and generate family dissatisfaction.

The analysis of the subjects' speeches led to the categorization of two thematic units: Main stressors harmful to patients and Influence of stress on patient care.

Category I – Main stressors harmful to patients.

It can be seen in this category that during their work activities, nurses are faced with various stressful situations. However, some stressful situations are pointed out in a notorious and more incisive way.

Reports evidencing these situations are described below:

> [...] lack of HR, lack of adequate structure, lack of material, lack of professional competence, lack of professional training, poor quality service, brutishness with the patient, decreased desire to serve the patient well (E10).

> [...] the lack of HR increases the number of tasks for professionals, increasing stress, fatigue and making better patient care impossible (E1).

> [...] professionals not trained for an urgency and emergency sector, lack of materials, lack of HR that ends up overloading the professional (E8).

> [...] All of them can lead to adverse events and/or death. (E33)

> It is a set, as all the stressors contribute to form a tired, unmotivated and indifferent professional to the patient [...]. (E16)

The statements show that the most stressful aspect of work activities is the professionals' lack of preparation, the lack of human and material resources, which leads to a

workload and emotional exhaustion, which can impair the quality of care provided to the patient. According to (SILVA; ROSA, 2016), Brazilian health institutions have been facing a lack of health planning, low quality of human resources, problems with equipment and failures in the physical structure.

For Rodrigues et al. (2017), the work environment with precarious working conditions and excessive workload are factors that contribute to stress. According to Santos et al. (2019), the urgency and emergency sectors present situations that expose professionals to suffering and work overload. The high demand for care exceeding the capacity of the hospital institution is one of the generators of difficulties for the nursing team, resulting in precarious care in the emergency sector. The authors report that the shortage of professionals causes an accumulation of tasks, which will cause anxiety and a feeling of impotence in professionals.

Thus, emergencies are sectors that must be prepared quantitatively and qualitatively to receive the high demand for care and provide adequate care to patients.

Category II – Influence of stress on patient care.

Regarding the influence of stress on customer care, it is noted that nurses perceive stress as a detrimental factor to nursing care, that is, it directly influences the care provided to the customer. As shown in the testimonials always associated with a negative connotation.

> [...] The emotional directly interferes in care, especially in patients with a greater degree of dependence on the nursing team (E16).

> [...] today a lot is said about patient safety. But how to ensure patient safety with a team stressed due to work overload, lack of HR, and often lack of adequate materials, so stress negatively reflects on patient safety, as physical and mental exhaustion affect performance, mainly in emergencies (E3).

> [...] A stressed person cannot provide good care to the patient, cannot perform their functions with the same efficiency, will not be able to work as a team (E11).

> [...] Feels more tired, less attentive, with greater irritability, works automatically, being prone to mistakes (E16).

> [...] the patient indirectly receives the stress, because we are in a bad mood (E21).

> [...] It is possible errors in the activity due to physical and mental fatigue: changing medication and behavior. Stress between professional and companion (E13).

> [...] Risks to adverse events (E25).

It was noted in the statements that occupational stress has a direct influence on the safety culture. According to the World Health Organization (WHO), safety is the reduction of the risk of unnecessary damage to an acceptable minimum, considered a constant component and closely related to patient care. (SILVA; ROSA, 2016).

Occupational stress is considered one of the factors that most affects nursing professionals and, consequently, influences the performance of the team in the provision of health services, generating insecurity in the provision of care (MUNHOZ et al., 2018).

Rodrigues et al. (2017), report that a disorganized work environment, added to the deficient improvement of human resources, exposes the nursing staff to stress and fatigue, in addition to the lack of motivation of professionals who perform care, which can result in situations of insecurity for patients.

Nursing exposure to stressors increases physical, psychological and emotional burdens. Physical loads are found in the form of tiredness, aches and pains. In the realm of the psychic and emotional, feelings of anxiety, impotence, exhaustion, stress, suffering, among others, are found. Thus, these feelings can be passed on to patients, influencing their treatment, can generate more dissatisfaction and suffering on the part of nursing professionals and, thus, make them experience feelings of professional emptiness, feeling of incapacity and dislike for work (SANTOS et al., 2019).

It is important to emphasize that effective care directly influences the patient's prognosis, for this it is necessary to have material and human resources quantitatively and qualitatively in accordance with the recommended, in addition to appropriate facilities, technological and infrastructure resources that meet the needs, even if minimally , for allowing the necessary care in a timely manner (TRETTENE et al., 2016).

IV.   FINAL CONSIDERATIONS

The results indicate that professional nurses working in urgent and emergency care are exposed to various stressful situations. It was found that for most nurses, all items represent a source of stress at work that can negatively influence patient care, with an emphasis on work overload, lack of human and material resources. That is, the working conditions experienced by nurses favor stress, and expose

them to greater vulnerability to the development of unsafe care. Thus, the incorporation of a culture of safety in the work environment is a fundamental strategy when one hopes to alleviate stressors, providing better working conditions and excellent health care.

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Natural, organic and biodynamic wines: sustainability in the production chain

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Abstract— Concern for the environment is a recurrent aspect in any agricultural scenario under discussion and sustainability has taken on proportions of a wide debate reaching the most diverse markets, including the wine chain. From this reality began to emerge the labeling diversity of wines such as: organic, biodynamic and natural, demonstrating a growing interest of consumers in these products and producers in meeting this demand. The entire production chain, from grapes to wine, has been looking for more sustainable solutions so that wine exploration can last and impact the environment less and less. For a better understanding of this new panorama, of terms and products, the present work had as main objective to carry out a bibliographical review through consultation of scientific works published in areas related to the proposed theme, using key words to the theme that resulted in this article of review.

I. INTRODUCTION

Global and current concerns such as the loss of biodiversity and habitats, water scarcity, deterioration and desertification of soils leading to reduced productivity, show how it is necessary to change the paradigm, with regard to the way we use resources natural [1]. However, the need to apply sustainable practices along the value chain is still seen mostly as an economic cost and a threat to the profitability of companies, when, in fact, it is an opportunity [2].

A company distinguishes itself from its competition if it manages to be unique in some aspect of the production process or product that is valuable to buyers. In this way, the company differentiates itself from its competitors, as it allows it to have a low cost or to ask its buyers for a premium price. [3] considers pollution a form of inefficiency in the relationship between environmental sustainability and competitiveness. That is, when there is harmful waste or wasted energy, it is a sign that resources have been used in an incomplete, inefficient and ineffective way. For the author, managers must begin to recognize environmental improvements as an economic and competitive opportunity, and not as an "annoying cost or unavoidable threat".There are several studies that show that despite the environmental and social problems, economic performance is the most important factor for companies that intend to implement sustainability initiatives and practices. However, it is already clear that ecological practices have positive effects on efficiency, quality and customer satisfaction.

For a better understanding of sustainability practices, it is first necessary to know the concepts that permeate sustainable viticulture, as there is a confusion of understandings of what natural, organic and biodynamic wines are, and this review article aims to clarify these concepts.

II.   METHOD

Bibliographical research of exploratory nature of articles published in national and international journals, published in the databases Scielo, Academic Google and Science direct, Scopus, Web of Science, EMBRAPA, Capes Periodicals, FAO, in the period between 2000 - 2021, without disregarding the classical authors.

The following keywords were used for the survey: agrobiodiversity, sustainability, sustainable viticulture, grape and wine production chain, wine classification, organic wines, natural wines, biodynamic wines, and sustainable territorialities.

Based on the works found, this review article was constructed.

III.   RESULTS AND DISCUSSION

3.1 Natural, organic and biodynamic wines

The International Organization of Grape and Wine (OIV), in resolution CST 1/2004 of its Technical and Scientific Committee, defines the concept of sustainability in viticulture as: "A global approach to the production and processing systems of grapes, which involves the economic continuity of structures and territories, obtaining quality products, improving precision viticulture, assessing environmental risks and product safety, safeguarding the health of consumers, enhancing heritage, historical and cultural aspects, scenic and ecological" [4].

The emergence of this concept, in an organization such as the OIV, followed the environmental concerns and the issue of sustainability that emerged worldwide after the Brundtland Commission report. In this context, the wine sector, like other intensive agro-industrial activities, contributes with an environmental impact that cannot be neglected. Despite the wine industry being one of the most innovative and competitive, environmental issues still lack the deserved attention [5].For[6],sustainable viticulture is a much broader concept than organic and biodynamic viticulture.

Wine is a product obtained through the fermentation of grape juice, which can occur by chance, since the conditions for the process to occur are easy to obtain, considering that you only need to have some crushed grapes and a little bit of warmth and patience to get the wine [7].

3.2 Natural wines

To date, there is no consensus on the exact definition of what a natural wine is. Table 1 shows the different views on the definition of natural wine.

Table 1: Definitions on natural wine by various international natural wine associations.

Association	Definition of Natural Wine	Standards
Raw Wine (United Kingdom, Germany, USA)	Natural wine is cultivated organically or biodynamically, using permaculture or similar) and made (or rather transformed) without additives or processing aids the fermentation process that occurs naturally, without intervention. The result is a living wine - healthy and natural.	Vineyard: Organic / Biodynamic Grapes Winery: No additives (no sulfite added), no gluing, no filtration
L'Association des Vins Naturels (France)	Natural wine is: a wine whose grapes come from organic or biodynamic agriculture, a wine that is vinified and bottled without additives	Vineyard: Organic/Biodynamic Grapes Winery: No additives or sulphites
S.A.I.N.S (France)	Natural wine with no inputs and no added sulphites	It is not allowed to add sulfites or other additives
Vini Veri (Italy)	Lack of definition	Vineyard: Organic Grapes Winery: sulfur dioxide cannot exceed 80mg/l for dry wines and 100mg/l for sweet wines
VinNatur (Italy)	Lack of definition	Vineyard: No use of synthetic pesticides Winery: sulfur dioxide cannot exceed 50mg / l

APVN (Spain)	It is a wine made with natural grapes, without adding any input in the field or in the winery, just the grapes.	Vineyard: Fertilizer, herbicides, pesticides, systemic chemicals, fungicides or genetically modified organisms are not allowed. Winery: No added sulphite

Author: [8]

In Brazil, although there is no official regulation for the use of the name "natural wine", there is a certain consensus among producers about the practices allowed to obtain a wine in this style. For most producers, natural wine is basically grape must from organic vines fermented from indigenous yeasts present in the fruit itself and without any intervention. In this way, sulfur is almost always banned and many winemakers are opposed to the use of oak aging as well. Natural wine's main characteristic is the absence of any compound added to the drink, from preservatives to any oenological inputs widely used in the traditional wine industry.

Natural wines are often quite sensitive and unstable. It is noteworthy that there is still no regulation on the use of the term "natural wine" and producers can interpret it in different ways.

3.3 Organic wines

The definition of "organic wine" varies depending on the location, because the laws that regulate its production are different in each country. In Brazil, the law that regulates is Law No. 10,831, of December 23, 2003 and the registered decree of Law No. 6323, which regulates the issue of production and marketing of organic foods.

What is considered organic wine, today, is the drink that comes from an organic plantation of grapes, regardless of the wine-making process. Organic wines are made from grapes grown biologically without the use of synthetic fertilizers and without the application of pesticides on the plants. The management of the vineyard is based on the use of natural products and in biological balance, to prevent the appearance of insects, fungi, spontaneous plants and/or other threats to the vineyard.

One of the main concerns of organic farming is the soil, and growers avoid unnatural substances to regulate the land and vines. According to them, the final concern is the consumer, who should not ingest residual pesticides through wine.

This type of cultivation is controlled by certifying bodies and inspecting the entire process. In certain places, the rules are more or less strict. There are countries, for example, that do not allow any chemical additives in the process at all. In others, however, the winegrower is allowed to use acidifiers and preservatives.

Although there are differences between countries about what is considered an "organic" product, public policies of mutual understanding can help to overcome this barrier. This is what Brazil and Chile did in April 2019, when they put into practice an agreement for the equivalence of organic products between the two countries. Signed in September 2018, the agreement establishes that Chile will recognize the certification made by Brazil to buy Brazilian organic products, and Brazil will accept certification from Chileans.

3.4 Biodynamic wines

A biodynamic wine can be understood as a combination of biological agricultural practices without the addition of synthetic chemicals, with biodynamic practices in order to influence the biological and metaphysical aspects of the vine and adapting the vines to the lunar phases, such as example the harvest on the night of the full moon, etc.

Biodynamic wines, in addition to being made from organically grown grapes, their producers follow the anthroposophical philosophy, proposed in 1924 by Rudolf Steiner. According to the principles of Steiner's philosophy, an agricultural farm should seek to be a fully self-sustaining environment, in harmony with the cosmos, with minimal interference from man, so that the land can recover its vital energy and produce fruits that express its characteristics. own of the place.

The rules for this type of agriculture were laid down in the book "The Spiritual Foundations of Biodynamic Methods". In it, it is stated that the processes in both the vineyard and the winery are governed by the position of the planets and the phases of the moon. No pesticides and fertilizers are used, however, the producer can initially rely on biodynamic preparations, based on medicinal herbs and minerals, until the ecosystem recovers its balance and requires less and less human action. The same precepts are followed in wine making, with as little interference as possible in the winemaking, without using active dry yeasts and with minimal (or no) preservatives.

As well as organic agriculture, there are bodies to regulate and authenticate producers who venture into biodynamic agriculture. In Brazil, it is represented by the Institute Biodynamic Certification Association (IBD). To be biodynamic, the label must comply with the rules of the "Demeter Seal", an American organization that regulates this style of wine.

3.5 Environmental, social and governance (ESG)in the wine production chain

ESG is an acronym in English that stands for environmental, social and governance, and corresponds to an organization's environmental, social and governance practices. The term was coined in 2004 in a Global Compact publication in partnership with the World Bank called Who Cares Wins. It arose from a provocation by UN Secretary General Kofi Annan to 50 CEOs of large financial institutions, about how to integrate social, environmental and governance factors in the capital market.

The understanding and applicability of ESG criteria by Brazilian companies is increasingly a reality. Acting in accordance with ESG standards increases the competitiveness of the business sector, whether in the domestic market or abroad. In today's world, in which companies are closely monitored by their various stakeholders, ESG is an indication of solidity, lower costs, better reputation and greater resilience amidst uncertainties and vulnerabilities, being an important indicator of sustainability in the production chain of wine.

For many producers, sustainability is seen only as an environmental issue, where a sustainable wine is synonymous with biological or biodynamic [9]. For [6], sustainable viticulture is a much broader concept than viticulture biological, biodynamic or in integrated production. An organic wine is made from grapes cultivated biologically without the use of synthetic fertilizers and without the application of pesticides on the plants. A biodynamic wine can be understood as the combination of biological agricultural practices without the addition of synthetic chemical products, with "dynamic" practices in order to influence the biological and metaphysical aspects of the vine and adapting the cultures to the lunar phases, such as the harvest on the night of the full moon, etc.

According to [10] a vineyard with integrated pest management is a long-term approach through a combination of biological and cultural inputs in order to minimize environmental, health and economic risks.

[11], in a study carried out in 7 different countries, concluded that sustainability is a very individual and personal concept. However [12] emphasize that

environmental aspects and concerns are the most studied in the concept of sustainability.

Environmental concerns in the vineyard are not only related to impacts on biodiversity, but also to workers. For [13] the use of pesticides can be effective and cheap, but it is also highly toxic for workers and wild animals.

[5] Emphasize that most environmental problems faced by wine organizations are intrinsically interrelated, suggesting that environmental sustainability at the industry and corporate level will only be achieved with a holistic approach.

For [14], the discussion of sustainability in the wine industry raises issues ranging from viticulture, followed by industrial operations and management (cellar) and distribution processes. For this author, analyzing the concept of sustainability of the International Organization of Grape and Wine (OIV), the social pillar has a broad approach emphasizing immaterial themes such as heritage, history and culture.

[11],argue that sustainability can be generically defined as an environmentally friendly production, socially equitable in the relationship between the company, workers and local communities, and at the same time being economically viable. For this author, the perception of the benefits of adopting a sustainable strategy translates into the manifestation of competitive advantages based on cost reduction and product differentiation.

A sustainable strategy can translate into increased productivity, not only in reducing the consumption of external inputs such as phytopharmaceuticals, water and energy, but also in process innovation due to a better application of existing production techniques, or implementation of new technologies such as energy renewables and more efficient equipment [15]. For these authors, the application of an improvement in existing technology can lead not only to a reduction in costs, but also to the development of a product for a new market segment, for example, when consumers are willing to pay a price -premium for an "environmentally friendly" wine. In this perspective, an environmentally sustainable wine can bring a competitive advantage if it is consumed in higher income markets, such as Europe and North America.

[16] report that there is no universally accepted definition of sustainability, nor consistent indicators that could assess individual organizations. According to the same authors, the most important economic indicators for producers are grape quality, economic yield and production costs. With regard to environmental indicators, producers first enumerate soil quality, water use and putting an end to biodiversity. In relation to the social

dimension, the main indicators are the retention of workers, training and a healthy work environment.

[17] argue that the challenges of sustainability can be better achieved if there is a balance between the economic, environmental and social dimensions, where companies should assess their performance based on their social and environmental impacts, in addition to their traditional objective of profit maximization. Producers who have implemented environmentally sustainable practices recognize the long-term relationships between the environmental, social and economic dimensions and believe that these practices are directly linked to improving the quality of the soil, grapes and wine or terroir [18].

[19], identified four reasons or stimuli that lead companies to adopt sustainable practices: a) strategic reasons aimed at increasing competitiveness, product differentiation, access to markets, positive image and reputation, and product quality; b) financial incentives such as cost reduction, greater efficiency and increased profits; c) internal reasons linked to management attitudes, employees, organizational culture, internal pressure on managers and social involvement activities; and d) external stimuli related to pressure from customers, investors, local communities, competitors and current legislation.

For [20], the analysis of the various motivations that lead economic agents in the wine sector to adopt sustainable practices is the first step to understand the relationship between companies and sustainability and to verify their behavior in response to certain stimuli. time that explain the different levels of sustainability in which a company or a country finds itself. The reasons may be ethical issues or strategic decisions based on the perception of a competitive advantage arising from sustainability, or even external stimuli imposed by the company's external institutional context.

3.2 Sustainability Programs

The sustainability program of Lodi and other regions of California has been adapted and adopted by CSWA with the aim of optimizing the quality of the grape, protecting and conserving the environment, maintaining the long-term viability of agricultural land and local communities, ensure the economic and social well-being of employed farmers, and support research and training, among others [16].

In 1995, the first sustainability program in New Zealand appeared, Sustainable Winegrowing New Zealand –SWNZ [11];[16];[20]. SWNZ certification started only with viticulture practices and, later, in 2002 certification was carried out jointly with the viticulture and winery operations. In this case, the use of a benchmarking system

aimed to continuously improve sustainability in both operations: vineyard and winery [11].

This system brought advantages to producers, as they could obtain a benchmarking not only regionally but also nationally in relation to the use of energy, water and agrochemicals and could verify where they were, taking advantage of the dissemination of research results [21].

In 1998, the South African government enacted the Integrated Production of Wine (IPW). In this case, it was a program with a marketing message, with a voluntary certification, a manual and guidelines of the practices to be implemented, providing information about the minimum requirements to reach the goals defined by the legislation of the Republic of South Africa [16]. The IPW, without being mandatory, turned out to be the starting point to assist producers in environmental aspects, given their lack of knowledge and resources to determine the environmental impacts of their activities [22]. The IPW was a tool to help and support producers to get started in sustainability practices.

During the first decade of this century, Australia received a visit from Dr. Cliff Ohmart, at the invitation of the McLaren Vale Grape Wine & Tourism Association, who influenced the creation of a regional sustainable viticulture program including a plan for certification, which developed a series of initiatives aimed at improving winemaking practices, grape quality and financial viability. To this end, they carried out various initiatives such as seminars and workshops and the preparation of an information bulletin for winemakers with data from meteorological stations and pest alerts in the region [16].

In 2009, "Vinos de Chile", a non-profit organization that represents 95% of bottled wines exported from Chile, launched a strategic plan for Chilean wines until 2020. This strategic plan marked sustainability as one of the main keys and was part of partnership between representatives of the wine industry and the University of Talca that created the National Code of Sustainability (CNS), encompassing a series of initiatives with the objective of establishing the sustainability of Chilean wines [16]. To this end, the CNS encompasses three areas: Viñedo (green area) with a focus on natural resources, pests and diseases, agrochemicals and occupational safety; Bodega (red area) which includes chapters such as energy, water management, contamination and waste prevention; Social (orange area), which includes relations with workers, communities and customers.

In 2015 a pioneering sustainability plan emerged in Portugal. The Alentejo Wine Sustainability Program (PSVA) emerged from a partnership between the University of Évora and CVRA and with financial support

from the European Union through the Alentejo Regional Operational Programme. As a voluntary membership program, its main objective is to provide recommendations to Alentejo producers with a view to improving their sustainability and competitiveness. To this end, a plan was developed based on three sectors: Viticulture, which includes several chapters related to the production of grapes; Winery, which includes chapters related to wine production; and Viticultura & Winery, which includes various implications of winemaking operations, such as wine quality, ecosystem management, human resources, surrounding communities, socioeconomic and regional development [23]. This document contains 177 evaluation criteria distributed across these three sectors indicated above. This program is intended to: support producers in improving their environmental, economic and social performance, promoting the sustainability of the region's wines; promote the efficient use of resources and reduction of operating costs in the wine industry; support the production of wines with recognized sustainable performance, through knowledge obtained in Research and Development projects and identify the performance of producers, comparing results and defining areas for improvement [24]. As a result of this initiative, PSVA managed to successfully integrate 168 members (wine and grape producers (or both products) and have associated the equivalent of 26% of the Alentejo vineyard area.

In relation to the various sustainability programs we cover, there are national programs such as New Zealand, South Africa and Chile, state programs such as California and regional programs such as McLaren Vale in Australia or Alentejo in Portugal. In Europe there are also other sustainability programs, in countries like France, Italy and Switzerland, although with fragmented initiatives, not having a regional format [14].

With regard to New World wines, most sustainability programs are linked to Public Institutes and Universities have a very important role in the transfer and sharing of knowledge. [20] emphasizes that a close relationship with the University can bring benefits to the wine industry, as the research results can help producers adopt sustainable practices and can provide answers to some management questions. The social responsibility of research can help guide sustainability by disseminating results that motivate economic agents to adopt a sustainable behavior and create an awareness of sustainability in industry and consumers.

Although the relationship between the University and economic agents has had good results in the sustainability program in California, [5] found that organizations in the wine sector often encounter difficulties in transferring results from scientific research to practice. These authors advocate further research with a primary interest in

commercial reality and perceptions of environmental concerns. The transfer of knowledge, the realization of synergies with the territory and a greater commitment of companies to research and development (ID) activities constitute challenges with a view to economic development [25]. Undoubtedly, "the widespread adoption of sustainable winemaking practices depends not only on rigorous science, but also on their effective delivery to producers" [13].

And it is in pursuit of this sustainable growth that the production chain of grapes and wine must be guided from now on, giving economic continuity to structures and territories, obtaining quality products, improving precision viticulture, assessing risks environmental and product safety, safeguarding the health of consumers, enhancing the heritage, historical, cultural, landscape and ecological aspects of all producing regions.

IV. CONCLUSION

It is possible to affirm that natural, organic and biodynamic wines are products that best represent the characteristics of the place where they were made, capturing the essence of the soil and climate, that is, these wines fully express the "Terroir" of each region that produces them.

There is no consensus on the definitions of natural, organic and biodynamic wines, these concepts are specific to each country/association.

From the literature review it was found that the main grape and wine producing countries around the world have sustainability programs in place, which demonstrates the concern to keep the exploration of this activity in an increasingly clean and lasting way.

New Zealand was the first country to implement a sustainability program in 1995 for grapes and in 2002 for wine, serving as an example for other countries that used this practice to build their own programs.

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Sustainable Development Goals and an interface with organic agriculture

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Abstract— *The United Nations Organization, through the 2030 Agenda, established as a global pact to end poverty in all its dimensions the Sustainable Development Goals (SDGs), also contemplate actions aimed at protecting the environment and mitigating climate change. The principle of organic agriculture is to establish production systems based on a set of procedures that relate plant, soil and climatic conditions, without the use of polluting inputs, such as synthetic agrochemicals. This study* aims *to identify the perception of organic agriculture practitioners in the São Francisco Valley region regarding the relationship of their practices with the SDGs. Bibliographic analysis, technical visit and interviews with producers were carried out. It was found that, although in their daily activities they adopt practices related to the goals established in the SDGS, most were unaware of such goals. There was* acknowledgement *of the importance and need to carry out more actions in favor of the SDGs. From this perspective, it is suggested that more actions are* taken *to sensitize society, in order to understand the SDGs, as well as their purposes, and thus achieve a better quality of life for all.*

I. INTRODUCTION

The Sustainable Development Goals (SDGs) are a global call by the United Nations (UN) to end poverty, protect the environment and the climate, and ensure that people everywhere can enjoy peace and prosperity [1]. There are 17 sustainable goals, which generate 169 goals that are generally integrated and indivisible*;* and mix, in a balanced way, the three dimensions of sustainable development: economic, social and environmental.

The 2030 Agenda for Sustainable Development was adopted, as of 2015, by 193 countries that are part of the UN. Among the goals, 2.3 stands out, which provides for "doubling the agricultural productivity and income of small food producers, particularly women, indigenous peoples, family farmers, shepherds and fishermen*,* through secure and equal access to land" [2].

In Brazil, some public policies were instituted in order to contribute to the achievement of this objective. Among them, the Food Acquisition Program (PAA), for example, in its update through Law N° 11947/2009 [3] which provides for school meals, Law No. 12512/2011 [4] which institutes the Environmental Conservation Support Program and the Rural Productive Activities Promotion Program, Law n° 10831/2003 [5], Law n° 11326/2006 [6] and Decree n° 7794/2012 [7], referring to organic agriculture and agroecology.

Organic agriculture enables the production of food free from synthetic pesticides, favoring the balance of ecosystems and contributing to a healthy diet. An organic production system is understood to be any which adopts the optimization of natural and socioeconomic resources, as provided for in Law N° 10831/2003[5] e Decree N°6323/2007 [13]. These systems aims at economic and ecological sustainability, maximizing social benefits, exerting cultural and biological methods in agricultural production, as well as in environmental protection.

Thus, organic agriculture can be presented as an instrument to enable farmers for the transition from conventional agriculture, as it has instruments and guiding laws that favor sustainable development, thus becoming a tool to achieve the SDGs proposed by the un.

This study aims to identify actions carried out by organic producers in the São Francisco Valley, which are part of the Association of Organic Producers from the São Francisco Valley (APROVASF), related to the SDGs.

II. MATERIALS AND METHODS

Bibliographic research, of an exploratory and qualitative nature, of articles published in national and international journals, provided by Scielo, Academic Google and Science direct databases, was carried out in the period between 2015-2021, without disregarding the classic authors, using the terms: organic agriculture, sustainability, sustainable development goals, 2030 agenda. As an inclusion criterion, the articles should bring information regarding the SDGs and organic agriculture, whose analysis of laws, decrees, treaties and specialized articles on the subject could show the relationship of legal provisions with the SDGs, and as an exclusion criterion articles that did not bring discussion about the relationship of organic agriculture with the SDGs. Then, a quantitative approach was used, with the application of a questionnaire in order to identify the perceptions of certified organic producers, who are part of APROVASF, of the practices already carried out and the SDGs.

The research was presented through an online meeting, due to the COVID-19 pandemic, *held* with the presence of representatives of the members. Then, an online questionnaire was made available to organic producers, containing an explanatory video about the 2030 agenda, with identification of the producer, 17 questions, one on each SDGs with brief guidance, to identify whether each interviewed performed actions that somehow promoted in their activities, directly or indirectly, the SDGs mentioned in the question, with the possibility of the following answers: performs; does not perform; and it does not apply. And finally an open question for comments on the

2030 agenda. Based on the above, members were invited to respond on each other's vision. Of the 24 associated producers, there were 17 responses in the questionnaire made available, some producers were unable to respond to the online form.

III. ORGANIC PRODUCERS OF SÃO FRANCISCO VALLEY

In the region of the valley of the sub-middle São Francisco, APROVASF has great diversity in its composition, from settler producers of agrarian reform, some owners of agricultural plots and other professionals in the agrarian sciences at their most diverse levels of graduation. The welcoming spirit of the members to the gender issue is also remarkable, as it highlights the term "producers" in the name of the association, as well as keeping a woman re-elected as president of the association. Perhaps this diversity and sympathy were essential for the group to unite and endure the most difficult times it faced since its beginning, in the search for a space that would represent it, where it could offer healthy food, produced with great respect for the land, for water, for the food itself, for itself and for the consumer of organic fruits and vegetables.

Officially formed in 2014, APROVASF has 24 members, 12 men and 12 women, including farmers and agricultural science professionals. The respective production areas are in settlements, irrigated perimeters, on the island, that is, in the rural area and also in urban areas, in the municipalities of Juazeiro and Casa Nova, in Bahia, Petrolina and Lagoa Grande, in Pernambuco, where they cultivate fruits, vegetables, grains and roots. It is noteworthy that the management of the entrepeneurship of these farmers can be by family or business.

There are different modalities of certification of the organic production of the members, namely: Participatory Certification System (SPC), with collective responsibility of the members of the system, in which the group of producers makes the visit and checks compliance with the requirements for organic management. And Audit Certification System, in which the majority of associates are present, who hire a certifier to carry out the audit, in accordance with Law n° 10831/2003 [5].

IV. RELATIONSHIP BETWEEN ORGANIC AGRICULTURE AND SUSTAINABLE DEVELOPMENT GOALS

The production, processing, labeling and marketing of organic products, which include primary or processed products, of plant or animal origin, is regulated in several

countries. In the United States, it is verified through the USDA-NOP (National Organic Program), section 205 (7 CFR 205) [8]; in Canada, by the Canadian regulation COR (Canadian Organic Rules), which allows, at the end of the process, the use of the Official Canadian Organic Product Seal, in addition to being possible to carry out the certification process based on the American regulation (NOP) for Canada, requesting the complement for validation of equivalence to Canadian regulation (Canada x USA Equivalence Agreement); in the European Union (EC) standards are governed by Reg. 834 of 2007 [9] and its implementing regulation - Reg. 889 of 2008 [10]; In Japan, by JAS (Japan Agricultural Standards); in China they are governed by the National Regulation of the Republic of China GB/T 19630 [11] for organic products; in South Korea they are governed by the South Korean FIPA/EFAPA Regulation for organic products; in Brazil, by Law 10831/2003 [5]; and in countries that do not have their own regulations, they usually accept to certify products according to the organic regulations of the International Federation on Organic Agriculture (IFOAM) [12] or other countries.

In Brazil, there is also a complex legal framework on organic agriculture which seeks to establish a sustainable model of agricultural production, namely: Law n°10831/2003 - Organic Production Law [5]; Law n°11326/2006 - National Policy on Family Agriculture [6]; Decree N°6323/2007 [13] - Regulates Law N°10831/2003 and Decree No. 7794/2012 - National Policy on Agroecology and Organic Production [7].

According to [14], one can point out in these laws the existence of an agroecological law, which institutes political and legal guidelines, principles, instruments and duties to the Public Power to implement a sustainable agroecological development model, however, it is restricted to small, medium-sized farmers and traditional people, given that the political and economic focus is still agrobusiness, relegating agroecological agriculture to the background.

In 2013, the Alliance for Food Sovereignty in Africa (AFSA) analyzed 50 case studies in twenty-two African countries, demonstrating that the use of agroecology enabled collaboration with the following SDGs: poverty eradication; zero hunger and sustainable agriculture; health and wellness; quality education; gender equality; clean water and sanitation; decent employment and economic growth; responsible consumption and production; action against global climate change and improvements in terrestrial life, directly contributing with ten of the seventeen SDGs [15].

In a research carried out [16], it is concluded that public procurement programs have great potential to contribute to the achievement of the UN 2030 Agenda, in particular the SDGs 02, by increasing the income of family farmers, and through supply healthier food for the population and promoting sustainable rural development.

The coordination of the implementation of the 2030 Agenda in Brazil takes place within the scope of the National Commission for the SDGs, created by Decree 8892/2016 [17]. Through this Commission, government representatives, local authorities, civil society, the private sector and other interested actors should work together and foster new partnerships for the implementation of the SDGs in Brazil.

V. RESULTS AND DISCUSSION

Members, in general, responded that they carry out various actions of the 2030 Agenda in their practices, as shown in Table 1, with very little divergence between the items. From the previous discussion, it is possible to see that the practice of organic agriculture meets some of the actions aimed at by the SDGs, but in the view of the interviewees, the perception was not the same.

Table.1: Answers about SDGs performed by members

SDGs	perform	not perform	Not applicable
1. No poverty	13	3	1
2. Zero hunger	16	1	0
3. Good health and well-being	14	3	0
4. Quality Education	10	7	0
5. Gender equality	14	3	0
6. Clean water and sanitation	10	7	0
7. affordable and Clean energy	10	7	0
8. Decent work and economic growth	11	5	1
9. Industry, innovation and infrastructure	12	5	0
10. Reduced inequalities	12	5	0
11. Sustainable cities and communities	12	5	0
12. Responsible	14	3	0

consumption and production			
13. Climate action	14	3	0
14. Life bellow water	11	5	1
15. Life on land	13	4	0
16. Peace, justice and strong institutions	13	4	0
17. Partnerships for the goals	14	3	0

Table 1 shows the seventeen SDGs that had responses with the highest agreement from members, with the SDGs listed 1, 2, 3, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16 e 17.

In the first SDG, a socioeconomic agenda was defined to eradicate poverty in all its forms. Generally speaking, Law 10831/2003 [5], Law 11326/2006 [6] and Decree 7794/2012 [7], have the presence of provisions that promote this first SDG. Farmers were asked if they were taking action to reduce the proportion of people living in poverty. There was agreement of twelve research participants.

The second SDG, which deals with zero hunger in sustainable agriculture, has among its objectives to end hunger, ensuring access to healthy and nutritious food for all, through sustainable production agriculture that promotes ecosystem resilience and makes it possible to increase income of small farmers, mainly beneficiaries of family farming [1]. It is stated that [14] Brazilian legislation seeks to promote this second SDG by encouraging the offer of healthy products free of intentional contaminants and with conscientious use of natural resources, in accordance with Law No. 11.346/2006 - National System of Food Safety and Nutritional [18], to ensure the human right to adequate food and food sovereignty and Law n° 10.836/2004 - Bolsa Família Program [19]. Producers were asked if they carry out sustainable agriculture, improved nutrition and actions to reduce hunger, where there was agreement among thirteen members.

In Brazil, some public policies were instituted in order to contribute to the achievement of objective 2.3. The Food Acquisition Program (PAA), for example, in its update through Law 12512/2011 [4] has among its main purposes, the incentive to family farming, promoting its economic and social inclusion, promoting production with sustainability, access to food, in the necessary quantity, quality and regularity, strengthening local and regional circuits and marketing networks, et cetera.

The third SDG is about promoting health and well-being, with goals aimed at reducing infant and maternal mortality rates, diseases caused by hazardous chemicals, in addition to reducing the contamination and pollution of natural resources. Producers responded if they promoted health and well-being. Many understood that the use of organic inputs, and the production of quality food, promote health and well-being. However, three people had a different understanding.

In the fourth SDG, the Agenda aims to achieve quality education, inclusive and equitable for all, from primary to technical and professional. Producers were asked if they carry out actions for learning opportunities (Quality Education). Although ten agreed, seven said they do not do it, there is a need for training in the association, which still does not happen with the desired frequency. According to [14], education and professional training is an instrument for implementing the National Policy on Agroecology and Organic Production, provided for in art. 4, IX of Decree 7794/2012 [7] and also the Environmental Education Law, governed by Law 9795/1999 [20].

The fifth SDG deals with the issue of gender equality with a view to the goals of promoting women. It highlights the goals of recognizing domestic work and defending women's equal opportunities for access to economic and natural resources, as well as access to property and control over land. Producers were asked if they carry out actions related to gender equality to provide more opportunities for women in the future. Although the president of the association is a woman and 50% of the members are too, there were three responses from producers stating that they do not carry out actions.

The National Policy on Agroecology and Organic Production establishes as a guideline the contribution to the reduction of gender inequalities, through actions and programs that promote women's economic autonomy [7], which corroborates the fifth SDG.

The sixth SDG is about ensuring the availability and sustainable management of water and sanitation for all, its goals are aimed at improving water quality, reducing pollution, and eliminating the dumping of hazardous chemicals and materials, as well as protecting and restoring ecosystems related to water. Producers were asked if they were promoting the availability and sustainable management of water and sanitation, and, although ten producers agreed to carry out actions, seven said they do not do it, even though organic agriculture defends the use of inputs that do not contaminate water, the elimination of agrochemicals and the conscientious management of natural resources. It is noteworthy here the growing concern around the practice of conventional

agriculture with pesticides and chemical fertilizers used in an abusive and intensive way, which, together with other tools adopted in this production system, increase the damage to the environment, especially to water and soil resources.

One of the purposes of Law 10831/2003 [5] is to promote a healthy use of soil, water and air, and to reduce to a minimum all forms of contamination of these elements that may result from agricultural practices, which complements the relationship of organic agriculture with the sixth SDG.

The seventh objective seeks to ensure reliable, sustainable, modern and affordable access to energy for everyone. Producers were asked if they were carrying out actions so that the energy supplied was clean and cheap, so that there would be no harm to the environment. Of the associates, ten responded that they do it and seven said they do not do it, it was observed that there was no agreement of an absolute majority.

Regarding the eighth SDG, producers were asked if they carry out actions to promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work, although only eleven answers were agreed, Law 10831/2003 [5], the Family Farming Law [6], Decree 7794/2012 [7] on agroecological and organic production promote this SDG, while emphasizing the healthy use of natural resources, observes labor rights, and environmental, social and economic as well as equity in the application of policies.

Regarding the ninth SDG, the question asked was whether producers carried out actions to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, obtaining agreement from twelve survey participants.

In the tenth objective, which seeks to reduce inequality within and between countries, it has as goals: to empower and promote the social, economic and political inclusion of all, regardless of gender, disability, ethnicity, economic condition and the guarantee of equal opportunities and reduction of inequalities of results [1]. The questioning was aimed at carrying out actions to reduce inequality, and promoting opportunities for the most excluded people, obtaining agreement from twelve survey participants. However, the public policies presented above emphasize principles of decentralization, socioeconomic sustainability and equity in the application of family farming policies to its beneficiaries, as well as the promotion of fair and sustainable systems of production, distribution and consumption of food, prioritizing family farming.

The eleventh SDG proposes to make cities and human settlements inclusive, safe, resilient and sustainable. In the questionnaire there was a query aimed at carrying out actions that contemplated this objective, with agreement from twelve research participants. The goals aim to ensure access to basic services and safe, adequate housing at affordable prices, as well as the promotion of inclusive and sustainable urbanization. Law 10831/2003 [5], Law 1326/2006 [6] and Decree 7794/2012 [7], presented points promoting this SDG, based on renewable resources and locally organized agricultural systems; encouraging the consumption of organic products, regionalization of production and trade in these products.

The twelfth SDG seeks to carry out actions to promote sustainable production and consumption patterns. There were fourteen producers who agreed that they carry out actions with this purpose. Agriculture and organic production promote sustainable development, the population's quality of life, the supply and consumption of healthy foods, promotion of the conscientious use of natural resources, the recycling of organic waste, reducing to a minimum the use of non- renewables, among other points mentioned in the current legislation.

As for the thirteenth objective, fourteen producers responded that they carry out actions that allow reducing the wear and tear on the planet in order to minimize climate impacts. Organic agriculture promotes sustainability, the conscious use of natural resources, conservation of natural ecosystems and restoration of modified ecosystems, through agricultural production systems and forestry extraction based on renewable resources, with the adoption of cultural, biological methods and practices and mechanics, which reduce polluting waste and the dependence on external inputs for production.

In relation to the fourteenth objective, only eleven producers agreed that they carry out actions to conserve and sustainably use the oceans, rivers and water resources for sustainable development. It is noteworthy here that when organic agriculture is practiced, the entire agroecosystem is evaluated and the aim is to promote conservation benefits that extend to animals, plants, energy resources, soils and water resources.

In the fifteenth on actions to protect, recover and promote the sustainable use of terrestrial ecosystems, forests, combat desertification, halt and reverse land degradation, only thirteen producers agreed, despite being strongly related to the purpose of an organic production system that seeks to preserve the biological diversity of natural ecosystems and the recomposition or increase of the biological diversity of the modified ecosystems in

which the production system is inserted, according to Law 10831/2003 [5].

With regard to the sixteenth SDG, the central focus is to carry out actions to promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions, with only thirteen producers agreeing.

And finally, in the seventeenth SDG, fourteen producers agreed that they are taking actions to strengthen the means of implementation and revitalize the global partnership for sustainable development.

Thus, according to [14] the National Policy on Organic Agriculture and the National Policy on Agroecology and Organic Production [7] seek to promote the SDGs, emphasizing points such as the preservation and restoration of biodiversity in ecosystems, the increase in biological activity and fertility of the soil and the promotion of the healthy use of natural resources, reducing its forms of contamination and the promotion of fair and sustainable production systems, with valorization of agrobiodiversity, corroborating with the results shown here.

In the questionnaire, members were also proposed to present effective actions to strengthen the association, being suggested by them: more support from government officials to promote organic products, engagement of members to enable production planning, dissemination focused on products and training, for members to have greater clarity of the benefits of organic agriculture for health and the environment, as well as being aware of global demands, becoming professional and marketing your business.

VI.   CONCLUSION

Although many events in defense of the 2030 agenda have been held, few producers know about it. However, they carry out actions focused on the existing goals, evidenced by the implementation of practices aiming the protection of the environment.

Within this perspective, it is suggested that more extension actions are carried out to raise awareness in people, in order to facilitate the understanding of the objectives and their goals, so that there is sustainable development in the region and a better quality of life for all.

Of the seventeen SDGs presented, it was possible to show that they all have some relationship with the laws and decrees related to agriculture and organic production existing in Brazil, as well as agreement of a good part of

the producers regarding the carrying out of actions in favor of these objectives. However, as explained above, the SDGs that have greater evidence and adherence to Brazilian legislation on organic agriculture are: 1, 2, 3, 6, 8, 10, 11, 12, 13, 15.

It is expected to show that organic agriculture can be recognized as a tool for meeting the SDGs, and through sustainable practices, encourage a greater number of producers to apply traditional and academic knowledge to achieve sustainable development goals.

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Drug-Induced Hepatotoxicity in COVID-19

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Abstract— Objective: The aim of this research is to map the scientific evidence on drug-induced hepatotoxicity in COVID-19.Method:This is an integrative literature review study, through a systematic search performed by the reviewers to identify all relevant studies on the different causes of liver failure in patients with COVID-19, published from June 16, 2021 to July 27, 2021.Results and Discussion: After analyzing the articles, six categories emerged, namely: 1) Drug-induced liver injury; 2) hepatotoxicity caused by Hydroxochloroquine in COVID-19; 3) the hepatotoxicity caused by Ivermectin in COVID-19; 4) hepatotoxicity caused by Tocilizumab in COVID-19; 5) hepatotoxicity caused by Azithromycin in COVID-19; 6) the hepatotoxicity caused by Remdesivir in COVID-19. Conclusion: COVID-19 has put the health systems of many countries under great pressure and has been particularly challenging due to the lack of predictive parameters and effective pharmacotherapies for the treatment of COVID-19 in advanced liver disease. Despite the common descriptions of liver enzyme alterations observed in patients with COVID-19, the frequency, intensity and impact of liver damage are discreet and of little clinical significance in relation to morbidity or mortality of this disease.

I. INTRODUCTION

Liver damage was reported as a common complication of New Coronavirus disease in 2019 (COVID-19). [1] The spectrum of liver damage in COVID-19 can be caused by direct infection, either by hepatotropism of the virus, or indirectly, such as systemic inflammation, hypoxic changes, iatrogenic causes, mechanical ventilation, exacerbation of underlying liver disease or hepatotoxicity of drugs used to combat the disease. [2]

Abnormality of liver enzymes is common in patients with the New Coronavirus, in addition to the virus itself, it is also possible that liver failure is due to hepatotoxicity of the drugs used to fight the infection, as well as to inflammation mediated by the immune system, with sudden increase and intense inflammatory substances and decreased oxygen associated with pneumonia, both of which can contribute to liver damage or even progress to liver failure in patients with COVID-19 who are severely ill. [1]

There are many drugs that can affect liver function, some of them may cause liver enzymes to rise asymptomatically, or may cause acute hepatitis. Liver damage may depend on the dosage of the drug used or it may be independent of the dosage of the drug used. Among the medications that can damage the liver, there are commonly used medications such as antibiotics, anti-inflammatory and antivirals. [3]

Drug-induced liver injury is potentially fatal and is also known as drug-induced hepatotoxicity, which is an important cause of acute liver failure, whose COVID-19 positive inpatients may undergo pharmacological polytreatment, making clinical management even more complex. In this context, information about the potential for hepatotoxicity of the drugs in use is important to prevent liver dysfunction and the side effects of the drugs used in its treatment. [4]

A percentage of patients with COVID-19 may have an asymptomatic course of viral infection, a good percentage may have fever and use antipyretics such as paracetamol or other analgesics, with potential hepatotoxicity, which is associated with the risk of liver damage that can occur in the later stages of COVID-19 infection and can result in a very dangerous synergy. [5]

In the Brazilian context, other drugs were used both in the hospital context and prescribed to the population, such as Azithromycin, Hydroxychloroquine, Paracetamol, Lopinavir and Remdesivir, drugs with already documented potential for hepatotoxicity. [6]

Thus, the objective of this research is to map the scientific evidence on drug-induced hepatotoxicity in COVID-19.

II. METHOD

It is an integrative literature review type research, which aims to gather and synthesize research results on a delimited topic, in a systematic and orderly manner, being an instrument for deepening knowledge about the investigated topic, allowing the synthesis of multiple published studies and general conclusions about it. [7]

A systematic search was performed by the reviewers to identify all relevant studies on the different causes of liver failure in patients with COVID-19 published from June 16, 2021 to July 27, 2021.

The methodological outline involves the exception of the following steps: (1) documentation of defined research objectives and research strategy, (2) identification and selection of peer-reviewed research articles, (3) final selection of peer-reviewed research articles from according to the defined eligibility criteria and according to the purpose of the review, (4) organizing and reporting the data and findings of peer-reviewed research articles in different sections and (5) discussion of results and conclusion.

Electronic databases such as PubMed, Cochrane Library, Google Scholar, Scopus and Web of Science were searched for potentially relevant studies using the health descriptors: acute liver injury, liver injury, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), new coronavirus disease 19 (COVID-19), liver disease and prognosis.

The retrieved studies were carefully examined to omit overlapping data or possible duplication. Those written in other languages without complete data and accessible information were excluded. The studies included in this review were published in the last 2 years in specialized journals, written in English and Portuguese, with reported clinical findings. Observational articles reporting the prevalence or incidence of drug-induced acute liver injury in adults, as well as randomized and nonrandomized interventions performed in different populations were included in this review article.

Studies reported on the findings and main drugs used in the COVID-19 pandemic and their likelihood of causing liver damage were also included.

Were identified 147 articles through the database, 87 were excluded due to duplication and 08 articles were selected for review.

The guiding question for the elaboration of this integrative review consisted of: What are the available scientific productions on liver injury induced by drugs used in COVID-19?

III. RESULTS AND DISCUSSION

In this integrative literature review, 08 original scientific articles were selected that strictly met the previously established sample selection and showed approximations with the object of this study. These were organized in alphanumeric codes, from CV01 to CV08, for better presentation and understanding of the results.

Table 1: Distribution of studies.

Nº	Base	Language	Author. Title. Periodical. Year	Objective	Methodology
CV01	Google Scholar	English	Orly, Alexander. et al.Drug-Induced Liver Injury and COVID-19 Infection: The Rules Remain the Same. Drug Safety. 2020.	Correlate potential hepatotoxicity of drugs that were used as treatment for COVID-19.	Experience report of Nursing students in the development of the curricular internship, which took place from April to July 2020.
CV02	PubMed	English	Hanafy, Amr. et al. Challenges in COVID-19 drug treatment in patients with advanced liver diseases: A hepatology perspective. World Journal of Gastroenterology. 2020.	Propose a review of medications that could be suitable for advanced liver disease.	Guideline for a step-by-step approach to treating COVID-19 in advanced liver disease.
CV03	PubMed	English	Vitiello, Antonio et.al. The risks of liver injury in COVID-19 patients and pharmacological management to reduce or prevent the damage induced. Egyptian Liver Journal. 2021.	Describe the pharmacological management in order to preserve the liver or reduce the damage caused by treatments with COVID-19 and anti-COVID-19.	Literature review
CV04	PubMed	English	Leegwater, Emiel et al.Drug-induced Liver Injury in a Patient With Coronavirus Disease 2019: Potential Interaction of Remdesivir With P-Glycoprotein Inhibitors. Clinical Infectious Diseases. 2021.	Propose a relationship with a drug-drug interaction between Remdesivir and P-glycoprotein inhibitors.	Case report of a critically ill patient with COVID-19 who developed hepatotoxicity after Remdesivir therapy.
CV05	PubMed	English	Boeckmans, Joost et al. COVID-19 and drug-induced liver injury: a problem of plenty or a petty point? Archives of toxicology, 2020.	Reflect on COVID-19 and drug-induced liver damage.	Literature review
CV06	PubMed	English	Cerqueira, et al. Viral and drug liver injury caused by COVID-19. Obesity Medicine. 2020.	Evaluate and discuss hepatic manifestations in COVID-19 such as infection, manifestations and drug effects.	Literature review
CV07	Google Scholar	Portuguese	Macedo, et al. Medicamentosconsiderados no tratamento da COVID-19 durante o período de pandemia no Brasil. RECIMA. 2021.	Bring a review of the current types of drugs used in the treatment of COVID-19 in Brazil, highlighting the importance of further	Literature review

				therapeutic studies on the disease.	
CV08	LILACS	English	Brito, Barros e Lopes. Mechanisms and consequences of COVID-19 associated liver injury:What can we affirm?World Journal of Hepatolog. 2020.	To review currently available data on liver damage in patients with COVID-19.	Literature review

Source: Author, 2021.

Table 2: Evidence from studies.

Nº	Evidências
CV01	Five main medications were widely used in COVID-19. Coronavirus has characteristics of hepatotropism, in addition most drugs are metabolized by the liver and in a pandemic context, due to the novelty of the disease, numerous prescriptions were made wrongly. This generated a higher rate of hepatotoxicity cases caused by medications.
CV02	In clinical trials of chloroquine for prevention and treatment with COVID-19, there were no reports of hepatotoxicity and the rates of serum enzyme elevations during treatment with chloroquine were low and similar to patients receiving placebo or standard care. Evaluation of previous studies indicates that, to date, no acute viral infections have been successful with chloroquine treatment in humans.
CV03	The mechanism by which Ivermect in can cause liver damageis still unknown. Single-dose therapy with Ivermect in has been associated with a low rate of serumamino transferaseelevations, in trials of Ivermect in to prevent SARS-CoV-2 infection and to improve the course of early and severe COVID-19, amino transfer asee levations Serum serum were notun common, butwerenot more frequent among patients who received Ivermect in than among those who received placebo or a drug comparator.
CV04	Literature data have shown that, in most cases, severe liver damage has been observed when Tocilizumab is combined with other hepatotoxic medicinal products and that liver failure and liver transplantation may occur in patients treated with Tocilizumab. Liver injury occurred as an unpredictable reaction, suggesting the need for careful monitoring during and after treatment.
CV05	Azithromycin can rarely cause clinically apparent liver damage. Because Azithromycin has become so commonly used, it has also become one of the most common causes of drug-induced liver damage and resembles that described with other macrolides. Azithromycin has not been approved for the treatment of viral infections, but some studies have supported its antiviral activity. Recently, few studies are emphasized with the use of Azithromycin in combination with Chloroquine/Hydroxychloroquine for the treatment of COVID-19.
CV06	Studies suggest that Redesemvir has the potential to cause liver damage. Remdesivir therapy given for 7 to 14 days was associated with smaller increases in serum aminotransferase but no other evidence of liver damage. Thus, elevations in serum aminotransferases are common during Remdesivir therapy but are usually asymptomatic, fully reversible, and not associated with jaundice.
CV07	The drugs used for treatment are still uncertain. One of the first drugs mentioned in the literature for the treatment was Chloroquine (CQ) and Hydroxychloroquine (HCQ). Additionally, Azithromycin (AZI), Nitazoxanide (NTZ) and Methylprednisolone (MPDN) are also considered therapeutic alternatives in Brazil. Therefore, it is necessary to identify an efficient treatment against COVID-19, and further research is needed on the drugs used to combat SARS-CoV-2.
CV08	Increases in serum aminotransferase levels (ranging from 16% to 62%) and bilirubin levels (ranging from 5% to 21%) have been reported and appear to be more frequently observed in patients with severe forms of COVID-19. Although absolute changes in these parameters are often seen, other variables, such as the proportion above the upper limit of normal, the onset of liver injury as a complication in severe cases and histopathological findings, reinforce that the liver changes are of dubious clinical relevance in the course. of this disease. Other factors

| | should also be considered in these analyses, such as the repercussions of hemodynamic changes, the presence of thrombotic events and, mainly, possible drug-induced liver damage with the current treatment. |

Source: Author, 2021.

After analyzing the articles, six categories emerged, namely: 1) Drug-induced liver injury; 2) hepatotoxicity caused by Hydroxochloroquine in COVID-19; 3) the hepatotoxicity caused by Ivermectin in COVID-19; 4) hepatotoxicity caused by Tocilizumab in COVID-19; 5) hepatotoxicity caused by Azithromycin in COVID-19; 6) the hepatotoxicity caused by Remdesivir in COVID-19.

The characteristics of these studies can be observed, in which articles in English are predominant (80%), such as clinical trials (60%), published in international journals (80%) and indexed in the PubMed database (62%).

Main drugs used that have hepatotoxic potential described in the literature were: Chloroquine, Azithromycin, Paracetamol, Lopinavir, Tocilizumab and Remdesivir.

Category 1: DRUG-INDUCED LIVER INJURY

In a pandemic context, different therapies were being tested in patients with COVID-19, including antiviral drugs. Self-medication is not recommended for any disease, but with the COVID-19 pandemic and the uncertainties it brought, the practice of self-medication has gained many followers and the side effects of this practice can be very dangerous. One of them is drug hepatitis. [6]

Novo Coronavirus has characteristics of hepatotropism, the relationship between the liver and COVID-19 may be related to the direct cytopathic effect of the virus. The postulated mechanism of viral entry is through angiotensin converting enzyme 2 (ACE2) receptors, ACE2 receptors are expressed in the gastrointestinal tract, vascular endothelium and liver cholangiocytes. Another mechanism that can cause liver damage is through the drugs that were used for COVID-19. [8]

Drug-induced liver injury occurs through several different mechanisms, including the direct impairment of the structural and functional integrity of the liver and the production of a metabolite that alters the hepatocellular structure and function. [9] In a meta-analysis study carried out in Jamaica, involving 20,874 patients with COVID-19, the combined incidence of drug-induced liver injury was 25.4%. [10]

Drugs that have been over-prescribed and used in COVID-19 such as Chloroquine, Azithromycin, Paracetamol, Lopinavir, Tocilizumab and Remdesivir are all metabolized in the liver. It is important to recognize

and remove the offending agent as soon as possible to prevent progression to chronic liver disease or acute liver failure. Adverse drug reactions are an important cause of liver injury that may require suspension of the offending agent, hospitalization or even liver transplant. [11]

The liver is responsible for the concentration and metabolization of most drugs, it is the main target of drug-induced damage. [12] Depending on the duration of the injury and the histological location of the damage, drug-induced liver injury is categorized as acute or chronic, as well as hepatitis, cholestatic, or a mixed injury pattern.[4]

Category 2: HEPATOTOXICITY CAUSED BY HYDROXOCHLOROQUINE IN COVID-19

Hydroxochloroquine is an anti-malarial drug, also used for rheumatoid arthritis, lupus erythrematosus, and amoebiasis, [13] which passively diffuses through cell membranes and into endosomes, lysosomes and Golgi vesicles, where it becomes protonated, trapping hydroxychloroquine in the organelle and raising the surrounding pH. [14] The high pH in endosomes prevents viral particles from using their activity for fusion and entry into the cell.

Hydroxychloroquine is a drug that interferes with lysosomal activity and autophagy, interacting with membrane stability and consequently altering signaling pathways and transcriptional activity, which can result in the inhibition of cytokine production and modulation of certain costimulatory molecules. [14] Regarding possible liver damage caused by the drug, hepatotoxicity in patients who used this drug is uncommon, but it is noteworthy that the drug may be associated with adverse cardiac, ophthalmological, hematological, neurological, musculoskeletal and gastrointestinal adverse effects, among others. [16]

Hydroxychloroquine's injury mechanism consists in the fact that it is metabolized in the liver and can alter the metabolism of other drugs, the toxicity may be due to reactive metabolites and oxidative stress induced by this drug or to an idiosyncratic or synergistic toxic effect associated with processes inflammatory. [15] Although the hepatotoxicity of this drug is rare, it was documented in a study carried out in Brazil, which concluded that there was a rapid normalization of liver enzymes after the withdrawal of hydroxychloroquine. [4]

In clinical trials of Hydroxychloroquine for prevention and treatment with COVID-19, there were no reports of hepatotoxicity and the rates of serum enzyme elevations during treatment with Hydroxychloroquine were low and similar to patients receiving placebo or comparator agents. [17] A study carried out in Brazil in March 2020 reported the case of a patient with severe COVID-19 pneumonia who developed hepatotoxicity associated with the use of hydroxychloroquine, marked by a 10-fold increase in transaminase levels; these levels regressed rapidly after drug withdrawal. [14]

An exception to this is the use of hydroxychloroquine in patients with porphyria cutaneatarda, and when used in relatively high doses, hydroxychloroquine can trigger an acute liver injury with sudden onset of fever and marked elevation of serum enzymes with increased excretion of porphyrins. [18] Therapy is unlikely to cause liver damage in normal individuals, but may trigger an acute worsening of porphyria cutaneatardain susceptible individuals. [19]

The effect of hydroxychloroquine on liver tissue appears ambiguous as it is used to treat liver infection with protozoa, but cases of fulminant liver failure have been reported.

Category 3: HEPATOTOXICITY CAUSED BY IVERMECTIN IN COVID-19

Ivermectin is an anti-infective agent with activity against several nematodes and parasites. [20] In Brazil, a wave of misinformation spread during this period and the drug was included in a list of drugs called "kit-covid-19", although it has no proven efficacy in the treatment of COVID-19, it was widely used by the population. Ivermectin therapy has been associated with minor, self-limiting elevations in serum aminotransferase and very rare cases of clinically apparent liver damage. [5]

In cell culture, Ivermectin has activity against several viruses, including Novo Coronavirus, in view of the increasing burden of serious diseases represented by COVID-19, drugs with antiviral activity against SARS-CoV-2 in vitro have often been tried to improve the course and prevent mortality. Ivermectin has been evaluated in several open-label studies with evidence suggestive of benefit, but in more carefully designed studies, Ivermectin at doses of 20 to 14 mg per day for 3 to 5 days had little or no effect in preventing infection or improving infection your result. [21]

Single-dose therapy with Ivermectin was associated with a low rate of serum aminotransferase elevations. A single case of clinically apparent liver injury has been reported after the use of Ivermectin, the onset of injury one month after a single dose and was characterized by a hepatocellular pattern of serum enzyme elevations without jaundice. Recovery was quick and complete. [24]

In trials of Ivermectin to prevent SARS-CoV-2 infection and to improve the course of early and severe COVID-19, serum aminotransferase elevations were not uncommon, but were not more frequent among patients receiving Ivermectin than among patients those who received placebo or a medicine comparator. Ivermectin is generally well tolerated and liver damage reported with its use was mild and self-limited in course, the reported occurrence of acute liver injury should be clarified and related to the severity of COVID-19. [23]

Category 4: HEPATOTOXICITY CAUSED BY TOCILIZUMAB IN COVID-19

Tocilizumab (TCZ) is a recombinant monoclonal antibody used to block the IL-6 signal transduction pathway [24]. Interleukin-6 (IL-6) plays an important role in the pathogenesis of cytokine storm and the progression of COVID-19, whose increased levels of IL-6 are key to cytokine storm stimulation and predict an increased risk of respiratory failure and death. [25]

Clinical studies have shown very good effects of TCZ on clinical and biochemical parameters in patients with COVID-19, but the most common side effects of TCZ include headache and hypertension, but hepatotoxicity ranging from mild elevation of transaminases to severe injury may rarely occur drug-induced liver disease, data on TCZ hepatotoxicity in COVID-19 disease are limited and inconclusive (26)

TCZ is used for the treatment of rheumatoid arthritis and systemic juvenile idiopathic arthritis, it was proposed for the treatment of COVID-19 when it came to the understanding that the virus not only attacked the lungs, but also provoked an exacerbated body response in an attempt to contain the virus, this mechanism was related to the cytokine storm syndrome (27)

The pathological immune response depends on the cytokine group, but IL-6 is considered an important mediator in the pathogenesis of CRS. TCZ was previously approved for the treatment of severe or life-threatening CRS induced by chimeric antigen receptor T cells. Therefore, in the absence of specific antiviral therapy, TCZ was included in the treatment of COVID-19, with the aim of interrupting the progression of systemic inflammation and CRS by blocking IL-6 (28)

A study in a hospital in Italy reported seven cases of patients with elevated liver enzymes at baseline who received TCZ for severe COVID-19 disease with

improved liver and lung function. In registry trials, serum aminotransferase elevations occurred in a high proportion (10–40%) of patients who received TCZ and, after licensing, were associated with several cases of clinically apparent liver damage with jaundice. (26)

Side effects with the use of TCZ include potential hepatotoxicity, literature data have shown that, in most cases, severe liver damage was observed when TCZ was combined with other hepatotoxic drugs that can cause liver failure. In most cases, TCZ has resulted in severe liver damage when used in combination with other potentially hepatotoxic drugs. (26)

Category 5: HEPATOTOXICITY CAUSED BY AZITROMOCIN IN COVID-19

Azithromycin can also rarely cause clinically apparent liver damage. Azithromycin is a licensed, widely available, inexpensive and generally safe drug, it was proposed as a treatment for COVID-19 initially, as it had in vitro activity against Zika and Ebola viruses and in vivo in preventing severe respiratory tract involvement in infections viral, probably due to its immunomodulatory action (29). However, it has now been concluded that it has no proven efficacy against COVID-19. (30)

Azithromycin inhibits protein synthesis and experimentally reduces inflammation and viral replication, possibly because cytokines and viruses are made of proteins and use cellular ribosomes for protein translation. (31) Furthermore, inhibition of virus production can reduce viral transmission to other people, an important additional benefit (29).

The typical liver injury caused by Azithromycin resembles that described with other macrolides, typical symptoms are fatigue, jaundice, abdominal pain, itching, fever and eosinophilia may also be present, this form of liver injury caused by Azithromycin is generally benign, histology In these cases, the liver usually demonstrates bile duct loss, which, if severe, can result in disappearing bile duct syndrome and chronic cholestatic liver failure, ultimately requiring liver transplantation (32).

The hepatocellular forms of liver damage caused by Azithromycin can be severe and lead to acute liver failure and death or the need for emergency liver transplantation. However, in most cases, recovery occurs within 4 to 8 weeks, the cause of idiosyncratic liver injury due to Azithromycin is unknown, but the speed of onset suggests hypersensitivity as the cause (9).

Category 6: HEPATOTOXICITY CAUSED BY REMDESIVIR IN COVID-19

Remdesivir is a nucleotide analogue RNA polymerase inhibitor that has potent activity against the RNA-dependent RNA polymerases encoded by SARS-CoV-2 (34). This drug was developed for Ebola virus disease, and has shown some in vitro efficacy against SARS-CoV-2, Remdesivir therapy is given intravenously for 5 to 10 days and is often accompanied by transient and reversible mild to mild elevations moderate in serum aminotransferase levels, but only rarely has it been associated with cases of clinically apparent liver damage, its liver effects being overshadowed by the systemic effects of COVID-19 (35)

They claim that the results of liver toxicity have been contradictory, however, and it appears that Remdesivir can cause liver dysfunction. According to (3). Data regarding the potential hepatotoxicity of Remdesivir are currently limited, Remdesivir has been shown to be toxic to human hepatocytes, the Food and Drug Administration (FDA) has warned of the incidence of elevated liver enzymes in patients treated with Remdesivir, indicating a potential induced liver injury by drugs (36)

They described five cases of patients treated with Remdesivir with high levels of aminotransferases (TGO and TGP), suggesting hepatocellular damage, but without liver failure (11). Adverse events of Remdesivir therapy include mild to moderate degrees of nausea and vomiting, headache, fatigue, renal dysfunction, elevations in serum aminotransferases and rash, and rare cases of hypersensitivity reactions, liver dysfunction and damage have been reported (37)

Before attributing liver dysfunction to Remdesivir, it is imperative to extensively evaluate other etiologies not related to COVID-19, such as viral hepatitis, potential hepatotoxic drugs, and autoimmune diseases (11). The use of Remdesivir in patients hospitalized with COVID-19 is associated with a transient mild to moderate elevation in liver biochemistry with low rates of discontinuation. (3)

IV.   CONCLUSION

COVID-19 has put the health systems of many countries under great pressure and has been particularly challenging due to the lack of predictive parameters and effective pharmacotherapies for the treatment of advanced liver disease. Despite the common descriptions of liver enzyme alterations observed in patients with COVID-19, the frequency, intensity and impact of liver damage are discreet and of little clinical significance in relation to the morbidity or mortality of this disease.

A better understanding of the natural history of liver involvement can be addressed in the near future with well-designed prospective studies on viral and immunological research. Thus, considering all these factors, respecting the rules set out above and excluding confounding factors, in particular those linked to the patient's behavior in times of crisis, should allow physicians to detect definitive drug-induced liver damage and avoid withdrawal inadequate use of a potentially useful drug.

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New Technologies in Education: Digital platforms usability

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Abstract— This essay aims to present High School and undergraduate pupils and teacher's perception as online platform users for remote classes at Brazil. Thus, researches have been conducted through an online questionnaire which made it possible to confirm that perceptions regarding the use (usability) and the emotions (psychological) are caused by this type of teaching. The aim of this study is to diagnose the positive and the negative points that the users showed while interacting in remote classes, their suggestions and their notes for improvements.

I. INTRODUCTION

In March 2020 all types of educational institutes had to discontinue their face-to-face classes which required adapting them to the virtual environment due to the forced lockdown because of the high level of contamination caused by the Covid-19 Pandemic.

Current teaching through online platforms and other digital resources such as recorded video classes and material sharing became popular as Emergency Remote Teaching (ERT), which arose several ways to deliver the content that should be applied as well as the fulfilment of the academic planning schedule.

It is believed that such social isolation measures which were adopted as a way of controlling and restraint to the spreading of the new corona virus was a modality to rush the development of the 4.0 education, in other words, the fourth Revolution that takes place through technology innovation.

However, this study aims to check the perception of High School and undergraduate students and teachers/professors while using the online platforms for their remote classes, also to report their main experiences (positive and negative ones) during this interaction.

For this, Bibliographic, Exploratory, Quantitative and Qualitative research have been conducted in order to deepen the knowledge about the usabilty of the most popular platforms used for remote teaching. A research based on questionnaires was applied to students, teachers and professors which intends to confirm both the use and the emotional perceptions that this type of teaching is causing. It also intends to understand how they are interacting during the teaching/learning activities, and based on this diagnose, new studies will be enabled in order to provide refined solutions to the remote teaching platforms.

1. Emergency Remote Teaching (ERT)

Although it is strictly related to the use of digital technology, Remote teaching must not be taken for Open and Distance Learning (ODL). According to Garcia, Morais, Zaros e Rego (2020);

> Remote Teaching allows the use of platforms already available and open for other purpuses which are not exclusively educational, as well as the addition of complementary tools and the introduction of the groundbreaking practices. [...] Teaching remotely allows school content sharing

in classes organized through profiles [environments controlled by login and password] created in the teaching platforms, such as, SIGAA and MOODLE, apps like Hangouts, Meet, Zoom ou social networks. (pág. 5)

The authors quoted above call attention to the importance of the coverage of meaningful learning, where knowledge should be embraced by the students' intellectual world as well their experiences.

Morer (2008) apud Gabardo, Quevedo e Ulbricht (2010) defend that successful online learning finds its balance between education and the institutional design: in other words, educational Direction opposed to technology Direction. It is not possible to consider one and discard the other.

How can we provide everyone with access, improve the use of skills and add quality to usability? A Society which encourages innovations and develops through studies must have everybody together [...] E-learning for all requires bringing down boundaries for those who don't have access to new infra-structures of knowledge. Opening up to inclusion involves extending na invitation to all groups (stakeholder groups) towards a dialogue about how the boundaries of motivation, technology, pedagogy and access can be brought down. (EHLERS, 2008, p. 17).

According to Behar(2020), in Open and Distant Education (OLD), teaching and learning processes happen due to the use of information and communication means and Technologies with pupils , tutors and teachers who are developing educational activities in several places and times. In other words, it has its own didatic-pedagogical system, through vídeo-classes, complementary material suggested by the teacher and the application of tests by the endo f each video-class. There is no interaction among students. They can watch the classes whenever they have time and their doubts can be solved by the subject's tutor.

1.1 Teachers/Professors

Considering the great education challenge despite the source, distant learning becomes even more complex. For Garcia, Morais, Zaros and Rego (2020) while in remote classes teachers and professors face the same challenges as they do in formal education such as introducing the contented, setting learning goals and submitting assessments.

Table 01 Illustrates what remote teaching must be like;

Table 01 – Remote Teaching according to Garcia, Morais, Zaros e Rego (2020 page 9)

Communication with the student	It can be synchronic (in real time) or asynchronous (in a diferente time), as well as in a standard class.
A more significant use of resources (technological, digital or analog)	Although technology is already been used in a daily basis, its use is now for educational purpures. The use of technological resources is included as part of the job [delivering classes], confirming one's expertise in communication technology.
Planning concerning the step's time management	Steps that should be related to the typical teaching process, such as introducing the content, time for intervantions and questions, time for Reading, Ações que devem estar relacionadas aos aspectos típicos da didática do ensino como: apresentação de conteúdo, oportunidade para intervenções e perguntas, tempo para leitura, further development and leaning assessment techniques.

In order to organize the activities, the teacher need to master the means for introducing the content, in other words, digital means such as platforms, apps medias. Also, they must master the methods and the processes that will be used [leaner-centered approach, hybrid teaching, questioning, etc.], besides paying close attention to the application of the learning rules.

Once these demands have been met, the teacher/professor starts to plan the lesson and sets the goals of the teaching/learning process, the contents and the evaluation process concerning the power of teaching techniques.

According to Gabardo, Quevedo e Ulbricht (2010) it is imperative that the Educational institutes develop online education projects focused on changing paradigms and the creation os a new culture in terms of this teaching style since this style has become a well-established and permanent pattern.

Nowadays, the development of new efficient methods of education are absolutely significant for building a Society based on knowledge, which demands more than just simple qualification, in other words, not only learning how to use technology, but also evolve in terms of thinking and acting in the teaching/learning process.

1.2 Pupils

One of the most challenging aspects of Remote Teaching is the pupils interest. For that, the lesson presentation must be as, or even more, attractive then what is available in open communication social networks.

Feitosa, Moura, Ramos and Lavor (2020) conducted a research with students which reports some complaints concerning remote teaching: the lack of interaction with students and teachers because they do not feel comfortable to take active part in class and to report their doubts; they want practical classes in labs; they claim to prefer hard copies of their books, therefore they need the library; and last but not least, they find online classes more tiring.

So that learning happens in a more spontaneous and motivating way, it is important to keep students' interest in the subject, making it easier for them to organize and cope with their state of mind, for instance, establishing a routine with a clear schedule, sleep well in order to have more concentration during class. Also, they should find na appropriate place to attend the classes, keep their material within reach and, if possible, assure good internet connection because it is known that the lack of e-accessibility is accounted for demotivation and dropouts.

1.3 Usability

So that users have a use experience either with a physical or virtual product in an efficient and pleasant, in this case, concerning digital platforms in particular, the ISO 9241-11 sets the goals of usability, which are: developing mechanisms that facilitate and promote success and satisfaction with the experience and the performance, without requiring previous knowledge from the user in relation to the technology. Such rule is based on three main pilars: Efficiency, Effectiveness and Satisfaction.

According to Costa e Marques (2001), Efficiency aims to measure the coverage and accuracy of the user when reaching his/her goal. Effectiveness assess the resources used in order to reach the goal: the more resources, the more effort and the least efficiency. And Satisfaction assures the comfort and the favorable reaction with which the user reaches his/her goals.

In order to guarantee the best use experience, ergonomic and heuristic criteria of the usability are applied to the development of Technologies and other platforms. Although this article does not intend to carry out such evaluation in the presented moment, such knowledge is the foundation for the development of the new technologies and to assure a its successful interaction with its users.

II.   METHOD

Based on the presented bibliographical survey, two (02) questionnaires have been applied through Google Forms, targeting teachers/professor and pupils respectively. In both questionnaires, the participants were well aware and agreed with the Consent Form (TECLE) – (mandatory term in request to the 466/12 –CNS-MS resolution).

The questionnaires addressed to High School and Higher Education (undergraduate and Lato and Stricto Senso students) and to the teachers/professor, were developed aiming to collect information about the experience and the usability in remote education through digital platforms.

It contains twenty (20) quali-quantitative questions which refer to the adopted platform, lesson's running time, familiarity with the technology, use experience, feelings and emoticons, assessment and pinpointing suggestions and improvements.

III.   RESULTS AND DISCUSSION

3.1 Teachers/Professors

In all, 37 answers were collected between April 1st and May 1st, 2021. The questionnaire was split in two parts. The first one contained questions which referred to the given classes and the second was about how one was feeling during the remote class period.

Higher Education professor are the majority of 83,8% of the answers. 17,2% teach High School classes, training courses and other types of courses. From this percentage, 67,6% give live classes and 27% give hybrid classes, which are live and recorded classes. 19 teachers (51,4%) use Google Meet (Classroom); 16 (43,2%) use Microsoft Teams; followed by Zoom: 3 professionals (8,1%). 02 claimed to use Blackboard and the others YouTube Live, WhatsApp, Big Blue Botton and Cisco Webex as you can see in graphic 01.
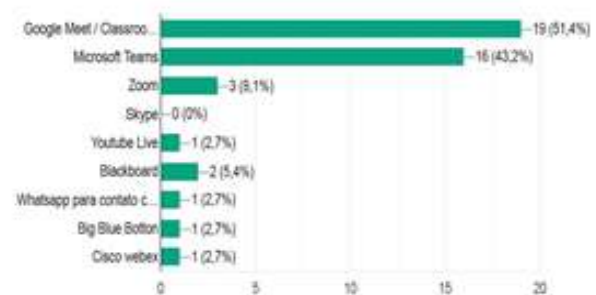

Fig.1: Graph of the most frequently used teaching platforms adopted by teachers.

45,9% said that they did not get any training, while 43,2% said that they had been provided with it. 8,2% seek for other qualification ways such as: videos, tutorials and colleagues' help. It is remarkable that in all 54,1% of the interviewees did not have any kind of training and, as a result, they had to look for other alternatives.
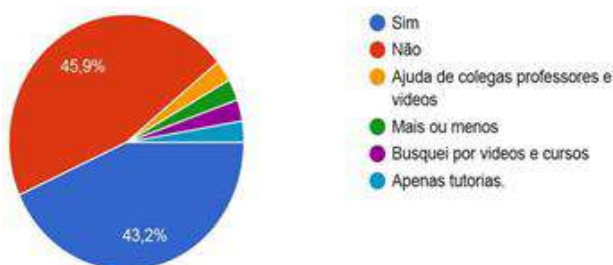

Fig.2: Qualification and training graph

The three biggest difficulties in relation to the platform and remote teaching reported by the interviewees were: technical and operational problems of the platform(29,7%); difficulties in assigning homework to students (16,2%) and 13,5% had problems in organizing the online content. Also,13,6% reported problems concerning students' interaction, unstable internet connection and that the platforms do not offer appropriate tools to a class, a total of 73% of the teachers claimed to have faced some kind of problem. On the other hand, 27% confirmed not having had problems at all.
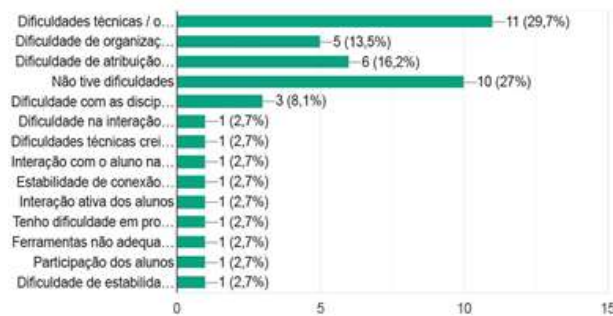
Fig.3: Main problems graph

The age range of most of the interviewees is between 36 and 55 years (75,8%), 39,4% ranges from 36 to 45 years and 36,4% ranges from 46 to 55 years. 9,1% are between 55 and 65 years and only 15,2% of the teachers are between 26 and 35 years-old.

Regarding the classes, 62,2% delivered theorical and practical classes; 24,3% delivered only theory and 13,5% only practice. The average running class time, the answers were varied, ranging between 1h30 and mostly 3h00.

About the feeling regarding remote classes, 13 teachers said to be discouraged; 10 feel frustrated and 6 reported annoyance and sadness. Other feelings such as fear, listlessness, emotional distress, uncertainty, anxiety and exhaustion have been mentioned. They also reported fatigue, headaches and voice failure.
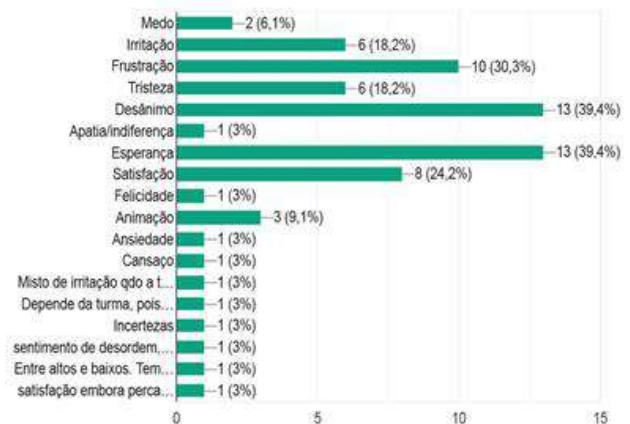
Fig.4: Feeling towards remote class graph.

It is possible to note the most of the feeling pointed by the participants were negative ones, especially because the majority showed difficulties while using the platforms, which includes lack of qualification or even a sponsorship in terms of money and equipment operation (digital accessibility which was mentioned by one interviewee). Peer interaction also suffered damages according to the participants. However, there still is a small portion with signs of hope regarding this teaching approach.

Regarding the lack of interaction, many students said that they did not turn on their cameras and that they did not took active part in the class. In general, teachers were worried about their pupils learning results and about how to assess them. Despite that, 13 interviewees were hopeful, 8 are satisfied and 3 are excited.

When asked about student's interest and attention to their subject in the remote style, in a scale from 0 to 10, meaning that 0 is absolutely negative and 10 is absolutely positive, results showed that 11 answers were between 5,0 and 4,0 points, while 22 answer were above 6,0 points. From these asnwers, most of them (8 answers) with 8,0 points, followed by 7 answers with score 7,0. 3 answers had score 9,0 and 6,0 each and one with 10,0. It shows that despite the problems presented by the teachers/professor, most of them still have a positev evaluation regarding student's interest and attention to class. There has been no register of an answer below 4 points.
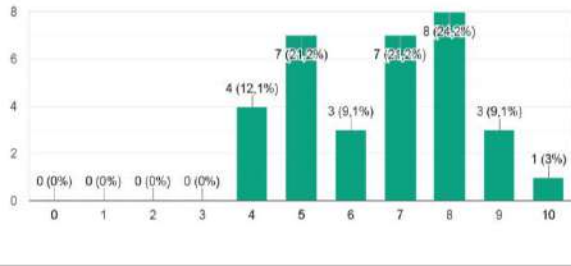
Fig.5: Graph about the score related to student's attention regarding remote teaching.

Regarding the remote teaching/learning process, the following suggestions have been made:

1. Teacher's qualification in order to use the platforms;

2. Sharing multiple screens and allowing better image quality;

3. Correspondence among the tools: storing the recorded classes for indefinite time.

4. Interactive board: tool used to doodle on the screen that can be shared with the student in real time with easy manual expression.

5. Improving the tool "allow control" on MSTeams.

6. Lower the time for classes in video-call.

7. Appropriate tools to use the apps on the computer as well as on the mobile phone;

8. Digital Acessibility to professionals and pupils: equipment and internet connection;

9. Splitting students in diferente meetings to alloow group work;

10. Suggestion to improve Meet: allow seeing students while sharing the screen as it is like in Zoom, without the need for another window.

11. Having a channel or a tool to assess and give feedback on the teaching/learning process that is more efficient and to confirm its effectiveness.

1.4 Pupils

Altogether, 116 answers were collected between April 1st and May 1st, 2021. Among the students who took part in the survey, only 7,8% were under 18. The great majority (70,7) are between 19 and 25 years, followed by 17,2% who are between 26 and 35 years, whish is a total of 87,9% of the participants. The smallest share (4,3%) is up to 45 years.

80% of the participants are undergraduate students, 7,8%are attending a Master course, 7% are Lato Senso extension students, which is a total of 94,8%. Only 5,2%

are in High School. All students confirmed having had remote classes, and 7,% of them claimed to have had hybrid or blended classes, which means, partly remote and partly face-to-face
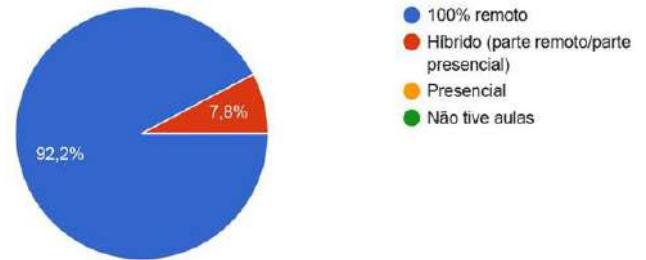
Fig.6: Remote synchronous and asynchronous classes graph.

Regarding the syncrhonicity of the classes, only 6,9% had asynchonous classes, in other words, with recorded vídeos and/or mailed videos. The other 93,1%had synchonous classes, which means, live classes in several platforms available, and most part of the users were in Google Meet (Classroom): 70,7%; followed by Microsoft Teams: 31% and Zoom: 20,7%. In a smaller scale, Skype was mentioned with 3,4% and Youtube Lives with 2,6%, which is a total of 6%. The other 5,3% correspond to less frequently used platforms: Zoom Cloud Meetings, Moodle e Blackboard.
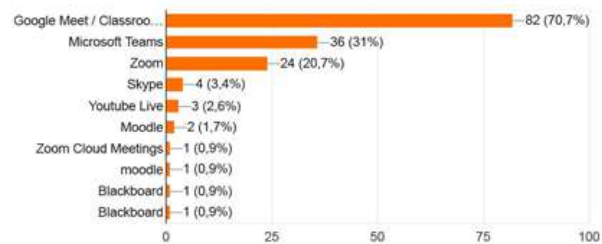
Fig.7: Platforms used for teaching graph.

Regarding the devices, 92,2% had access to classes mostly on their computer, while 7,8% had access by their phone.

Class running time was reported to have 18,1% over 2h45; 42,2% were said to last between 1h45 and 2h30 and 38,8% between 45' and 1h30. From these participants, 36,5% said that there is not a break. 52,2% have a break that ranges between 10 to 15 minutes and 9,6% have up 30 minutes break.
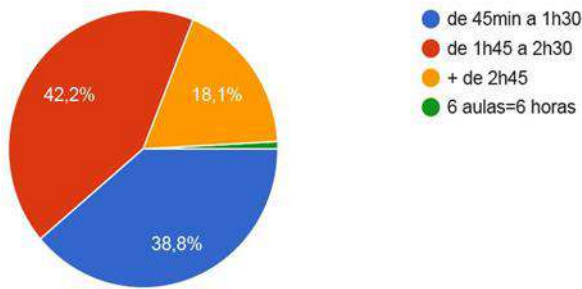
Fig.8: Class running time graph.

Regarding the satisfaction to this break, 56,5% believe that this amount of time is not enough to rest and return to the activities and 43,5% feel comfortable and agree that the time is sufficient to rest and return to work.
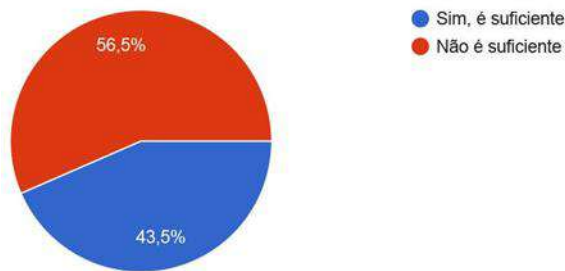

Fig.9: Satisfaction regarding break time between remote classes.

Most students reported that they turn on the camera only when they are asked to do so (63,5%), 27% do not turn it on at all and only 8,7% keep their câmeras on most of the class.
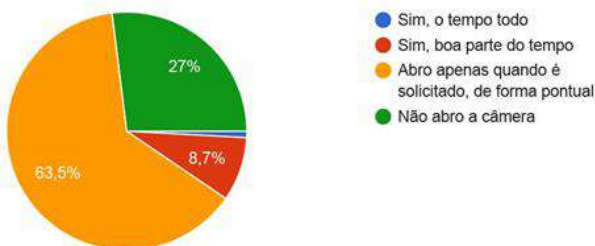
Fig.10: Graph about the use of câmeras in remote classes.

On the one hand, those who were asked whether they felt comfortable with their cameras on, 3,5% reported to be constrained. On the other hand, the same percentage (3,5%) reported thar there was no constraint at all. The biggest share (45,2%) claims not to feel comfortable,

30,4% are unaffected, which means that they do not bother, and 17,4% will definitely not turn their câmeras on. It is clear that using the camera is not welcomed by most of the students (66,1%)
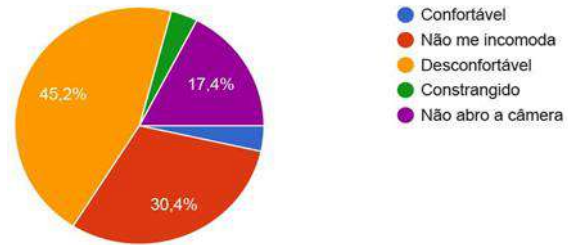
Fig.11: Graph about how students feel about turning their cameras on during remote classes.

After evaluating from 0 to 10 their satisfaction regarding remote teaching during the pandemic, 0 meaning absolute diss, 5 is the average which means students are unaffected by the situation, and 10 showing complete satisfaction. Results show that 21 students (18,1%) graded 5. Other 33 students (28,5%) reported dissatisfaction as their grades was below 5.

So, those who are dissatisfied correspond to 46,6% of the participants, which shows that, compared to teachers, students are even more upset with this teaching/learning style. In relation to the scores given which were between 6 and 7 points, corresponds to 31% of satisfied participants, and between 8 and 10 points, reported even more satisfied participants, a total of 62 students (53,4%) revealed their satisfaction.
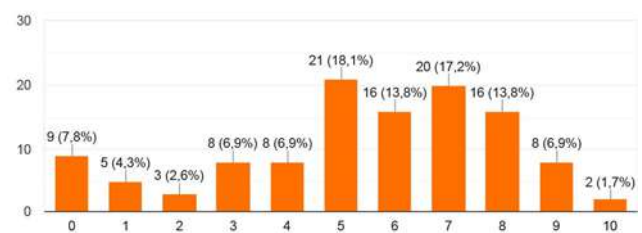
Fig.12: Graph about the use of cameras during remote classes.

The last question was optional and it was about recommendations to improve this teaching process:

1. Professor should reduce the demand for homework and projects as it has become exhausting. Demands on projects have increased significantly with remote teaching;

2. Breaks every hour as it is tiring and uncomfortable to be in front of the screen for long hours without a time to rest. Besides that, it is hard to focus.

3. More rapport from everyone: both speakers (teachers and professor) and listeners (students);

4. That classes were recorde for further revisiting, or even to be watched at any other time;

5. Teachers' qualification and support to operate the technology;

6. Shorter classes, focused on the content instead of the course load accomplishment.

7. More interaction among teachers and student through active methodologies, in other words, activities that require active participation from students instead of only expository lectures.

8. Improving visual aids in order to facilitate learning and hold their attention;

9. Having a schedule containing deadlines and course contente; and making it available to student so that they can have a clear view of the course;

10. Avoid showing videos during class. Assign them for recorded classes and only bring the content for discussion in class;

11. Smaller groups with 10 to 15 sudents to facilitate interaction, content delivery before class discussion, feedback about the class to check whether students are following and learning successfully;

12. Understanding the remote classes cannot be delivered as a face-to-face class, in other words, avoid adapting face-to-face to remote. Although the goal is the same, they are still different things.

IV.   CONCLUSION

Professors and students had been familiar with face-to-face classes and, due to the Covid-19 pandemic, had to face the need for social distancing, which caused na abrupt and dramatic break in the already existing teaching style. The solution for this problem was the adoption of the Emergency Remote Teaching (ERT) in all levels of education.

This research aimed to confirm the perception of students, teachers and professors from High School and Higher Education (undergraduate and extension courses), while using online platforms for remote classes and to pinpoint their experiences. As remote teaching is a style

that has, for first time, become part of most of these people's lives, presumably, will continue to be for a long, if not, indefinite time.

Through this survey applied online, via Google Forms, it was possible to confirm the perceptions for both use (usability) and emotional (psychological) which this teaching style causes, since usability involves the aspects of efficiency, effectiveness as satisfaction regarding the products.

According to the survey applied to teachers and professor, we now understand that half of the interviewees received no training at all and from these interviewees, more than 70% reported trouble in working with the platform, such as technical and operational as well as homework assignment.

The lack of interaction with students who do not turn their cameras on and do not take active part in class, already mentioned in this research, may have been one of the reasons why teachers/professor feel discouraged, frustrated, annoyed and sad. According to the answers, other feelings were also reported: fear, listlessness, emotional distress, uncertainty and exhaustion. Fatigue, headaches and voice failure were also said to have happened.

However, as almost 40% of the professionals feel discouraged, the same percentage feels hopeful, which can be reassuring given the circumstances.

For the students, the greatest dissatisfaction was in relation to remote classes. They would appreciate if classes were shorter because they feel very tired and they lose focus after one hour in class. We noticed that the use of cameras is not considered a positive aspect for most students. However, they believe and understand that rapport is important coming both ways: from students and from teacher. Moreover, educational institutions must provide professionals with qualification in order o make accurate use of Technologies and active methodologies.

In face-to-face teaching, for many times, students' performance was passive towards the content given, regarding practice and teaching techniques. With remote teaching, we were able to observe students also playing their roles as a co-author and taking responsibility over their own learning process.

In general, both users (professionals and students) reported their experiences in a more negative way, mainly to what refers to their difficulties and limitations. This way, we can conclude that both professionals and students require a more empathic and receptive attitude among each other and also towards the new technologies. Teaching and learning will happen in this new context and a scenario

common to all, in other words, teachers and students will have to be responsible and committed to the teaching process.

As for further studies, the suggestion is to make an analysis based on the diagnose introduced by this research, as well as on ergonomic and heuristic criteria of the usability of the main platforms previously mentioned by the users in order to suggest improvements on the systems. This way, we are looking for the decrease on hostility towards technology and, consequently, making the learning process more efficient and effective. Also, this can maximize the comfort and satisfaction of the users, which may contribute positive and significantly to the teaching/learning process.

ACKNOWLEDGEMENTS

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Short Circuit Classification using the Discrete Fractional Fourier Transform and Artificial Neural Network

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Abstract—The basic principle of the protection philosophy is to select, coordinate, adjust and allocate the various equipment and protective devices in an electrical system to keep a specific relationship between them. An abnormality in the system can be isolated or removed without affecting other parts of the system. Another concern linked to protection systems is the efficiency of the distribution network at critical moments: many consumers can remain without electricity supply after the protection system has operated. Thus, the time spent by maintenance teams in locating the point of occurrence of the fault and preparing a diagnosis of the problem and corrective or even preventive measures should be as little as possible.This paper presents a methodology for detecting and classifying short-circuit faults in power distribution systems. An artificial neural network is applied to categorize short circuit types. The pre-processing of signals is carried out through the fractional Fourier transform, a variation of the Fourier transform, which allows the representation of signals in the domains between time and frequency. The developed system showed accuracy in all tests performed, detecting faults, classifying and identifying the phase affected by single-phase and two-phase faults.

I. INTRODUCTION

The increase in demand for electric energy has led to a reformulation of the commercial and technical structures of the electric power system in recent years. Power quality has become an increasingly important object of study in the sector. It is directly related to market competitiveness and technical aspects of services offered by agents of generating, transmitting, and distributing electricity [3].

Especially in the last two decades, the Brazilian energy sector has changed, such as the diversification of the nature of loads, incorporation of direct current transmission systems, and the increase in the number of distributed generators connected to the system [12].

The impact of such changes in the energy sector motivated the National Electric Energy Agency (ANEEL in the Portuguese acronym) to publish the Procedures for the Distribution of Electric Energy in the National Electric System (PRODIST in the Portuguese acronym), a set of

rules and guidelines that guide the actions of the agents in the electricity sector, facing the new scenario of the system [1]. In module 8, the PRODIST Processes procedures relating to the quality of electrical energy [2].

One of the faults related to various disturbances in the electrical power system is the short circuit. The characteristic of a short circuit is a closed path from very low impedance in an electrical circuit. Voltage increases, voltage interruptions, harmonic distortions, and current increases are disturbances related to short circuits in the Electric Power System.

Short-circuits can be classified according to their characteristics and are divided into Single-phase short-circuit, 2-phase short-circuit, 3-phase short-circuit, 2-phase ground short-circuit and 3-phase ground short-circuit.

The effects of each type of short circuit are felt differently by the electrical system; interruptions and voltage rises may occur due to permanent short circuits, phase voltage dips may be related to single-phase short circuits, among other disturbances.

The need to maintain energy quality presupposes that disturbances that degrade energy quality are studied and that new methods of analysis and classification of failures in the electrical system are proposed.

In [3], [15], the authors proposed a method based on artificial neural networks that classified disturbances in the electrical power system. The results obtained were satisfactory regarding the classification of voltage rises, impulsive transients, voltage sags, and harmonic distortions.

The use of artificial neural networks for fault classification was demonstrated in [7], where a system capable of determining the origin of faults in the windings of a power transformer was presented. The proposed system distinguished whether faults were due to mechanical or electrical defects in the windings.

A method to detect and classify ten short-circuit faults in distribution networks was proposed in [13] with the Fortescue approach and softmax regression to alleviate the adverse effects of transient data samples on fault classification.

A linear recursive model to detect faults using irradiance and temperature in the photovoltaic panel as input and power as output signals were proposed by [14]. The method used machine learning to classify each fault for short circuits, open circuits, partial shading, and degradation.

Given the advances in signal processing techniques, this article proposes a method based on the Discrete Fractional Fourier Transform (DFrFT) and artificial neural network to detect and classify short circuits.

The divisions of the article are sections and divided by: Section II presents the Fractional Fourier transform. Section III defines the types of short circuits. Section IV the methodology. Section V Results and Discourses. Section VI Conclusions.

II. FOURIER'S FRACTIONAL TRANSFORMATION

The Fractional Fourier Transform (FrFT) is the best-known example of a fractional transformation, whose applications are developed in several areas. Generally, it is a generalization of the Fourier transform that allows signals to be represented in intermediate domains, that is, domains that lie between time and frequency [8], [16]. One of the ways to represent the FrFT is through its integral form, as in equation (1):

$$F^a f(t) = \int_{-\infty}^{\infty} K_a(t_a, t) f(t) dt \qquad (1)$$

Where the term $K_a(t_a, t)$ is the core of FrFT that can be written through spectral expansion in terms of Hermite-Gaussian eigenvectors as in equation (2):

$$K_a(t_a, t) = \sum_{k=0}^{\infty} \psi_k(t_a) e^{jka\pi/2} \psi_k(t) \qquad (2)$$

The spectral expansion of the FrFT core in terms ofHermite-Gaussian eigenvectors is possible since they are a canonical family of eigenfunctions shared between the Fourier transform (F.T.) and the FrFT. In equation (2), the k-nth Hermite-Gaussian function is given by [10],[16]:

$$\psi_k(t) = \frac{2^{1/4}}{\sqrt{2^k k!}} H_k(\sqrt{2\pi} t) e^{\pi t^2} \forall \, k = 0,1.2,\dots \qquad (3)$$

Several studies have been carried out in recent years to obtain a discrete version of FrFT and develop applications of the tool in the field of digital signal processing. The fractional discrete Fourier transform (DFrFT) can be obtained through the spectral expansion of the matrix F of length N of the Discrete Fourier transform (DFT), which can be written as:

$$F = EAE^T \qquad (4)$$

Where DFT eigenvectors are defined in the matrix E and the eigenvalues in the diagonal matrix A. Thus, it is possible to obtain the discrete version of the FrFT obtaining the i-th powers of the eigenvalues of the DFT, that is:

$$F = EA^a E^T \forall\, a \in \mathbb{R} \qquad (5)$$

Obtaining the discrete version of FrFT through thisapproach depends on the method used in the spectral expansion of the DFT matrix F and on the determination of an adequate set of eigenvectors in this expansion since the F matrix has repeated eigenvectors.

One of the methods used to obtain the DFT eigenvectors is the implementation of generating matrices that, from an eigenvector v related to the eigenvalue t', determine the eigenvector v' associated with the eigenvalue t''. Methods based on matrices that switch with the DFT matrix are also used, that is, matrices that have standard sets of eigenvectors, and although these are in more recent studies, methods based on closed formulas are also used to obtain the DFrFT eigenvectors.

In addition to methods based on DFT autodecompositionto obtain a discrete version of FrFT, more straightforward methods are employed on continuous FrFT sampling.

The method used in this paper to calculate the DFrFT is based on the discretization of the integral form of FrFT through Shanon interpolation as proposed in [11], [16].

III.   SHORT CIRCUIT

Several disturbances in the electrical system are related to short circuits, so it is necessary to implement efficient methods for classifying, detecting, and distinguishing events in the electrical power system. Statistical analyzes indicate single-phase short circuit as the most common fault in the electrical system (70%), followed by two-phase short circuit (15%), two-phase ground short circuit (10%), and three-phase short circuit (5%) [6], [15].

In this context, to carry out this study, the most common short-circuit of the electrical system were selected so that the characteristics of each one are used in the training of an ANN artificial neural network that classifies the types of short-circuits and distinguishes short-circuits. Circuit of other faults in the electrical power system.

Single-phase short circuit is a type of asymmetric short circuit that occurs when there is contact between the three phases of the system and earth. A single-phase short-circuit is called frank, or metallic when there is no reactance between an affected phase and a ground.

Generally, single-phase short circuits are associated with considerable drops in the phase voltage amplitude of thephase affected in the fault. Figures 1, 2, and 3 illustrate three examplesof single-phase short circuits in the system.
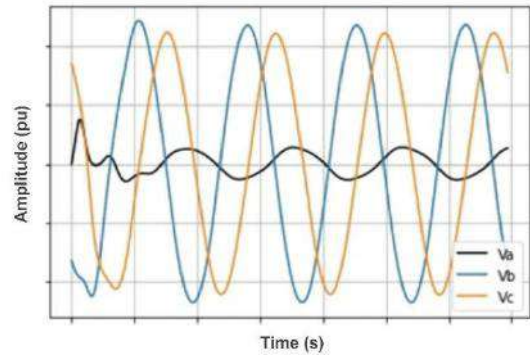

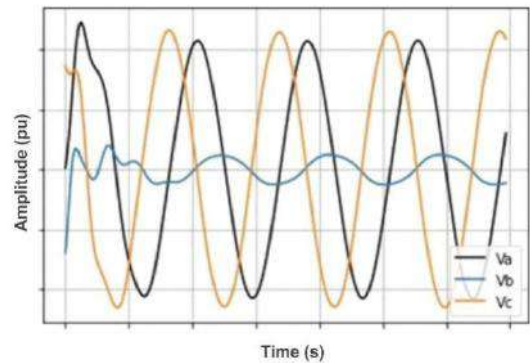*Fig 1. Single-phase short circuit in phase A*

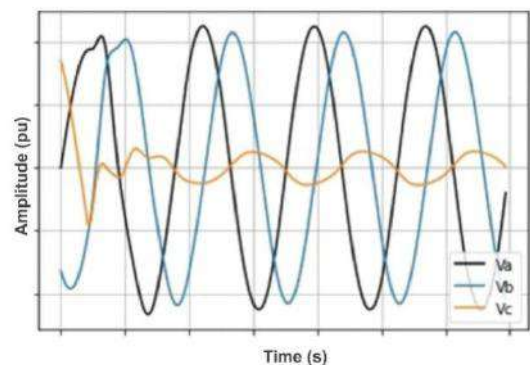*Fig 2. Single-phase short circuit in phase B.*

Fig 3. Single-phase short circuit in phase C.

A two-phase short circuit is a type of asymmetric fault that occurs between two phases of the system and may or may not be grounded. As with the single-phase short circuit, the contact between the two phases can occur

through reactance, or metallic contact between the phases can occur.

Generally, the phases involved in a two-phase fault are also affected by voltage drops. Figure 4 illustrates Frank's two-phase short circuit between phases A and B of the system.
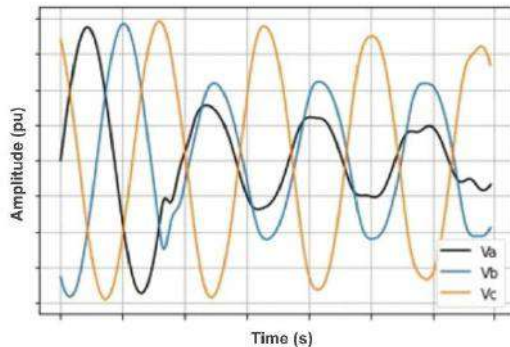

Fig 4. Two-phase short circuit in phases A and B.

A three-phase short-circuit is a symmetrical fault. That is, it does not cause unbalance in the system, as all phases are requested equally. As it is a balanced short circuit, there is no zero sequence. Even though the ground is involved, the current through the neutral is equal to zero. Figure 5 represents an example of a three-phase-to-ground short circuit.
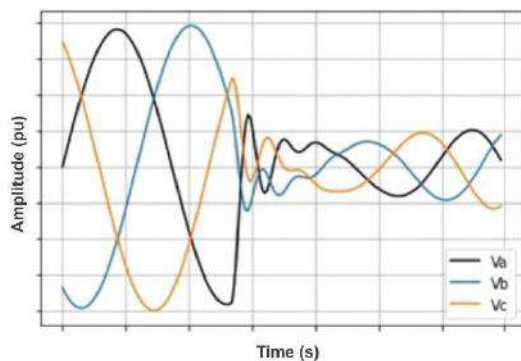
Fig 5. Three-phase-to-ground short circuit.

As the figures illustrate, each type of short circuit has specific characteristics and is related to several disturbances that degrade the quality of electrical energy. Therefore, it is necessary to implement analysis methodologies that allow a detailed study of this type of fault.

IV. METHODOLOGY

The field of digital signal processing has a close connection between theory and practical applications in new technologies. Finite length transforms initially defined in the real body, eventually give new signal synthesis and analysis tools.

This article presents an event classification method based on signal processing and computational intelligence in the electrical power system. The transformation used for the extraction of characteristics from the analyzed signals is the discrete fractional Fourier transform.

The algorithms used to classify events are multilayer perceptron artificial neural networks whose training is done through the backpropagation of the error.

The use of artificial neural networks in conjunction with DFrFT for pattern recognition was proposed [4]. The authors demonstrate that the error in pattern classification can be 5% lower using DFrFT than DFT and 14% smaller than results obtained without pre-processing the signals.

In this article, artificial neural networks were usedto classify input signals according to the type of short-circuit, identify the phase affected by two-phase and single-phase faults, and detect a short-circuit in the electrical network.

In all tests performed, 260 samples of each event were considered. Each of the samples considered contains the phase voltage in phases A, B, and C and the phase currents in phases A, B, and C.

Each artificial neural network (ANN) implemented was trained with 70% of the total samples considered (182 samples), and the test validation is performed with 30% of the total samples (78 samples).

A. ANN pre-processing and training

The signals used to carry out the work were obtained by simulating the IEEE 34 bus test network in the virtual environment Typhoon H.I.L. [5], [9], [17]. In the pre-processing of signals, see Figure 6, DFrFT is applied to signals whose fractional parameter a (which determines the order of the transform) varies from $0.5 <$ to < 0.8.
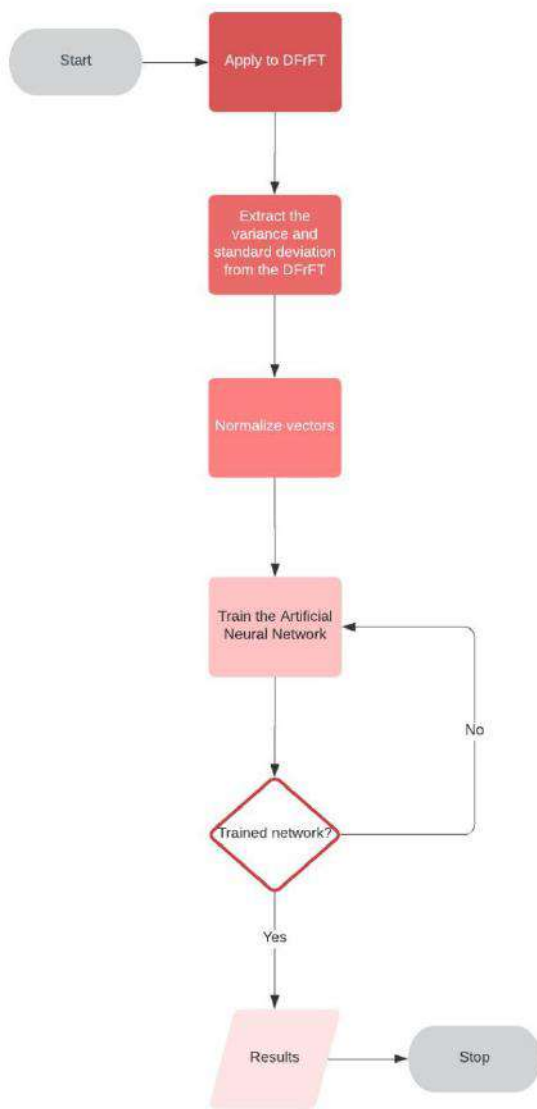
Fig 6. Basic flowchart of ANN pre-processing and training.

After applying the transform, the variance and standard deviation of each DFrFT vector were obtained according to equations (6) and (7).

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i, \mu)^2 \ \forall \ i = 1, 2, \dots, N \qquad (6)$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i, \mu)^2} \ \forall \, i = 1, 2, \dots, N \qquad (7)$$

Finally, all resulting vectors are normalized between0 and 1 for the training of ANN to be carried out.

B. Artificial neural network for short circuit detection

The artificial neural network implemented for short circuit detection was trained using the Adam method, and the hyperbolic tangent activation function was used. The hidden layers have 20, 10, 9, and 8 neurons plus an input layer and an output layer, both with one neuron.In order to validate the model, tests were performed using DFT and DFrFT to pre-process signals with $a = 0.5$.

C. Artificial neural network for short circuit classification

The artificial neural network implemented for the short circuit classification was trained through the Adam method, and the activation function used was the Rectified Linear Unit – Relu. The network has four layers, two hidden layers, one input layer, and one output layer. The number of neurons per layer is 1, 25, 16, and 1. All tests were validated by comparing the results using DFT and DFrFT in pre-processing signals with $a = 0.5$.

D. Artificial neural network for identification of the affected phase in single-phase short circuit.

The artificial neural network implemented to identify the phase affected by single-phase faults was trained using the Adam method, and the activation function employed was the hyperbolic tangent. The network has five layers, three hidden layers, one input layer, and one output layer. The number of neurons per layer is 1, 20, 18, 15, and 1. All tests were validated by comparing the results using DFT and DFrFT in pre-processing signals with $a = 0.8$.

E. Artificial neural network for the identification of the affected phase in biphasic short circuit

The artificial neural network implemented to identify the phase affected by biphasic faults was trained using the Adam method, and the activation function employed was the hyperbolic tangent. The network has five layers, three hidden layers, one input layer, and one output layer. The number of neurons per layer is 1, 20, 18, 15, and 1. All tests were validated by comparing the results using DFT and DFrFT in pre-processing signals with $a = 0.8$.

V. RESULTS AND DISCUSSION

A. Short circuit detection

The method developed to detect short-circuits in the electrical network presented 100% accuracy for all test cases. The ANN trained with the variance and standard deviation of the DFrFT vectors showed faster convergence, in 194 iterations (Figure 7), against 200

iterations for the ANN trained with the variance and standard deviation of the DFT vectors (Figure 8). Table I shows the results obtained.
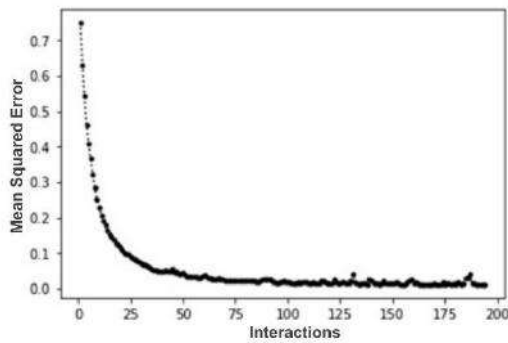

Fig 7. Decay the mean square error in relation to the number of iterations for the ANN trained with the DFrFT vectors.
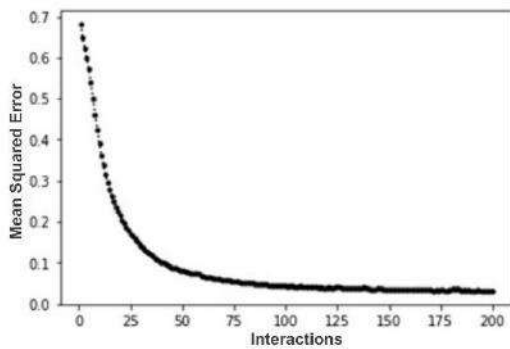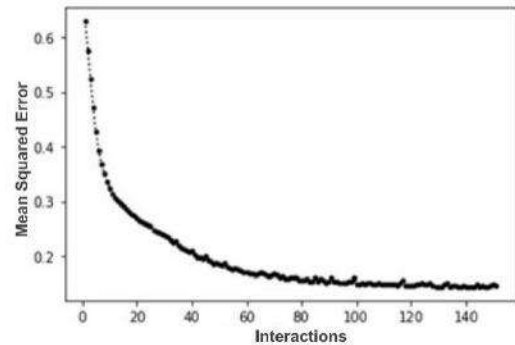

Fig 8. Decay the mean square error in relation to the number of iterations for the ANN trained with the DFT vectors.

Table I		
Results Obtained for Short Circuit Detection		
Transform used	DFT	DFrFT
Accuracy for short circuit detection	100%	100%
Number of iterations	200	194
Activation function	Hyperbolic Tangent	Hyperbolic Tangent
Initial learning rate	0,001	0,001

B. Short circuit classification

The results obtained for the classification of the short circuit demonstrate the advantage of using DFrFT over DFT. In addition to the faster convergence of the ANN, the accuracy obtained in the classification of events was greater.

Despite the greater precision and faster convergence, data pre-processing with DFrFT has a higher computational cost.This fact must be considered in real-time implementations. The results obtained can be seen in Figures 9 and 10.

Fig 9. Decay the mean square error about the number of iterations for the ANN trained with the DFrFT vectors.
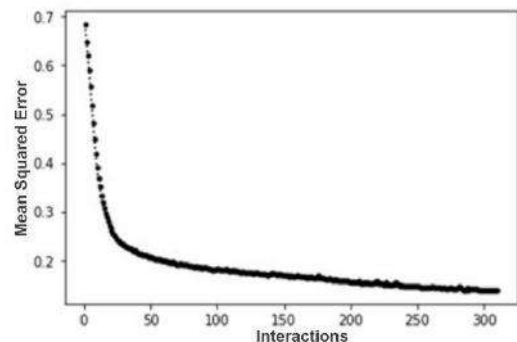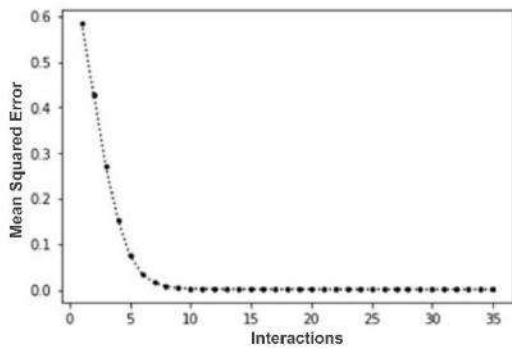

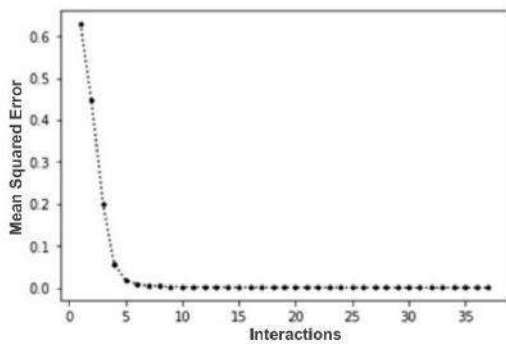*Fig 10. Decay the mean square error concerning the number of iterations for the ANN trained with the DFT vectors.*

Table II		
Results Obtained for Short Circuit Classification		
Transform used	DFT	DFrFT
Accuracy for three-phase short circuit	99,18%	99,75%
Accuracy for two-phase short circuit	85,21%	94,97%
Accuracy for single-phase short circuit	96,74%	98,14%
Number of iterations	310	151
Activation function	Relu	Relu

Training method	Adam	Adam
Initial learning rate	0,001	0,001

Activation function	Hyperbolic Tangent	Hyperbolic Tangent
Training method	Adam	Adam
Initial learning rate	0,01	0,01

C. Identification of the phase affected by the fault in single-phase short circuits

There was no evidence of the superiority of DFrFT over DFT, and vice versa, in the tests performed. Both ANN showed 100% accuracy in all cases considered, but ANN trained with DFrFT vectors showed a slightly faster convergence. The results can be seen in Figures 11 and 12 and Table III.

D. Identification of the phase affected by the fault in two-phase short circuits

The results obtained are similar to the results in identifying the affected phase in single-phase faults. Both ANN has 100% accuracy; however, in this case, convergence was slightly higher in the ANN trained with DFT vectors. The results obtained can be seen in Figures 13 and 14 and Table IV.
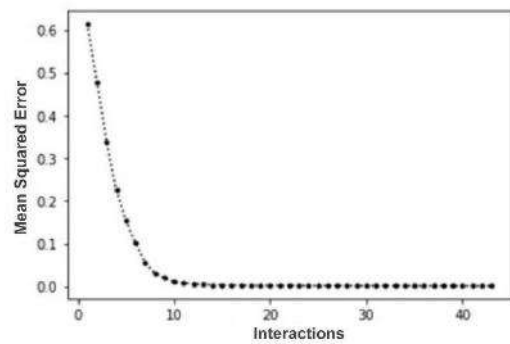

Fig 11. Decay the mean square error concerning the number of iterations for the ANN trained with the DFrFT vectors.

Fig. 13. Decay the mean square error with the number of iterations for the ANN trained with the DFrFT vectors.

Fig 12. Decay the mean square error about the number of iterations for the ANN trained with the DFT vectors.
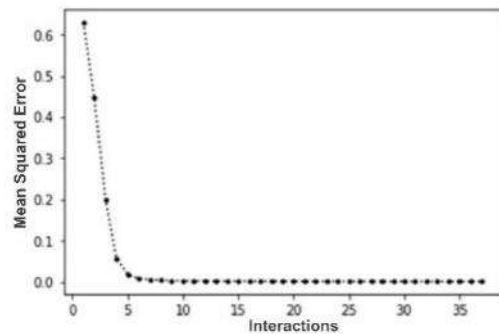

Fig.14. Decay the mean square error concerning the number of iterations for the ANN trained with the DFT vectors.

Table III

Results Obtained for The Identification of The Phase Affected by Single-Phase Faults

Transform used	DFT	DFrFT
Precision for phase A fault	100%	100%
Precision for phase B fault	100%	100%
Precision for phase C fault	100%	100%
Number of iterations	37	35

Table IV

Results Obtained for the Identification of the Phase Affected by Two-Phase Faults

Transform used	DFT	DFrFT
Precision for phase A fault	100%	100%
Precision for phase B fault	100%	100%

Precision for phase C fault	100%	100%
Number of iterations	37	43
Activation function	Hyperbolic Tangent	Hyperbolic Tangent
Training method	Adam	Adam
Initial learning rate	0,01	0,01

VI.   CONCLUSION

The increase in distributed generators, the diversification of load types, and other changes have raised important questions regarding the power quality of the electrical system. Maintaining energy quality in the face of the new scenario requires new methodologies for managing, operating, and protecting the electrical power system. The method presented in this article showed promising results in the tests performed and highlights the increasingly important role of signal processing techniques and artificial neural networks. The results obtained show the potential for using DFrFT concerning DFT since DFrFT has a greater degree of freedom, which allows for more accurate results and faster ANN convergence.

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Temporal and spatial distribution of storms on January 24th and 28th, 2020 in Belo Horizonte, Minas Gerais, Brazil

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Abstract—The South Atlantic Convergence Zone (SACZ) is the main meteorological system responsible for the occurrence of regular rains in almost the entire central and southeastern region of Brazil in rainy season. During the January 2020 these complex system has generate severe storms especially in Minas Gerais state. These intense episodes of precipitation induced real catastrophes and numerous impacts throughout Metropolitan Region of Belo Horizonte (MRBH) like overflow of water courses and destruction of road systems with closure of major avenues, causing deaths due to flooding or landslide and very high economic losses. The Belo Horizonte City recorded the highest intensity of rain measured in one hundred and twelve years of hydro-meteorological monitoring. The aim of this paper is the analysis of temporal and spatial distribution of rainy 24 and 28 January recorded at 46 automatic weather stations (AWS). These were the worst of all storms recorded at MRBH. In the temporal analysis, were applied the regional IDF relationships, the regional annual frequency curves with dimensionless intensities, and synthetic time-distribution graphs of rainfall or hyetographs. To verify the spatial distribution of these storms some statistical tools from the QGIS software were applied with the isohyets maps drawing. These shown that at the south-central portion of the city high-value isohyets conforms approximately to the high elevations on the windward slope, thus reflecting the prevalent direction of humidity inflow and the role of regional orography in the process of intensifying short-time rains.

I. INTRODUCTION

Designed by engineer Aarão Reis in 1897 Belo Horizonte was one of the first planned capitals in Brazil. The city started in the 1920s to channeling most of its watercourses, and with that, started its urban flooding problems. Thus, years after the channeling of the first stream, in 1929, a flood devastated the capital, showing that the rectification and fixation of the sections of the rivers and the transformation of their stretches into artificial channels did not solve the drainage issues, on contrary they accelerated and intensified their impacts.

Even so, decades later, the solution found by the municipal government was to expand and deepen the Arruda's stream channel, believing that with these works they would be solving all drainage city problems. Since then flood events have been numerous.

The city of Belo Horizonte was affected in 2020 year by several storms, having recorded one of the rainiest months of January of the last one hundred and twelve years, since the beginning of its hydro-meteorological monitoring, accumulating in 2020 a total of 935.2 mm.

The second rainiest January registered 850.3 mm in 1985 and the third registered 795 mm in 2003.

The most critical precipitation occurred on January 24th and 28th, 2020 registering daily heights of 171.8 mm and 117.4 mm, respectively, with the 24th day recording the highest accumulated in the entire monitoring period, as Belo Horizonte Station data operated by the National Institute of Meteorology – INMET. However, in the south-central portion of the city, the "Leitão" automatic station registered on the 28th, in three hours, a height of 186.4 mm with an intensity of 62.13 mm/h, the greater intensity over the entire measurement period. A 30-50 mm daily precipitation accumulated is already considered high, and greater than 50 mm is extremely high. Raining 100 mm or more in one day is something special that doesn't happen very often. It is an extremely large amount of rain, with the potential to cause serious damage and flooding in urban centers [1].

The events of January 2020 were of great magnitude and exceeded the response capacity of the micro and macro drainage and flood-dampening systems in the capital and in some municipalities of the Metropolitan Region of Belo Horizonte (MRBH). Floods were recorded in several water courses in the sub-basins that drain Belo Horizonte – "Arrudas" and "do Onça" watersheds, resulting in impacts of various magnitudes, which only didn't become a greater tragedy, due to actions of monitoring, prevention and contingency measures implemented by Belo Horizonte City Hall (PBH) by the Secretariat for Protection and Civil Defense.

This article presents a temporal and spatial analysis of the rains measured in forty-six rain gages stations (Fig. 1) on the 24th and 28th of January 2020, based on the network of automatic hydro-climatological stations of the "Hydrological Monitoring and Flood Warning Program of the Belo Horizonte municipality", operated by Superintendence of the Development of Belo Horizonte (SUDECAP), and automatic gauges stations of INMET and National Center for Monitoring and Natural Disaster Alerts (CEMADEN) and conventional stations database provided by the Brazilian National Water and Sanitation Agency (ANA).
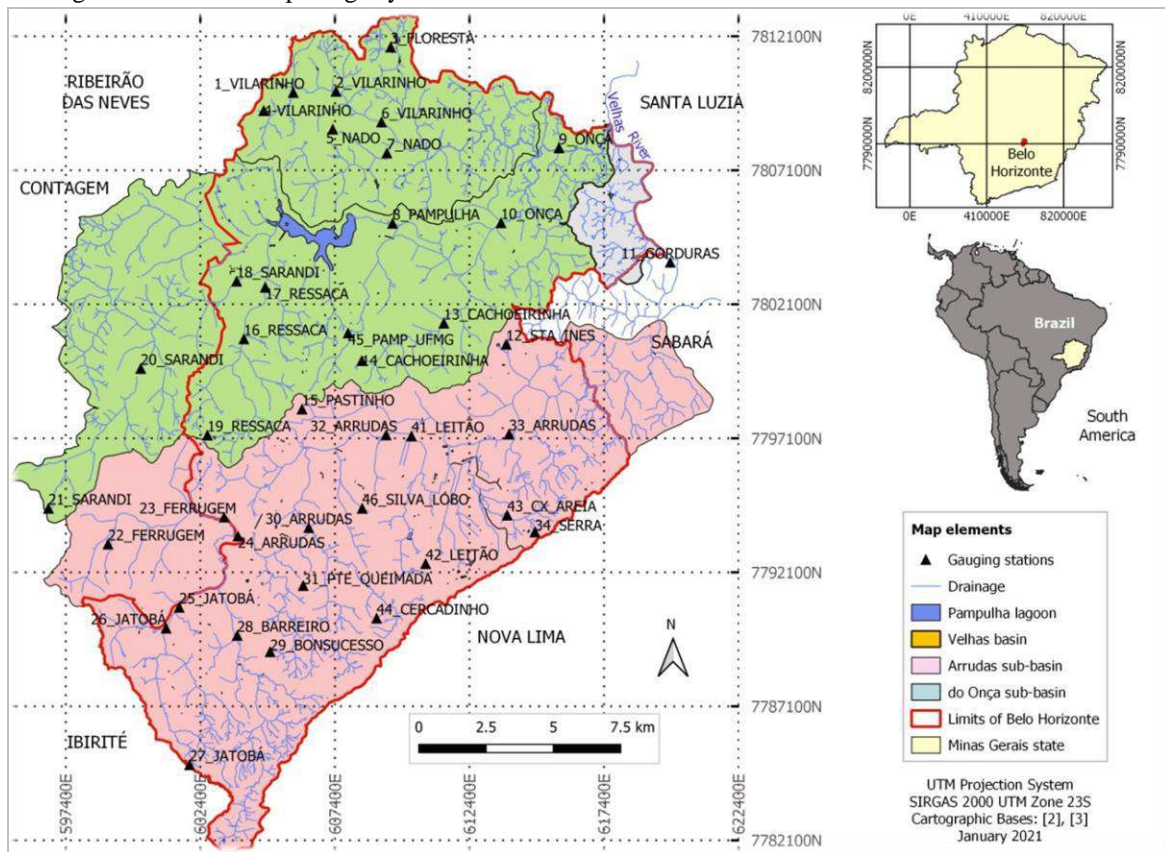

Fig. 1: Map of the study area – Belo Horizonte's rain measurement stations and sub-basins

II. METHODOLOGY

The flowchart of the presented methodology for the study of the temporal and spatial distribution of intense rainfall is illustrated in Fig. 2and the different aspects of it are explained in more detail in the following section.

2.1 Study Area and Data Collection

Located in the São Francisco river basin the limits of Belo Horizonte define a 331.4-km² area, between latitude 19°48'57"S and longitude 43°57'15"W, who has two sub-basins of "das Velhas" river: the "Arrudas" stream which drains the administrative regions: Barreiro, West, Northwest, Center-South and East; and the "do Onça" stream which drains the regional: Pampulha, Northeast, Venda Nova and North (Fig. 1).

Its climate is classified according to Köppen-Geiger as Cwa – tropical of altitude with dry winter and rainy summer. Throughout the year, it is under the control of the South Atlantic Subtropical Anticyclone (SASA) and, consequently, it has been subjected to large scale descending vertical movements [4].

During the spring and summer months when the South American Monsoon System is well organized, there is an expressive horizontal transport of humidity and heat from the Amazon region to Southeast Brazil. In that environment the South Atlantic Convergence Zone (SACZ) develops. This is the main large-scale system responsible for the rainfall regime over the Southeast regions of Brazil according to [5], [6], [7], [8] and [9].

The MRBH can be considered as a rainy region, presenting a basic unimodal cycle, marked by a clearly-defined wet season from October to March, followed by a dry season from April to September. Convective storms associated to frontal systems are at the origin of short-duration intense rainfall episodes over the city [4].

According to 2010 census [10] Belo Horizonte has a population of 2.5 million inhabitants. In the last decades there has been a significant increase in its urban population and that impacts the environment quality growing impermeable areas and intensifying floods.

It is observed that with the plumbing and rectification of their numerous water courses, the strangulation of the flow is notorious, causing overflows and flooding in the city. The drainage works adopted were mainly carried out with a view to solving localized problems of floods or making the implementation of "sanitary" avenues feasible. Besides, the process of uncontrolled urban growth has resulted in frequent and serious problems of urban flooding, configuring crises in drainage system.
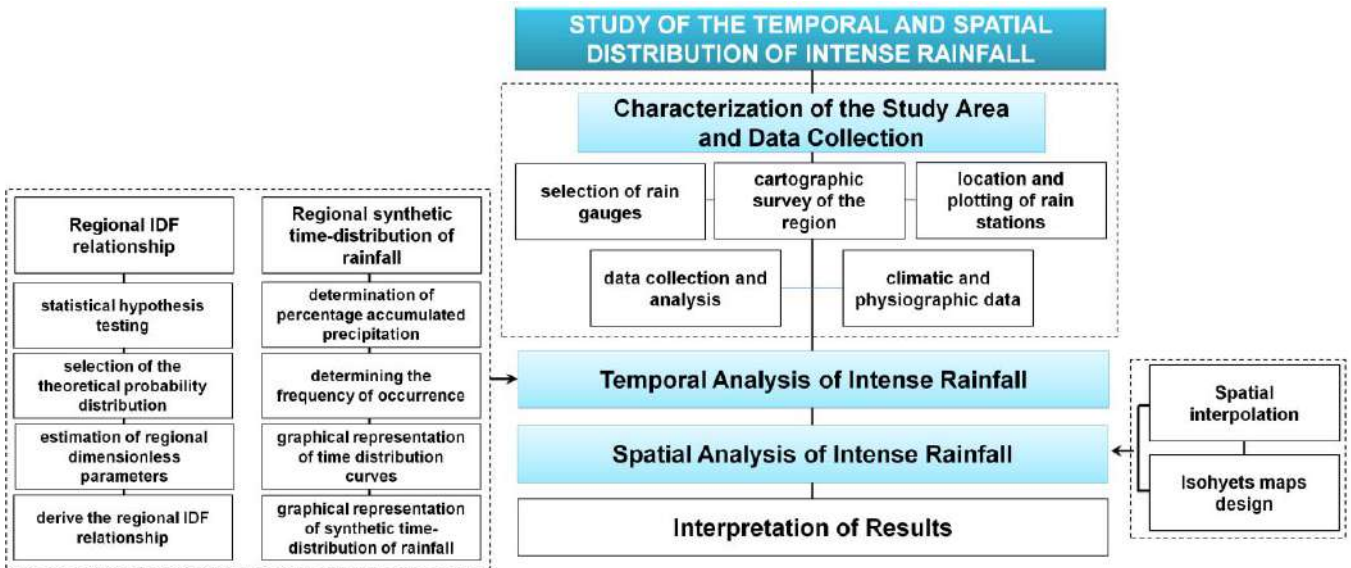

Fig.2: Overview of methodology

The regional relief is characterized by pronounced variations in altitudes, between the extremes of 650 m and 1500 m (Fig. 3), which are known to exert an important influence of intensifying condensation and consequently rainfall over the city.

In the storms of the 24th January 2020 all water courses in the city had floods, while in the 28th, the regions of Barreiro, West and South-Center were the most affected. The high altimetry levels contributed in these events with

increase of the drained volume, the reduction of the time-concentration with anticipation of the peak of floods and increase of the maximum flow in the hydrographs, increasing the frequency and the magnitude of the floods.
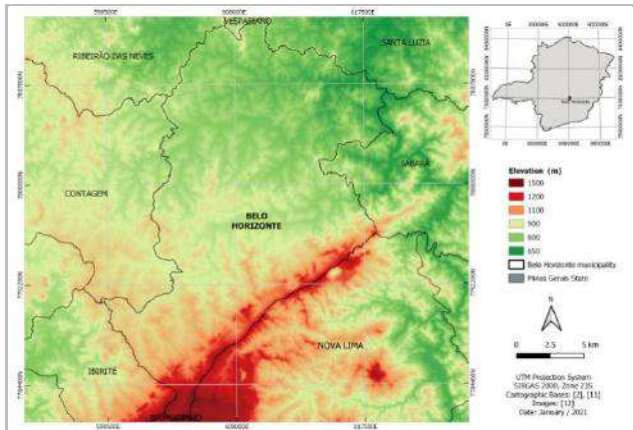
Fig. 3: Hypsometric map of Belo Horizonte

2.2   Temporal Analysis of Intense Rainfall

In many hydrological applications, interest lies in an estimation of the probability of occurrence of extreme events, as extreme rainfall intensities. These events are random variables and their probability of occurrence is represented by probability distributions.

In an extreme value analysis the determination of the most highly probable type of distribution is especially difficult. Some plausible distributions are "tied" and statistical test are performed to find the best distribution.

A methodology has been worked out by [13] that used the theory of probability weighted moments (PWM), introduced by [14], to define quantities known as L-moments. The L moments of order r, denoted by λ, can be written as linear combinations of the corresponding PWMs, these denoted by β, and defined as the following mathematical expression:

$$\beta_r = E\{X[F(X)]^r\} \tag{1}$$

The estimators for the first four L-moments can be calculated in terms of the PWM estimators from

$$\hat{\lambda}_1 = \hat{\beta}_0$$
$$\hat{\lambda}_2 = 2\hat{\beta}_1 - \hat{\beta}_0$$
$$\hat{\lambda}_3 = 6\hat{\beta}_2 - 6\hat{\beta}_1 + \hat{\beta}_0 \tag{2}$$
$$\hat{\lambda}_4 = 20\hat{\beta}_3 - 30\hat{\beta}_2 + 12\hat{\beta}_1 - \hat{\beta}_0$$

where $\hat{\beta}_r$ represent the unbiased PWM estimators for a given ordered sample $\{X_n \leq X_{n-1} \leq \cdots \leq X_1\}$ of size n.

Formally,

$$\hat{\beta}_r = \frac{1}{r+1} \sum_{j=1}^{n-r} \frac{\binom{n-j}{r}}{\binom{n}{r+1}} r \leq n-1 \tag{3}$$

As compared to conventional moments, L-moments generally yield more robust and accurate estimates of distribution parameters and quartiles of a random variable. L-moments and L-moments ratios can be interpreted as measures of distributional shape. For instance, λ1 is a measure of locations, λ2 is a measure of scale, the ratio L-cv = λ2/λ1 is analogous to the conventional coefficient of variation, the rations τ3 = λ3/λ2 and τ4 = λ4/λ2 represents measures of skewness and kurtosis, respectively.

2.2.1   Regional IDF relationship

Specific applications and illustrations of the theory for regional frequency analysis has been applied by many authors like [4][15], [16] and[17], and others that as [18], [19], [20]and [21] used "index-flood"-type procedures along with L-moments and L-moments ratios averaged over a number of sites within a region, to propose a set of statistics which provide objective backing to the typical stages involved in regional frequency analysis, such as data consistency, identification of homogeneous regions and choice of frequency distribution and estimation of its parameters.

These statistics are: the discordancy measure (Di) for screening discrepant data at site I, the heterogeneity measure (H) for identifying homogeneous regions, and the goods-of-fit measure Z for selecting the appropriate regional probability distribution.

These techniques have been used to define the regional IDF relationship valid for the MRBH, by combining regression models with the dimensionless regional frequency curves that results to be,

$$\hat{\imath}_{T,d,j} = 0{,}76542 \, d^{-0{,}7059} P_j^{0{,}5360} \mu_{T,d} \tag{4}$$

where $\hat{\imath}_{T,d,j}$ is the storm rainfall intensity of duration d associated to return period T, at site j inside the MRBH (mm/h); d is the rainfall duration (h); Pj is the mean annual precipitation (mm) at site j, from the isohyets map and $\mu_{T,d}$ is the regional dimensionless quartile. These quartiles refer to the ratios $\frac{i_{T,d}}{\bar{\imath}_d}$, where $i_{T,d}$ represents the intensity of rain (mm/h) for a return period T and $\bar{\imath}_d$ the average intensity of the maximum events of precipitation at a given location within the MRBH, both for the duration d according to [4], [15] and[17].

It is observed in equation (4), that the annual precipitation is a variable independent of the regional IDF relationship for the MRBH. The inclusion of annual precipitation in this equation synthesizes the influence of two factors on the maximum intensities of precipitation. The first one refers to the spatial differences in available humidity for the origin and continuity of the occurrences of intense rainfall, indirectly quantified by the variation of the annual rainfall totals in the MRBH. The second, inherent to the layout and spatial conformation of the isohyets map, reflects the orography influences on the intensification of precipitation events [4].

This pioneering work provided better estimates of quartiles and regional synthetic time-distribution precipitation, leading, in turn, to the assertiveness of the estimates of the characteristic variables of urban drainage systems projects, as found by [22] who verified the effectiveness of this equation in the dimensioning of drainage systems for the present day, not having found significant differences between the results obtained in their study and with the application of Equation (4).

After estimating the dimensionless quantiles for all the studied durations was prepared regional annual frequency curves for dimensionless intensities on extreme I-Gumbel type paper [4]. These curves were used to estimate the frequency of precipitation that occurred in the city of Belo Horizonte in January 2020.

2.2.2 Regional synthetic time-distribution of rainfall

The methods for creating reference hyetographs are described in the literature. The division of these methods has been described in many works, including [23], [24] and [25] as based on IDF/DDF curves, historical rainfall data, and stochastic methods.

According to [25] the best known with widespread use to analyze the variability of precipitations over time is the method proposed by [26]. Huff' curves are, therefore, a probabilistic representation of the ratio of cumulative precipitation heights.In this method, the temporal distribution of the storm is obtained by the relationship between the percentiles of the total precipitation and the percentiles of the total duration. The storms are grouped according to the occurrence of their maximum intensities in the 1st, 2nd, 3rd or 4th quartile of the temporal distribution of the total height of precipitation. For each quartile, dimensionless mass curves are associated with probabilities ofexceedance, selected to construct synthetic time-distribution of precipitation relative to different probabilities of exceedance and duration of precipitation in a region.

In order to determine the temporal distribution of precipitation, established design hyetograps for the MRBH based on Huff's methodology and on information compatible with the hydro-climatological conditions of the region. The great advantage of this method is the establishment of regional hyetograps, provided that regional homogeneity has been previously defined. These are used in the analysis of the most critical condition of rainfall in January 2020. With these studies, it is possible to construct the hyetographs of MRBH projects for different intervals of precipitation duration and probabilities of exceeding 10% to 90% ([4],[15], [17]).

2.3   Spatial Analysis of Intense Rainfall

2.3.1 Spatial interpolation

The analysis of the spatial evolution of rainy events isbased on event data collected at various points in the study area. These data are selected for different durations.

Then, the spatial analysis of the data is made through interpolations of these and the tracing of isohyets. Spatial interpolation is a process used to estimate unknown values of a function from known values of the same function. In this sense, several interpolators can be used, such as Kriging, Minimum Curvature, Nearest Neighbor, Radial Base Function, Moving Average, Local and Inverse Polynomial of Distance Power, or Inverse of Distance to a Power, or even, Inverse Distance Weighting (IDW) ([27]).

Interpolation results can vary significantly based on the method and parameters you choose. For modelling spatial distribution of rain using one spatial interpolation methods applying the software QGIS that is a free and open source GIS application enabling the user to visualize, manage, edit, analysedata, and compose printable maps. QGIS interpolation supports Triagulated Irregular Network (TIN) and Inverse Distance Weighting (IDW) methods for interpolation. TIN method is commonly used for elevation data whereas IDW method is used for interpolating other types of data such as punctual rainfall measures.

In the IDW interpolation method, point samples are "weighed" during interpolation according to how the influence of one point relative to another declines with the distance from an unknown point that you want to create. This method is widely used in the interpolation of rainfall data, as the study for Brazilian Goiás State [28]. These authors varied the power parameter to be equal to 2, 3, 4 and 5 and concluded that $\beta = 2$ produces more accurate results than the others,

$$\hat{Z}_j = \frac{\sum_{i=1}^{n}\left(\frac{z_i}{h_{ij}^{\beta}}\right)}{\sum_{i=1}^{n}\left(\frac{1}{h_{ij}^{\beta}}\right)} \tag{5}$$

$$h_{ij} = \sqrt{d_{ij}^2 + \delta^2} \tag{6}$$

where, $\hat{Z}_j$ is the interpolated value of grid node j; h_{ij} is the effective separation distance between grid node j and neighboring point i; Z_i are neighboring points; β is the weighting power (power parameter); d_{ij}^2 is the distance between grid node j and neighboring point$i$; $\delta^2$is the smoothing parameter.

2.3.2 Isohyets maps design

Isohyets are used to represent the rainfall values measured across the study area. The construction of this

map is proceeded by an interpolation performed in a discrete way between successive points. Among the interpolation methods, the IDP stands out for being a method that seeks the minimum variance with a low density and irregularly spaced data network [29].

III.   RESULTS AND DISCUSSION

3.1   Location of Monitoring Stations

Forty six rain gauges were selected and information was collected from institutions that operate the hydro-meteorological gauging stations in Belo Horizonte, as well as results of studies developed by ([4],[15] and [17]).The physiographic aspects of the region also were used as a basis for analyzes.

The precipitations that occurred on 24 and 28 January 2020 in 10-minute intervals were accumulated in intervals of 1, 2, 3 and 4-hours for the entire automatic network operated by SUDECAP, INMET and CEMADEN and conventional station database provided by ANA in the city of Belo Horizonte.

3.2   Meteorology of January 2020 events

Raining heavily in January is quite common over Brazil. In a normal situation, the country already has a high availability of humidity and hot air, basic ingredients for the formation of large clouds that cause storms. In addition, it is a month in which the South Atlantic Convergence Zone (SACZ) events and the areas of instability in the Inter-tropical Convergence Zone (ITCZ) which cause heavy and voluminous rain also begin to act on the country. In January 2020, the meteorological systems were operating in Brazil, and described below.

The South Atlantic Convergence Zone (SACZ) is the most important phenomenon on the inter-seasonal scale that occurs during the summer over Brazil, resulting from the interaction of the wind circulation of several meteorological systems that act at the same time ([5],[6], [7],[8], [9]). The Bolivian High (BH), which is a large system of high atmospheric pressure is an anti-cyclonic circulation, counterclockwise which develops during the summer over the Bolivian Altiplano, a high plateau region of the Central Andes ([30], [31]).

Inter-tropical Convergence Zone (ITCZ) is a system of low pressure in which the circulation presents the colder center than your periphery and occur more frequently in January. A warmer air rises on the periphery, where there is formation of cloudiness [32]. Cold Front on the Southeast Coast (CFSC) is the presence of an atmospheric trough (waving in the clockwise movement of winds) at medium levels of the atmosphere [1]. The most intense period of rain that occurred on January 24th was between

19:30h and 22: 30h, while on 28th was between 20:20h and 23:20h.

3.3   Temporal Analysis of January 2020 rainfalls

The rainfall on 24 and 28 January 2020 with durationsof 1, 2, 3 and 4 hours, were dimensionless by the regional average and represented in graphs of the MRBH annual regional curvesobserved (Fig. 4). It was observed that in the January 24th storm, all monitoring points registered rainfall with return periods below 100 years. However, the January 28 storm was much more severe in terms of short duration, since in some points return periods of around 1000 years were observed, as is the case with stations 30-Bonsucesso, 43-Caixa de Areia and 44-Cercadinho, while at station 42-Leitão outliers of the time series were. According to WMO (2009), the presence of these values in historical series can influence the values of the series mean and standard deviation, and, consequently, the frequency analysis, suggesting evaluations of PMP - maximum probable short-term precipitation for the MRBH.
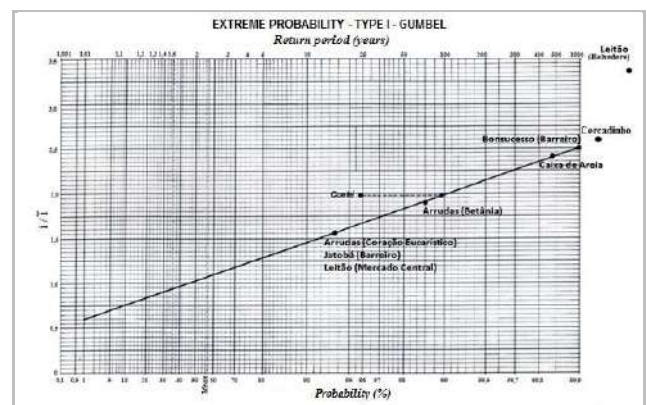

Fig. 4: Regional annual frequency curve for dimensionless intensities. Precipitation duration = 3 hours

As it is the largest storm in the Belo Horizonte region with maximum intensity at the first three hours Fig.5 to 7show the temporal distribution of the January 28 rainfall occurring in the "Leitão" stream (Central-South Region) for different exceedance probabilities, were built according to [4]. This author has demonstrated that this analysis is essential to obtain reliable results on the effects of floods in urban basins.
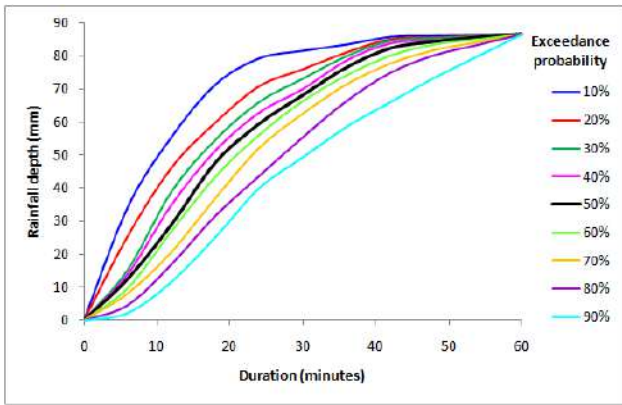
Fig.5: Temporal distribution of precipitation for different probabilities of exceedance and duration < 1 h
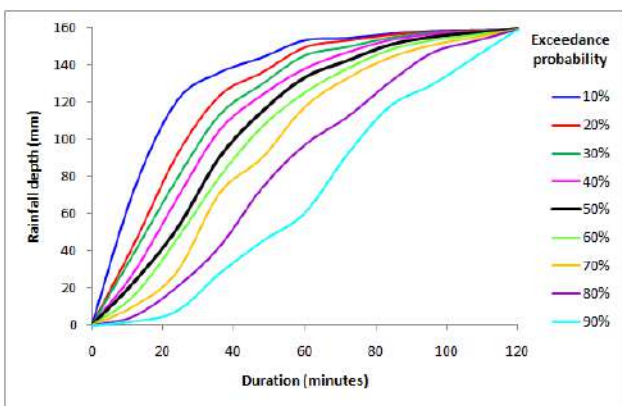

Fig. 6: Temporal distribution of precipitation for different probabilities of exceedance and 1h < duration < 2 h
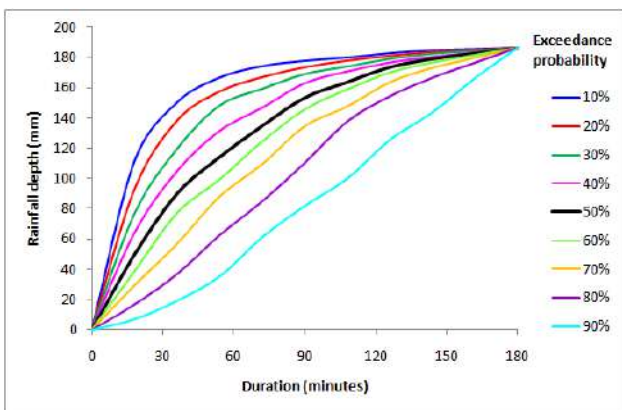

Fig. 7: Temporal distribution of precipitation for different probabilities of exceedance and 2h < duration < 3 h

According to [34] the median curve (50% probability of exceedance) is the most representative although the others allow determining the flow relationships for various types of distributions that occur in nature with each one of the four basic types of storm (quartile groups). This author suggests that the 10% and 90% curves are useful for

estimating runoff in the most extreme types of temporal distributions. However, he also claims that the median curve is the most stable curve in all quartiles compared to the 10% and 90% curves.

Fig.8 to 10 show the rainfall design hyetographs for the probability of exceedance = 50%, rain durations = 1, 2 and 3 hours. It is observed that 60% of the rain occurs in the first hour of the event. These should be used in a typical rainfall-runoff hydrologic model.
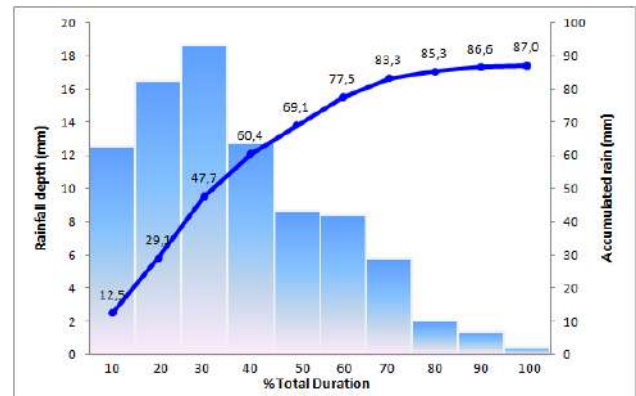

Fig. 8: Time distribution of rainfall for duration < 1 h and probability of exceedance = 50%
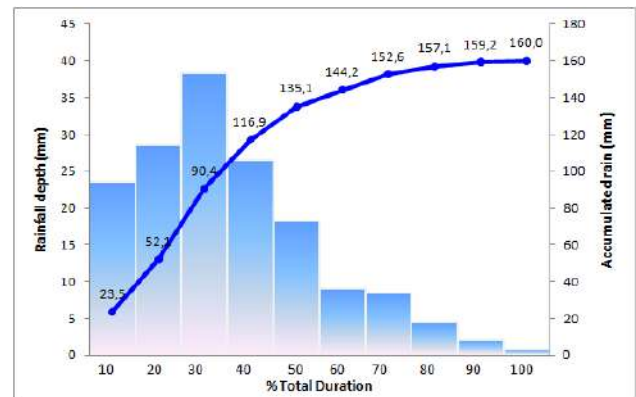

Fig. 9: Time distribution of rainfall for 1h < duration < 2 h and probability of exceedance = 50%
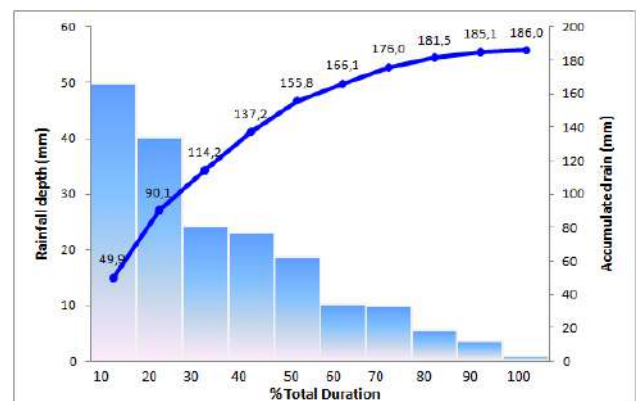

Fig. 10: Time distribution of rainfall for 2h < duration < 3 h and probability of exceedance = 50%

3.4   Spatial Analysis of January 2020 rainfalls

In order to represent the rainfall values in the entire study area, it was necessary to apply an interpolation for spatial analysis using the QGIS software. As a product ofthe interpolation map, the extraction of isohyets can be performed. The analysis showed that the Inverse of Distanceto a Power (IDP) type was the most representative, generating isohyets at 10 mm intervals.

Fig. 11 and 12 illustrate the products of the analyze were empirical evidence of the influence exerted by the relief of city on the intensity of precipitation in the interior of the region can be observed. This orographic influence on rainfall can be visualized on these figures. At the south-central part of the region, high-value isohyets conform approximately to the high elevations on the windward slope, thus reflecting the prevalent direction of humidity inflow into the area. These characteristics are expected to explain part of the spatial variability of short-duration rainfall over the region.

It can be seen in the maps in Fig. 11 that the event on the 24th was of great magnitude and covered the entire municipality, having surpassed the response capacity of the drainage and flood dampening system implemented in the city. According to the Civil Defense at 7:41 pm it was raining extremely hard in the Pampulha, Barreiro, Center-South, Northwest and East regions having accumulated in 24 hours 180.8 mm, 179.0 mm, 174.4 mm, 170.0 mm and 169.8 mm, respectively. In the Northeast, Venda Nova, and West regions, the rain was heavy, registering 159.4 mm, 154.4 mm and 151.8 mm, respectively. In the Northern region of the capital, it rained moderately, accumulating 118.8 mm. Streams overflowed, avenues were flooded and people were stranded. The Bernardo Vasconcelos Avenue in the Northeast region was flooded after the Cachoeirinha stream which cuts this avenue did not support the volume of water and overflowed. The Cristiano Machado Avenue one of the most important in the city was flooded in São Gabriel Station'.

Fig. 12 shows that the event on the 28th was also of great magnitude, being more intense mainly in the regions of Barreiro, Center-South and West. In the Center-South region, a height of 183.4 mm was recorded, corresponding to 55.7% of the expected value for the entire month of January. Rain was also critical in the Barreiro and West regions, having accumulated 136.6 mm and 103.6 mm in 24 hours. On the other hand, in the North it rained 4.2 mm and in Venda Nova it only rained 0.4 mm. Several regions of the city were flooded such as Prudente de Morais avenue in the Center-south region (Leitão stream), Tereza Cristina avenue in Barreiro region (Ferrugem stream), and West region (Arrudas stream).

IV.   CONCLUSIONS

The results obtained with the application of the methodology make it possible to validate the application of the MRBH IDF equation and the respective annual regional frequency curves for dimensionless intensities, as well as the design hyetographsforthe different precipitation duration intervals and probabilities exceedance.These studies are of technical and scientific importance, represented by the knowledge of the pluviometric regime, in view of its use in the design of hydraulic structures. If compared to the punctual studies existing in the region, developed with short historical series, their results are more reliable, because, in addition to being based on a much larger number of pluviograph posts, with more representative historical series, they were of a regional character.

The high spatial resolution of the data showed regional seasonality satisfactorily, with high rainfall in the south-southeast portion, following the high topography of the Curral mountains and reflecting the orographic influence in the intensification of precipitation events.

At the time of the 24th all monitoring points recorded rainfall with return periods of less than 100 years. On the 28th, the eventwasmoresevere, reaching periods of return ofaround 1000years; the Leitãostation recorded outliers of the time series.It is concluded that these studies can be used in planning the occupation of the flood plains of Belo Horizonte, as well as in proposing structural and non-structural measures to mitigate damage caused byextreme hydrological events suggesting, however, new assessments of the PMP - maximum probable short-term precipitation for the RMBH, in view of the event recorded mainly in the Leitão stream.

The results observed in the present work can be used as a reference for site suitability analysis of watersheds infrastructure. The parameters can be integrated with other hydrological information in GIS domain for decision making regarding water conservation structures by local government authorities related to water management projects.
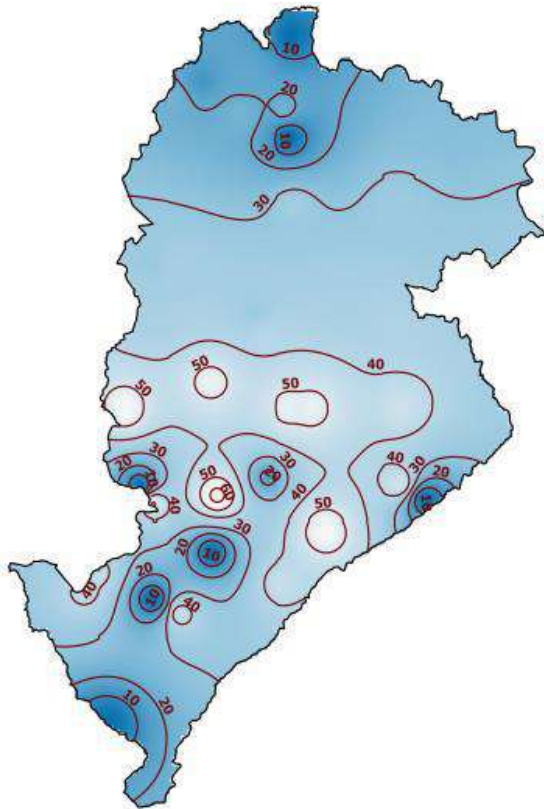
(a) Duration = 1 hour
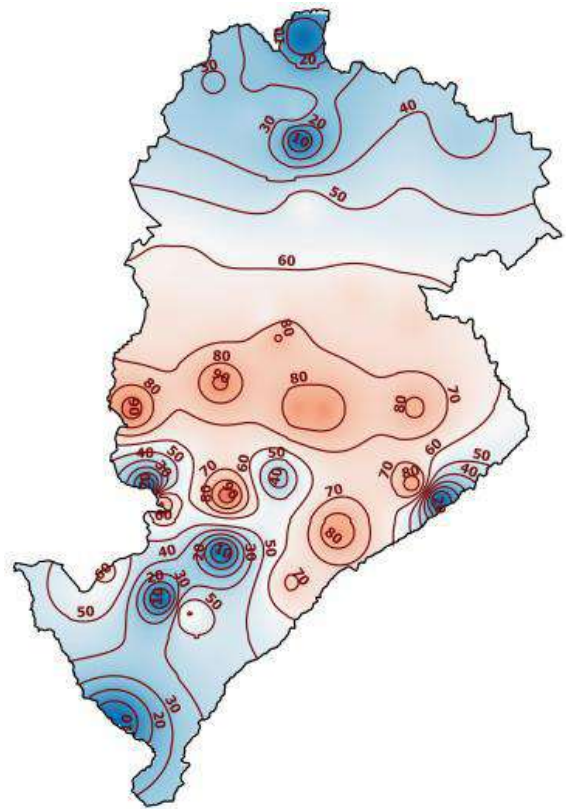
(b) Duration= 2 hours
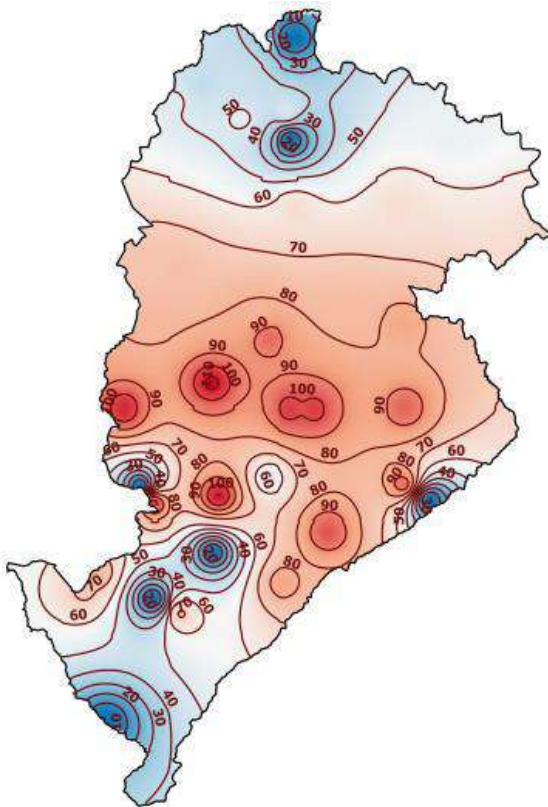
(c) Duration= 3 hours

Fig. 11: Maps of isohyets of precipitations in 24 January 2020.

(a) Duration = 1 hour

(b) Duration = 2 hours

(c) Duration = 3 hours

Fig. 12: Maps of isohyets of precipitations in 28 January 2020.

V.   ACKNOWLEDGEMENTS

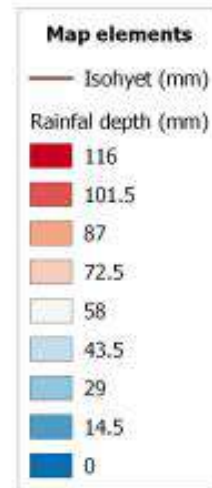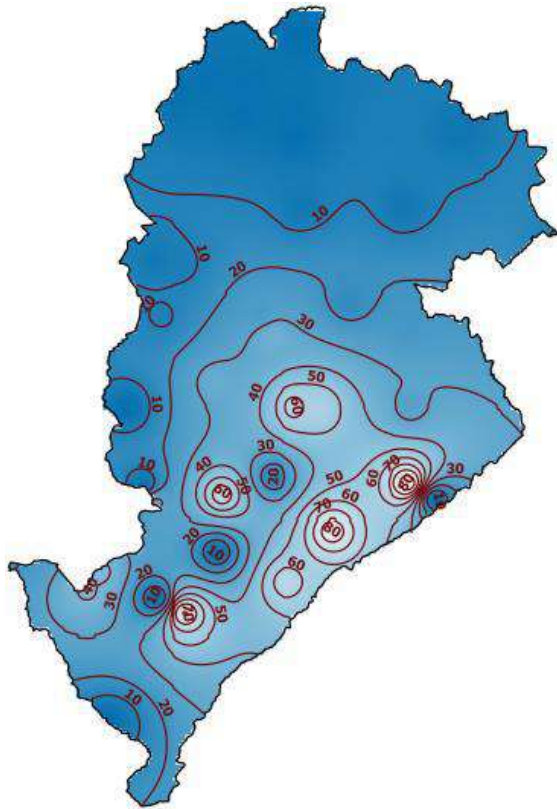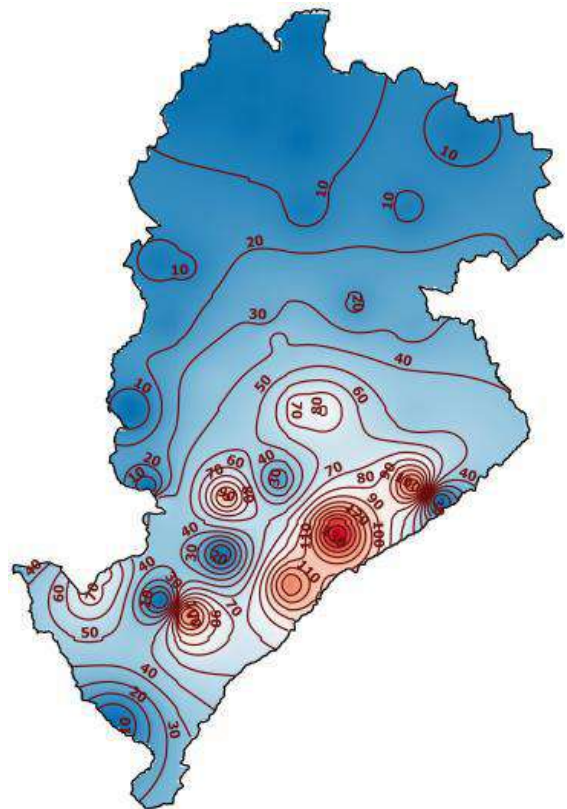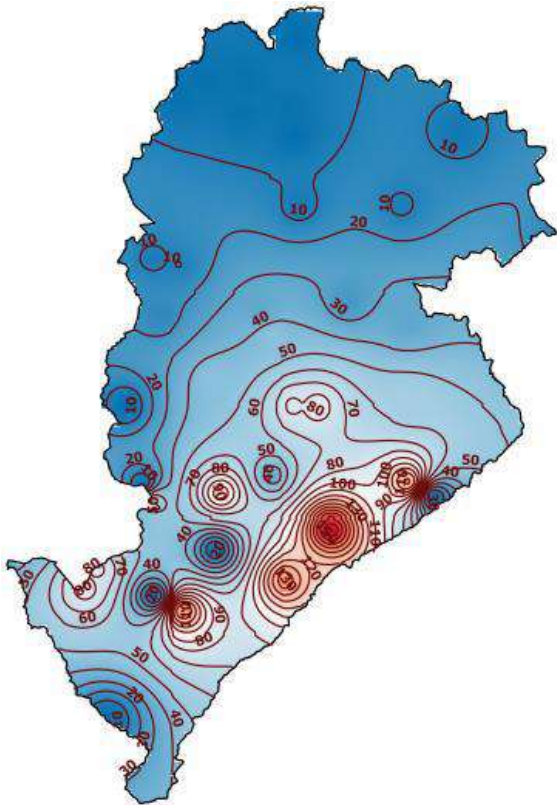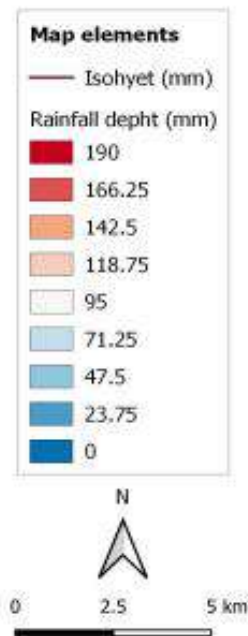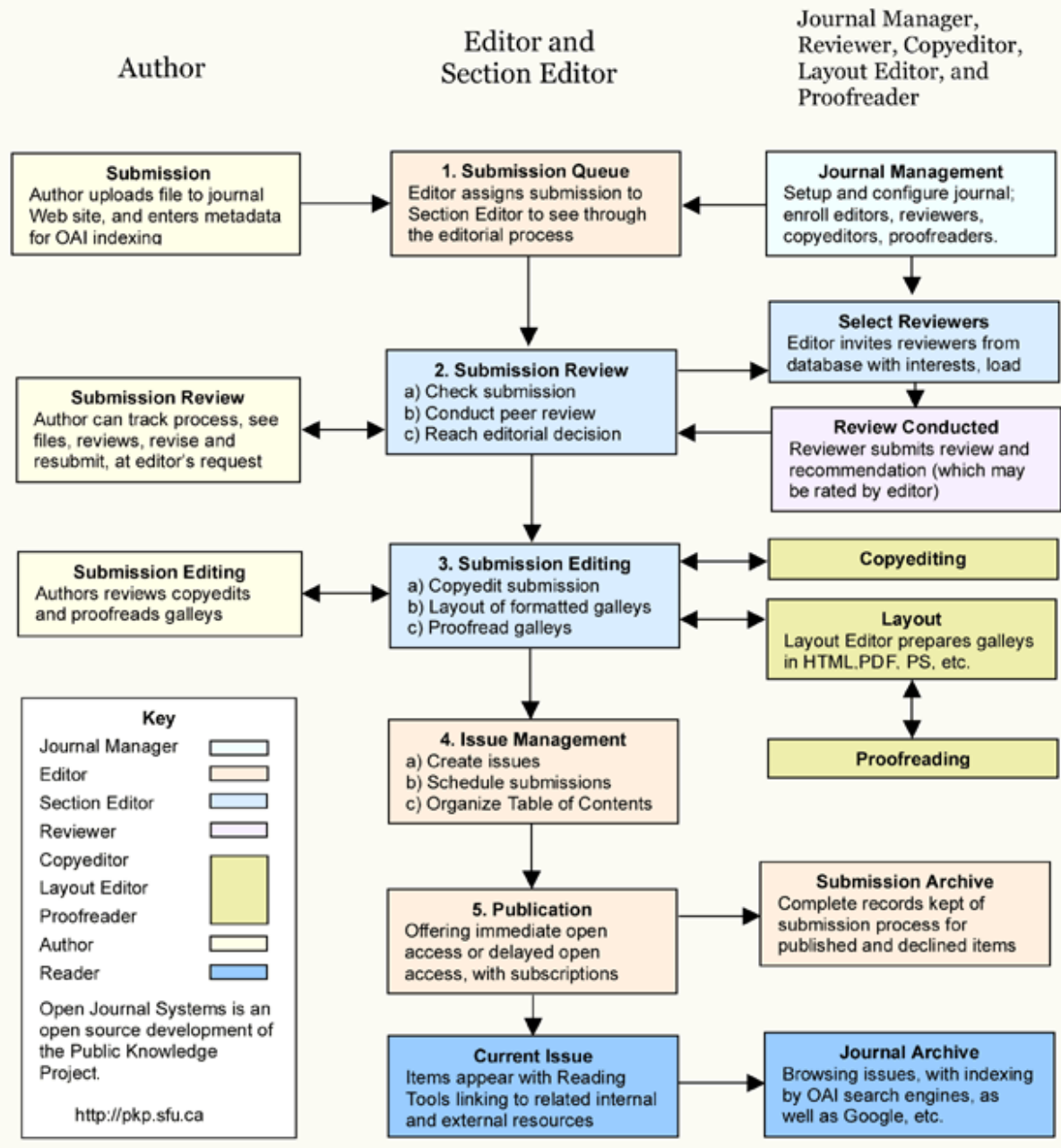For providing the data for this study the author wishes to thank the Brazilian National Water and Sanitation Agency (ANA), the Belo Horizonte City Hall – Superintendence of the Development of Belo Horizonte (PBH-SUDECAP-DGAU), the National Center for Monitoring and Natural Disaster Alerts (CEMADEN) and the National Institute of Meteorology (INMET).

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